# COASTLAND
# INTERNATIONAL ORTHOPAEDIC JOURNAL

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# COASTLAND INTERNATIONAL ORTHOPAEDIC JOURNAL

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*Advancing Knowledge, Shaping Orthopaedic Practice*


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The Coastland International Orthopedic Journal (CIOJ) is committed to advancing knowledge, innovation, and clinical excellence in orthopaedics and traumatology. As the official publication of the Cochin Orthopedic Society, CIOJ serves as a platform for high-quality research, evidence-based practice, and academic exchange, with a vision to improve musculoskeletal health regionally and globally.


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## Editor's Message

It gives me immense pleasure to welcome you to the Coastland International Orthopaedic Journal (CIOJ), the official academic publication of the Cochin Orthopaedic Society.

I sincerely thank the President, Secretary and the Executive Committee members of the Cochin Orthopaedic Society for their vision, encouragement, and unwavering support in initiating this journal. Starting a scientific journal is never easy, and this step reflects the collective academic maturity, commitment, and forward-thinking approach of our society. I congratulate the entire team on taking this important milestone in strengthening our academic footprint.

CIOJ is conceived with a clear objective—to maintain high international standards of scientific publishing while providing a robust platform for quality clinical research, original articles, reviews, technical notes, and case-based learning. With a strong editorial board and a transparent peer-review process, we are confident that the journal will achieve good indexing and global visibility in a short span of time.

I warmly invite clinicians, young surgeons, postgraduate students, and researchers to submit their original work and become active contributors to this growing scientific forum. Sharing good clinical work and innovative ideas is essential not only for individual academic growth but also for advancing orthopaedic care globally.

Together, let us build CIOJ into a respected international journal that reflects the clinical excellence and academic strength of our orthopaedic community.

**Dr Sujit Jos**
Editor-in-Chief
Coastland International Orthopaedic Journal

# Massive heterotopic ossification excision and total hip arthroplasty in a below knee amputee with malunited acetabulum and protrusio : A case report

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**Abstract :** A 28-year-old man, who had previously undergone open reduction and internal fixation (ORIF) of the right acetabulum and a below-knee amputation after a high-velocity motor vehicle accident, presented with a stiff hip and inability to independently don his prosthesis. Imaging revealed massive heterotopic ossification (HO) with both intra- and extra-articular ankylosis of the right hip. He underwent single-stage HO excision and conversion total hip arthroplasty (cTHA), with excellent clinical and radiographic outcomes at 1-year follow-up

**Conclusion:** Conversion THA in the setting of massive HO and acetabular malunion is technically demanding and requires meticulous preoperative planning. Advances such as three-dimensional (3D) modelling can aid in safe HO excision, neurovascular protection, and precise implant positioning, ultimately leading to excellent functional recovery. Keywords: Heterotopic Ossification, Ankylosis, Total hip arthroplasty, 3D print

## INTRODUCTION

Conversion total hip arthroplasty (cTHA) following acetabular fracture fixation is among the most challenging reconstructive procedures in orthopaedics[1]. The presence of heterotopic ossification (HO) further complicates exposure and component placement. HO is a recognized complication after acetabular surgery[2], with severity commonly described using the Brooker classification, which also correlates with function and outcomes[3].

Excision of HO is the treatment of choice for extra-articular ankylosis, but preoperative planning is difficult, particularly in massive mature HO associated with intra-articular ankylosis. Computed tomography (CT) is the gold standard for mapping HO, and the use of 3D-printed pelvic models offers a valuable tool to simulate safe dissection planes and plan reconstruction[4].

We present a rare case of combined intra- and extra-articular hip ankylosis due to massive HO in a young man with acetabular malunion and ipsilateral below-knee amputation, managed successfully with single-stage HO excision and cTHA using 3D-printed model–based planning.

**Case :**

A 28-year-old man presented with chronic low back pain and inability to bend for prosthesis application. Three years earlier, he sustained a high-energy motor vehicle accident resulting in a right acetabular fracture and ipsilateral lower limb crush injury. He was treated elsewhere with staged ORIF of the pelvis and acetabulum and a right below-knee amputation.

On examination his right hip had a well-healed scar and was fused in 5° flexion and 15° abduction with no movement in any plane. Laboratory markers (ESR – 28 mm/hr, CRP – 4 mg/L, ALP – 65 U/L) were normal .

Radiographs demonstrated malunited anterior and posterior columns with retained implants, medial acetabular migration, and massive mature HO bridging the acetabulum and proximal femur (Brooker grade IV) Fig 1.


Figure 1: Pre – operative anteroposterior (AP) radiograph of the pelvis with a ball marker for templating showing right sided massive HO of Brooker grade 4 with implants in right SI joint, right acetabulum and symphysis and protrusio

CT scan showed mal united fracture of both columns, heterotopic mass extending superior, anterior and posterior to the right proximal femur causing extra articular ankylosis(Fig 2 a).

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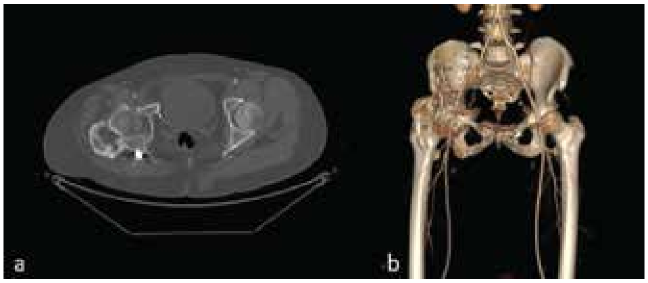


Figure 2 : a) A Cross section of axial CT scan showing both extra articular and intra articular ankylosis b) CT angiography superimposed images showing the external iliac vessels traversing over the HO without any encasement

There also was intra articular ankylosis with trabeculae crossing the hip joint posteriorly fusing with the acetabulum. There was severe protrusio with intact medial wall. CT angiography superimposed images revealed the external iliac vessels closely abutting but not encased by the HO.

Given his age, we initially considered salvage of the joint. But with severe intra-articular fusion and acetabular deformity, joint salvage was not possible. Hence, we were left with HO excision along with hip arthroplasty. We debated whether to do this in 2 stage with HO excision initially and total hip arthroplasty at a later stage. 3D printed model of the pelvis was obtained in view of complexity of the case(Fig 3). With 3D print in hand , we felt that we could do both these procedures together with an osteotomy through the ossific mass along with neck of femur. Our next worry was how to protect the neurovascular bundle which was in close proximity to neck and HO mass anteriorly. 3D printing was helpful here, as we felt we could run a finger down the anterior neck.


Figure 3: 3D print model showing massive HO (a) bridging the greater trochanter and superior acetabulum and intra articular ankylosis of the femoral head and acetabulum and (b)the posterior aspect of right hip with a narrow canal beneath the HO bridge

**Operative Technique**

We approached the hip posteriorly with gluteus max release. Deeper dissection revealed gluteus minimus that was completely osssified. The gluteus medius was identified which was thinned out and was retracted anteriorly(Fig 4 i) . Short external rotators were tagged and incised.

Figure 4: i)Intra operative picture showing the hip through posterior approach with the gluteus medius (A), which is thinned out, retracted anteriorly and the HO mass superior (B) and posterior location (C) ii)Intra operative pictures of excised HO mass that was usedas graft

As planned with 3D printing, we placed three K-wires on the tip of greater trochanter and the level of osteotomy marked and proceeded. We could book open the entire HO mass and femur anteriorly. With a finger running down the anterior part of HO protecting the neurovascular bundle, careful piecemeal resection of HO was performed. The highly vascular HO was kept aside and used as graft for subsequent medial wall reconstruction of acetabulum(Fig 4 ii). Distal femoral traction pin with 5 mm Steinman pin was used to lever the limb for manipulation because of short below knee stump. Reaming into the femoral head was done gradually till foveal fat was identified. A screw tip was seen protruding on the acetabular floor which was left as such and covered with graft. We used the excised bone to build up the protrusio by reverse reaming. Sequential reaming was done to size 54. Femur canal was then prepared and sized. An uncemented total hip arthroplasty was performed with size 54 Gription multihole cup fixed with 2 screws , 36 mm XLPE insert, Ceramic 36 mm femoral head and size 2 Accolade 2 stem. Combined anteversion of 40 degrees was achieved and the hip was found to be stable . Meticulous excision of contused muscle and proper soft tissue handling was ensured throughout the surgery. Capsule and short external rotators were repaired. Drain was placed and fascia lata was repaired. Wound was closed in layers.

**Postoperative Course**

Radiographs demonstrated satisfactory medial wall reconstruction, restored offset, and removal of impinging HO(Fig 5).

Figure 5: Pre operative clinical picture of the patient donning his prosthesis needing assistance as he cannot flex his hip due to ankylosis.b)Post operative clinical picture of the patient donning his prosthesis independently

The patient commenced weight-bearing on postoperative day 1. HO prophylaxis with indomethacin 25 mg thrice daily was prescribed for 6 weeks. At 6 weeks, he was independently mobile and able to don his prosthesis unaided(Fig 6).

Figure 6: Post operative plain radiographs of pelvis (AP)showing functional excision of HO with good implantpositioning and COR restoration

At 1 year, he remained pain-free, returned to motorcycling, and radiographs revealed minimal (Brooker grade1) recurrence of HO.

## DISCUSSION

This case highlights the unique challenges of conversion THA in the setting of massive HO, intra- and extra-articular ankylosis, and ipsilateral below-knee amputation. Traditional strategies often recommend staged excision and arthroplasty. However, by employing 3D modelling technology, it was possible to clearly define the anatomical relationships between heterotopic bone and vital neurovascular structures, as well as to identify interfering implants encased within the ossified mass. The model also provided critical guidance in mapping osteotomy and excision planes, which helped to minimize blood loss and avoid unnecessary soft-tissue trauma. Previous studies emphasize CT as the gold standard for HO mapping, but reports of 3D printing–assisted planning in this scenario remain scarce. Our case demonstrates that 3D simulation can reduce operative risk and optimize functional outcomes.

## CONCLUSION

Single-stage HO excision and conversion THA, can be a safe and effective solution in young patients with complex post-traumatic ankylosis. Preoperative 3D modelling[5] allows precise planning, protects vital structures, and ensures successful functional recovery.

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## ETHICAL CONSIDERATIONS

Informed consent was obtained from the patient regarding taking his pictures and discussion of the case for academic purposes. Patient data was anonymized to protect confidentiality and our institute ethical committee clearance obtained.

## AUTHORSHIP AND CONTRIBUTION:

Dr.Bipin Theruvil performed the surgery, Dr Varsha drafted the manuscript and Dr. Pooja collected the data.

# A rare case of chronic cauda equina syndrome secondary to high-grade dysplastic spondylolisthesis In a young adult : A case report

Madhavan. M[1], Krishnakumar. R[2], Dr. Arunagiri. S[3]

## INTRODUCTION

Cauda equina syndrome (CES) is a serious neurological condition occurring due to compression or injury to cauda equina. It cause motor, sensory and autonomic dysfunction like saddle anesthesia,1bowel, bladder incontinence and lower limb weakness. The causes are disc herniation, spinal stenosis, trauma, neoplasm and spondylolisthesis.

Spondylolisthesis is forward slippage of a vertebra relative to the one below it. Dysplastic spondylolisthesis is a developmental subtype, due to congenital anomalies of the lumbosacral junction like hypoplasia of facets, domed sacrum,and dysplasia of parsinterarticularis. 2High-grade-Meyerdinggrade III,IV & V, the deformity can cause biomechanical stress, sagittal imbalance, and predisposition to neurological compromise. High-gradedysplastic spondylolisthesis is uncommon. History include progression of slip, increasing deformity, and secondary structural changes that increase the risk of neural element compression. Many patients present with back pain, radicular symptoms, postural changes, and difficulty walking[3].

As chronic compression of the nerve roots in CES can lead to irreversible damage, early recognition, imaging, and surgical decompression are essential to optimize outcomes. Among young adults, with high-grade dysplastic deformity, slow progression may mask the severity until major symptoms appear. The present case shows an unusual presentation of chronic CES secondary to high-grade dysplastic spondylolisthesis in a young adult, showing diagnostic and therapeutic challenges.

A 21-year-old female presented with a 2-year history of chronic low back pain, which was continuous in nature and radiated to both lower limb, more on the left side. The pain was associated with bilateral lower limb numbness, paresthesia and weakness, leading to progressive difficulty in walking. She also reported neurogenic claudication, with perineal and perianal region saddle anesthesis.

There was a history of urinary incontinence and recurrent urinary tract infections for the past 2 years, suggestive of autonomic involvement. The patient complained of constipation, indicating chronic sacral nerve root compromise.

The patient had lumbar spine tenderness localized over the L4 and L5 vertebral levels. Lumbar spine range of motion (ROM) is painful on flexion and extension. Neurological examination showed positive Lasegue's test at 40° on the right and 30° on left. Motor examination (5/5) in L1, L2, and L3 myotome bilaterally, with reduced power (4/5) in the L4, L5, and S1 myotome on both sides. Sensory examination showed normal sensation in the L1, L2, and L3 dermatomes, reduced sensation on the left at L4, and reduced sensation bilaterally at L5 and S1 S2 S3 S4 S5. Reflex examination showed diminished knee and ankle reflexes and plantar was mute on both side. MRI of lumbar spine with whole spine screening showed anterior listhesis of L5 over S1,central disc bulge,hypertrophy of the facet joints and ligamentum flavum caused severe central canal stenosis, lateral recess narrowing, compression of cauda equina roots, and severe bilateral foraminal stenosis with impingement of the exiting L4 nerve roots bilaterally (Figure1).

Figure 1: MRI-Lumbar Spine Axial and Sagittal

Post-void residual urine volume is 232 cc on ultrasonography. Diagnosis was high dysplastic spondylolisthesis of L5 over S1, Meyerding Grade III, SDSG – Type 5 balance spine retroverted pelvics based on pelvic incidence 70o pelvic tilt 38osacral slope 32o (Figure 2).

The high dysplastic according to the severity index.The patient was counseled on the need for immediate surgical decompression and lumbosacral stabilization to stop neurological deterioration. The recovery of bladder and bowel function was explained to be guarded due to the chronicity of symptoms. After getting informed and written consent the patient underwent posterior decompression and spondylolisthesis reduction with stabilization from L4 to S1, along with bilateral posterolateral fusion at L4-L5-S1 and

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posterior interbody fusion at L5-S1 under general anesthe-

Figure 2: X RAY Lumbar Spine-Lateral and Spino-Pelvic Parameters

This zone was identified using a standing lateral radiograph of the lumbar spine that also captures the hips.On radiograph, square area is demarcated by drawing a horizontal line through the center of the S2 vertebral body. The boundaries of the line segment are determined by two vertical reference lines: one is the gravity line, which runs vertically through the midpoint of the inferior endplate of L5, and the other represents the ground reaction force, passing vertically through the center of the femoral head (Figure 3).

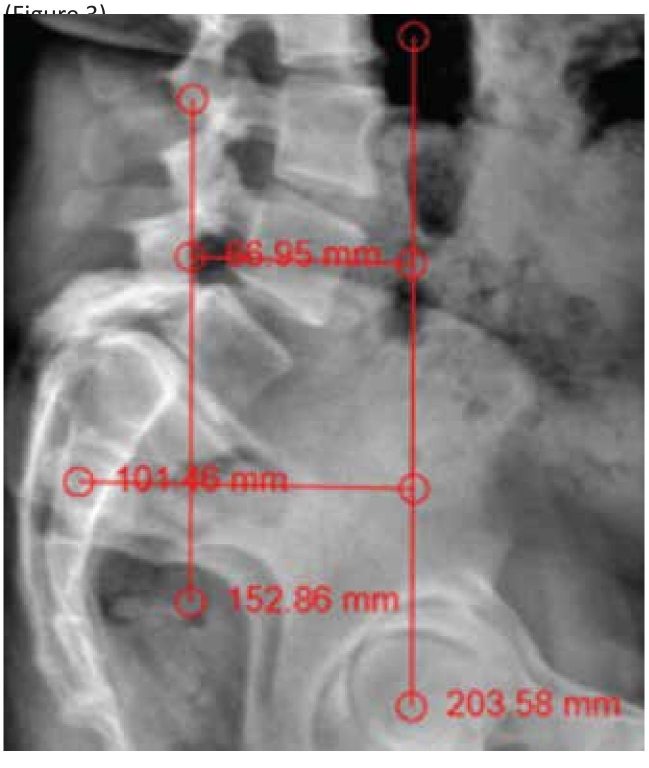


Figure 3: X RAY Lumbar Spine-Severity index

**DISCUSSION**

High-grade dysplastic spondylolisthesis is a rare but important cause of spinal instability and neurological compromise, usually at lumbosacral junction. Dysplastic morphology like domed sacrum, abnormal facets, and elongation of neural arch structures predisposes to severe vertebral slip, canal compromise, and nerve root compression.[5] When the slip progresses to Grade IV or spondyloptosis, cauda equina compression can occur. This causes sensory, motor, and autonomic dysfunction. Chronicity of compression is main determinant of prognosis. Long-standing neural compromise reduces chance of full recovery, particularly of bladder and bowel function.

Surgical strategies are: in situ fusion, partial reduction, or complete reduction with circumferential fusion. Reduction with fusion is associated with better restoration of spinopelvic balance and long-term outcomes, but it carries the risk of neurological injury due to nerve stretch. Complete reduction and circumferential fusion in children and adolescents helps to achieve substantial deformity correction and high fusion rates with improvement in functional outcomes. But autonomic recovery is unpredictable[7].

Surgical planning was done in the current study, as per the model described by Lamartina. That model provides practical tool for preoperative planning and supports the surgical decision to extend fixation above the L5–S1 segment.[8] post op lumbosacral kyphosis improved (Figure 4).

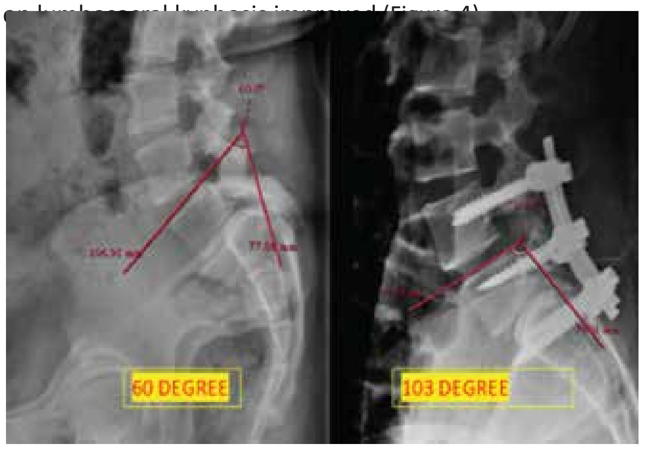


Figure 4: Lumbo-Sacral kyphosis-Preop and Post OP

The literature also showed that long-standing cases, as in this patient with a two-year history of symptoms, have guarded prognosis for sphincter recovery. Pain relief, motor improvement, and functional ambulation are achievable after decompression and stabilization with pedicle screw, connecting rod and autologous bone graft (Figure 5)[9].

9 Case reports and prospective studies showed that urinary and bowel dysfunction may improve gradually after

surgery, but complete recovery is not always possible. So, Surgical decompression and stabilization are standard of care to prevent further deterioration, but chronicity of symptoms must be taken into account when counseling patients regarding outcomes.

Figure 5 : Post op X ray Lateral and CT Lumbar spine Sagittal

Emary PC.[10] Case reports of high-grade spondylolisthesis have been rarely published in the chiropractic literature. Documented here is a case involving a 28-year-old woman who presented to the World Spine Care clinic in the Dominican Republic with minimal neuromusculoskeletal symptoms despite a grade 4 spondylolytic spondylolisthesis. The key imaging and etiological features of this clinical disorder are presented.

## CONCLUSION

Chronic cauda equina syndrome secondary to high-grade dysplastic spondylolisthesis in young adults is an uncommon. Early recognition and timely surgical management are important prevent irreversible sequelae, as delayed presentation limits the chance of full neurological recovery. This case proves the importance of more clinical suspicion, comprehensive neurological evaluation, and multidisciplinary intervention in young patients presenting with persistent low back pain and progressive neurological symptoms

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# Developmental dysplasia of the hip: current concepts in early detection and management

Joyance James M S(Ortho)[1]

## INTRODUCTION

Congenital dislocation of the hip has been known at least since antiquity, but much of the work in understanding and treating it has been in the post-Roentgenographic era. Congenital dislocation of hip is now referred to as developmental dysplasia of the hip (DDH), since it is a huge spectrum, ranging from asymptomatic mild acetabular dysplasia to frank dislocated hips[1-2]. The incidence of DDH varies according to time and population studied, but globally the approximated incidence is 1 to 10 per 1000 live births. Since it is a spectrum of conditions with long lasting effects, early diagnosis and appropriate treatment is of utmost importance for a healthy childhood. Early treatment can possibly prevent invasive procedures and assuring a healthy, concentric hip joint for the future. Many nations have neonatal hip screening programs; these can help in early detection and early treatment[3]. Developing nations where institutional births are not a norm, still see many dysplastic hips being missed and presenting late in the walking age group.

### Natural History

Hip instability as assessed by Barlow and Ortolani tests are common in the first few months of life, more so in girls. Spontaneous improvement is seen in up to 90% infants who had initial instability[4]. This occurs because of gradual decrease in the maternal relaxin hormone in the infant blood and the improvement in the muscle tone. Persistent untreated dysplastic hip leads to altered hip biomechanics owing to decreased joint congruency. The link between early hip arthritis and untreated dysplasia of acetabulum is well established[5-6]. Unilateral dislocated hips when untreated, will develop limb length discrepancy, gait abnormalities, genu valgum and other sequelae. Bilateral dislocated hips may present with waddling gait, exaggeration of the lordosis and back pain.

### Clinical Features

The diagnosis of DDH in early infancy is mainly clinical. The two classic maneuvers widely used are: Barlow test, which assesses if a hip can be dislocated and the Ortolani test, which assesses if the dislocated hip can be reduced7. Barlow test is done in supine position with hips at 90˚ flexion and posterior axial pressure to dislocate the hip, Ortolani test involves gentle abduction and anterior lifting of femur, to reduce the dislocated hip joint. Other important clinical features include reduced hip abduction, asymmetrical thigh and gluteal folds. There would be apparent limb discrepancy, in case of dislocated hips (Galeazzi sign).

When there is a delay in diagnosis or a neglect and the child presents after infancy in the walking age-group. There will be a Trendelenburg gait, because the dislocated and high riding femoral head will cause abductor weakness. The limb length discrepancy will be more marked. Children with bilateral dislocation may present with excessive lumbar lordosis due to hip flexion contractures and symmetrical restricted hip abduction.

### Imaging

Ultrasonography (USG) of hip is the most commonly employed diagnostic method in early infancy since most of the acetabulum and femoral head is cartilaginous. Although there are various methods of quantifying the acetabular dysplasia, most commonly used is the one described by Graf[8]. The timing of USG screening has been debated based on whether a universal or a selective USG screening protocol is followed, however delaying USG screening by 4-6 weeks seems most pertinent, since most of the hip instability at birth resolves by 4 weeks[9]. The Graf method employes measurement of two angles: alpha angle or acetabular roof angle which is measured between the ilium and osseous acetabular wall, elaborated in Fig 1, should be > 60˚, and the beta angle, between ilium and the labral cartilage, which should be < 50˚. Dynamic USG (Harcke's method) can assess stability of the hip under stress maneuvers. USG is also used to evaluate the effectiveness of harness treatment.

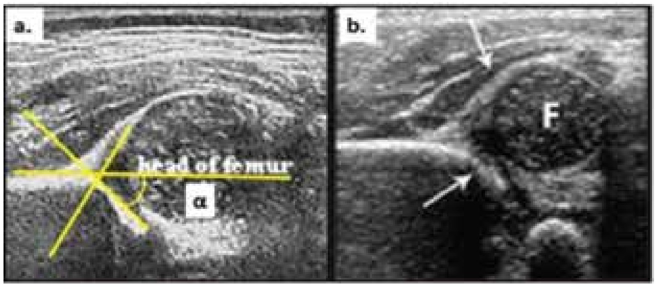


Figure 1: USG of hip, (a) shows a normal hip with the angle between central ilial line and acetabular roof, alpha angle of > 60. Angle between the central ilial line and labrum is beta

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angle, (b) shows a femoral head with is subluxated and a dysplastic acetabulum with reduced alpha angle.

Since, universal USG screening carries high risk of high false positives, American Academy of Paediatrics (AAP) recommends selective screening for infants with high risk[10]. Risk factors predisposing to dysplasia of hip are: positive family history, first born, girl child, multiple gestation, breech presentation, oligohydramnios[11].

Plain radiographs are rarely used in the neonatal period or for routine early screening since the cartilaginous acetabulum and unossified femoral head will not be appreciated on the X-rays. However, it the stand imaging method used after 6 months. Commonly, done views are the antero-posterior (AP) view of pelvis with both hips (both patellae facing forwards), frog leg lateral view and rarely the Von Rosen view. The radiographic lines are described in Fig 2.

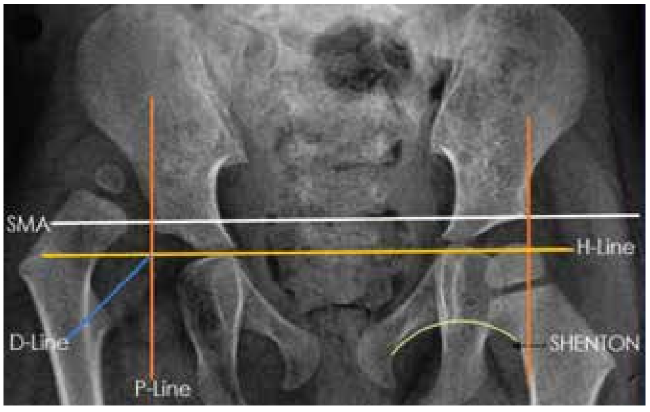


Figure 2: Pelvis with both hips antero-posterior view showing x-ray. H-line is the Hilgenreiner's line drawn from the outer margin of the acetabulum. P-line is the Perkin's line passes through the triradiate cartilage. SMA is the superior margin of acetabulum line which joins both lateral acetabular sourcils. D-line is the diagonal line from the intersection of H and P lines at 45˚. Shenton line is drawn from the inferior neck surface to the superior margin of obturator foramen.

Two important classification systems are based on the antero-posterior radiograph of pelvis with both hips. The Tonnis classification takes the reference of the center of femoral head ossific nucleus and its relation to the radiographic lines to quantify the disease[12]. Another recent classification system is by the International Hip Dysplasia Institute (IHDI) which takes the center of the proximal femoral metaphysis (H-point) as the reference point[13-14]. Hence, this classification can be used even before the ossific nucleus is visible on the radiographs, the classification is explained in Figure 3.

**Management**

The aim of treatment of DDH is to obtain and maintain a concentric reduction of the femoral head inside the acetabulum. This will allow normal development of the hip joint as the normal forces act across the hip once the child walks. For infants younger than 6 months, bracing remains the standard of care[15]. Braces can broadly be categorized as dynamic – allowing some active hip movements or static braces which are rigid and don't allow active movements. Pavlik Harness is the commonly used one for infants less than 6 months. It has shown a success rate of > 90 %[16]. Failure rates are higher with greater risk of AVN when the treatment is initiated after 4-6 months, the ideal time for treatment is before 6 weeks[17]. The duration of bracing is typically around 6-8 weeks with periodic USG monitoring to see the improvement in USG parameters.

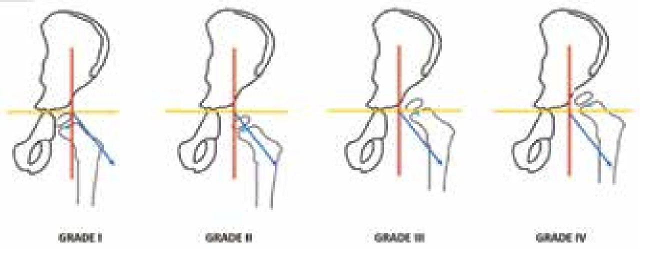


Figure 3: IHDI classification of DDH. Yellow line - H (Hilgenreiner) line, red line - P (Perkin) line, blue line—D (Diagonal) line, blue dots at the centre of metaphysis – H point.

If the USG parameters on bracing don't show an improvement or if there is persistent subluxation or instability beyond 6 months then attempt of close reduction, confirmation of concentric reduction with arthrography, followed by hip spica casting should be done. Percutaneous adductor tenotomy facilitates the close reduction. Post reduction spica immobilization is usually with hips flexed at 90 degrees with controlled abduction. Medial open reduction is usually enough is infants in case close reduction fails.

Children above 12 months may need antero-lateral open reduction along with either femoral osteotomy or acetabular osteotomy or both. In high riding dislocations, femoral shortening will facilitate reduction of the femoral head, derotation can help in re-orienting the femoral head in cases with dysplastic acetabulum[18]. Usually in children less than 18 months, a concentric reduction with open reduction without a pelvic osteotomy is enough due to the remodeling potential. The role of initial concomitant pelvic osteotomy for children in the 18 months – 4 years age group requiring is debated, many surgeons opting to address the acetabular dysplasia during the open reduction. In older children or those with persistent dysplasia after initial reduction of the hip will require pelvic osteotomy since the remodeling potential is limited[19]. However, in children above 4 years most surgeon routinely perform pelvic osteotomy since the remodeling potential is unpredictable after that age. An overview of treatment according to age is given in Table 1.

| Age of Child | Preferred Treatment |
|---|---|
| Up to 6 months | Pavlik Harness |
| 6–12 months | Close Reduction or Medial open reduction |
| 12–24 months | Close Reduction or anterolateral open reduction |
| 2 years –8 years | Anterolateral open reduction of hip +/ femoral osteotomy +/pelvic osteotomy |

Table 1: Preferred treatment according to age.

The role of pelvic osteotomy is to resolve the acetabular dysplasia and improve femoral head coverage. Various pelvic osteotomies have been described in the literature. The choice of pelvic osteotomy depends on the age of the patient, type of dysplasia, shape of acetabulum and the status of triradiate cartilage[19-20]. These can be broadly be classified as re-shaping osteotomies or re-directional osteotomies. Reshaping osteotomies are incomplete innominate osteotomies which are inherently stable like Dega osteotomy, Pemberton pericapsular osteotomy (among the most popular), Fig 4. Re-directional osteotomies, Fig 5 are complete osteotomies which alter acetabular orientation without changing the size or shape of the acetabulum like Salter innominate osteotomy, triple pelvic osteotomy and Bernese periacetabular osteotomy.

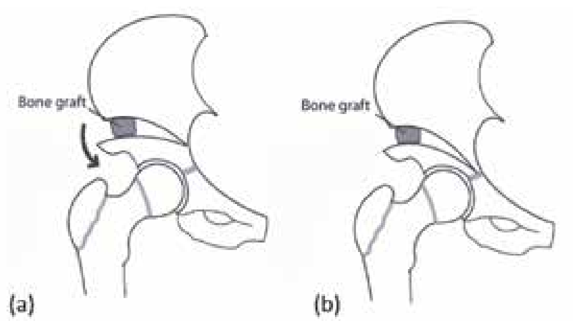


Figure 4: Reshaping acetabular osteotomies, (a) Dega acetabuloplasty, (b) Pemberton acetabuloplasty

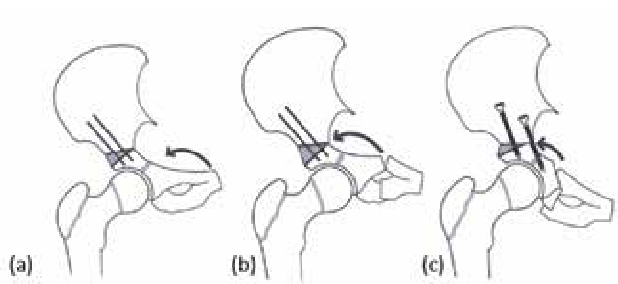


Figure 5: Redirecting osteotomies, (a) Salter innominate osteotomy, (b) triple pelvic osteotomy, (c) Periacetabular osteotomy.

**CONCLUSION**

A thorough clinical examination is of utmost importance in early diagnosis of DDH. Use of USG either as universal or selective screening has reduced the incidence of late presenting DDH. Since, the costs of surgical intervention is much greater than that of conservative management with bracing, hence, early referral and selective USG screening of high-risk children is essential, especially in developing countries[21]. Post treatment radiological follow-up is essential to pick up persistent acetabular dysplasia and avascular necrosis of femoral head. The choice of pelvic osteotomies is influenced by multiple factors and should be treated promptly to reduce risk of early degenerative changes in the hip.

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# Novel approaches beyond fusion in lumbar degenerative disease

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**Abstract-**Background: Degenerative lumbar spine disease management has evolved beyond decompression and fusion to include minimally invasive endoscopic surgery, motion-preserving technologies, intradiscal biologics, annular repair, and vertebrogenic denervation, aligned to specific pain generators.

**Objective:** To synthesize 2020–2025 evidence on contemporary options beyond fusion and present a mechanism-based patient selection algorithm for Indian orthopaedic practitioners.

Methods: A targeted narrative review examined minimally invasive/endoscopic decompression, lateral/oblique interbody fusion with navigation/robotics, motion preservation (TDR), intradiscal biologics including nucleus pulposus allograft, annular closure devices, basivertebral nerve ablation, and adjacent segment disease (ASD) prevention strategies.

**Results:** Endoscopic discectomy matches microdiscectomy outcomes with faster recovery; LLIF/OLIF restore height and lordosis via muscle-sparing corridors; navigation/robotics enhance accuracy and efficiency; TDR preserves motion with durable mid-term outcomes in selected single-level disease; nucleus pulposus allograft provides sustained benefits in early–moderate discogenic pain; annular closure reduces reherniation in large-defect scenarios; basivertebral nerve ablation offers durable relief for vertebrogenic pain; and alignment-centric constructs mitigate ASD risk.

**Conclusions:** Mechanism-based, least-invasive effective algorithms can optimize outcomes and reduce morbidity in degenerative lumbar disease. Long-term comparative effectiveness, refined selection tools, cost-effectiveness analyses, and technology accessibility remain priorities for broader adoption in Indian practice settings.

Keywords: Degenerative lumbar spine disease, minimally invasive spine surgery, motion preservation, endoscopic discectomy, intradiscal biologics, basivertebral nerve ablation, India

## INTRODUCTION

Degenerative lumbar spine disease is a major cause of disability in India, affecting working-age populations and placing substantial burden on healthcare systems and productivity. The condition encompasses disc degeneration, facet arthropathy, stenosis, and spondylolisthesis, with pain phenotypes that include radiculopathy, discogenic pain, and vertebrogenic pain mechanisms.

Historically, surgical treatment centered on decompression and fusion, which, while effective, is associated with muscle injury, motion loss, prolonged recovery, and risk of adjacent segment degeneration affecting 15–30% of patients within 5–10 years. Over the past five years, international evidence has matured for minimally invasive endoscopic decompression, lateral and oblique interbody fusion with navigation or robotics, motion-preserving total disc replacement (TDR), intradiscal biologics including nucleus pulposus allograft, annular closure devices, and basivertebral nerve ablation, offering a portfolio of mechanism-aligned alternatives suitable for Indian surgical practice where feasible.

This review synthesizes contemporary evidence (2020–2025) to equip Indian orthopaedic surgeons with knowledge of evidence-based options beyond fusion, recognizing regional resource constraints, patient preferences, and clinical contexts in India.

## Methods

A narrative review was conducted of peer-reviewed literature and clinical guidance published 2020–2025 across endoscopic decompression, lateral/oblique interbody fusion with navigation/robotics, TDR, intradiscal biologics and nucleus pulposus allograft, annular closure, basivertebral nerve ablation, and ASD prevention. Priority was given to systematic reviews, randomized controlled trials (RCTs), prospective cohorts, and contemporary clinical guidance from major international societies and centers relevant to degenerative lumbar disease and feasible implementation in Indian healthcare environments. Representative sources included Spine, Journal of Bone & Joint Surgery, Asian Spine Journal, Brain & Spine, Neurospine, and institutional clinical resources, with all

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citations from 2020 onward to reflect current devices, techniques, selection criteria, and outcomes.

## RESULTS

### Minimally Invasive and Endoscopic Decompression

Transforaminal endoscopic lumbar discectomy (TELD) has become increasingly popular in Asia, achieving pain and functional outcomes comparable to microdiscectomy with significant advantages in perioperative morbidity, shorter hospitalization (1–2 days vs. 2–3 days), and faster return to work in appropriately selected contained herniations. Contemporary case series from Asian centers and multinational reviews confirm that endoscopic approaches are safe and effective in experienced hands, with a recognizable learning curve of approximately 50–100 cases. Indian centers with trained endoscopic programs can benefit from reduced tissue trauma, blood loss, and length of stay while maintaining outcomes comparable to open microdiscectomy, making this a viable option where expertise exists.

### Lateral and Oblique Interbody Approaches with Navigation/Robotics

Oblique lateral interbody fusion (OLIF) and lateral lumbar interbody fusion (LLIF) have gained traction globally for restoring disc height and segmental lordosis through retroperitoneal corridors that avoid posterior muscle dissection, reducing approach-related morbidity. Comparative series show that OLIF and ALIF achieve similar decompression and alignment correction, with OLIF particularly attractive for single-position workflows when combined with percutaneous pedicle screw fixation. Navigation-guided and robot-assisted single-position prone LLIF further enhance accuracy, reduce intraoperative radiation exposure, and improve operative efficiency in multilevel constructs—advantages that can benefit Indian centers aiming to optimize safety and efficiency in complex degenerative cases.

### Motion Preservation: Lumbar Total Disc Replacement

Modern lumbar total disc replacement produces sustained reductions in pain and disability with preservation of index-level motion, with systematic reviews and mid-term cohorts demonstrating superiority or non-inferiority compared with fusion in appropriately selected single-level degenerative disc disease with intact facets and no significant deformity. While TDR adoption in India has been gradual due to cost and regulatory considerations, available evidence supports its role for active patients with single-level DDD and preserved facets, where insurance or patient resources permit. North American and European coverage recommendations have refined indications and contraindications, which can inform Indian practice guidelines as technology becomes more accessible.

Intradiscal Biologics and Nucleus Pulposus Allograft

Intradiscal strategies including mesenchymal stromal cells (MSCs), platelet-rich plasma (PRP), and nucleus pulposus allograft represent a paradigm shift toward biologic and regenerative approaches for early–moderate discogenic pain. Nucleus pulposus allograft (VIA Disc NP) offers a cell-free, off-the-shelf option with prospective and real-world data showing sustained 24-month improvements in pain and function, with generalizability across Pfirrmann grades and Modic strata. For Indian practitioners, such cell-free biologics may offer a more accessible pathway to regenerative treatment compared with cellular products, pending regulatory approvals and cost considerations.

### Annular Closure After Discectomy

A pivotal randomized trial and subsequent meta-analysis demonstrated that bone-anchored annular closure devices significantly reduce symptomatic reherniation and reoperation through five years in patients with large annular defects (>6 mm) after discectomy, with preserved disc height. This approach directly addresses a high-risk recurrence scenario and can be incorporated into Indian surgical practice when intraoperative defect size and disc height criteria are met, offering an elegant prevention strategy that avoids revision surgery.

### Basivertebral Nerve Ablation for Vertebrogenic Pain

Basivertebral nerve ablation (Intracept procedure) has emerged as a validated option for chronic axial low back pain with Modic type 1 or 2 endplate changes, demonstrating durable improvements in pain and disability through five years across RCTs and pooled analyses. This implant-free, minimally invasive denervation technique preserves future surgical options and represents an important addition to the therapeutic armamentarium for patients with refractory vertebrogenic pain who have exhausted conservative management. Regulatory approval and technology access in India will determine feasibility for Indian patients.

### Adjacent Segment Disease Prevention

Recent guidance emphasizes limiting fusion length, restoring pelvic incidence–lumbar lordosis (PI–LL) congruence, optimizing bone health and metabolic parameters, and strategically using motion preservation to mitigate adjacent segment degeneration burden. These principles are universally applicable and should be incorporated into surgical planning for all degenerative lumbar cases, regardless of the primary intervention chosen.

## DISCUSSION

The 2020–2025 evidence base supports a broadened, mechanism-based approach to degenerative lumbar disease that extends well beyond decompression and fusion. For Indian orthopaedic surgeons, adopting a selective, evidence-informed portfolio aligned to pain generators and structural pathology—endoscopic decompression for radiculopathy, intradiscal options for discogenic pain, basivertebral ablation for vertebrogenic pain, and MIS fusion or motion preservation for instability or deformity—can optimize outcomes while reducing morbidity and recovery time.

Key challenges in implementing these advances in Indian practice include:

1. Technology and training availability: Endoscopic decompression, navigation/robotics, and some biologics require specialized equipment and training that may not be accessible in all Indian centers.
2. Cost and accessibility: Motion-preserving devices, advanced biologics, and navigation systems carry significant costs that may limit access for many Indian patients; however, cost-effective alternatives and phased adoption pathways warrant exploration.
3. Regulatory frameworks: Some advanced biologics and devices require regulatory approvals in India; practitioners should stay updated on device clearances and permissible applications.
4. Evidence gaps: Long-term head-to-head comparisons of novel techniques in Indian populations, health-economic analyses, and locally derived selection algorithms remain priorities to guide guideline development and coverage decisions.

### Clinical Algorithm for Indian Practice

Step 1: Identify the dominant pain generator through history, examination, MRI (disc pathology, facet status, canal/foramen anatomy, Modic changes), and standing alignment (PI–LL).

Step 2: For contained soft herniation radiculopathy without instability → Endoscopic TELD where expertise available; otherwise, standard microdiscectomy.

Step 3: For spinal stenosis without instability after failed conservative care → Targeted decompression; consider interspinous device in extension-predominant symptoms if suitable anatomy.

Step 4: For axial discogenic pain with preserved disc height/containment → Explore intradiscal biologic or nucleus pulposus allograft options when available.

Step 5: For vertebrogenic pain (Modic 1/2) refractory to conservative care → Basivertebral nerve ablation when regulatory approval and technology access permit.

Step 6: For single-level DDD with intact facets and no deformity in active patients → Consider TDR if cost and insurance permit; otherwise, MIS TLIF/PLIF.

Step 7: For instability, deformity, or multilevel disease → MIS LLIF/OLIF/TLIF with percutaneous fixation using navigation where available to optimize alignment and accuracy.

Step 8: Across all cases, prioritize restoring PI–LL alignment, limit fusion length, and use motion preservation where appropriate to mitigate ASD burden.

## CONCLUSIONS

Degenerative lumbar spine disease in India can be managed using mechanism-based, least-invasive-effective strategies that extend well beyond decompression and fusion. Endoscopic decompression, intradiscal biologics, motion preservation, annular closure, and vertebrogenic ablation offer evidence-supported alternatives with varying feasibility and accessibility across Indian centers.

Priorities for advancing Indian spine surgery include:

1. Building capacity and training in minimally invasive endoscopic and navigation-guided techniques.
2. Developing health-economic models to support cost-effective adoption and insurance coverage of advanced technologies.
3. Establishing local guidelines and algorithms adapted to Indian practice contexts, patient populations, and healthcare systems.
4. Strengthening research and registries to generate locally relevant evidence on outcomes, safety, and cost-effectiveness.
5. Facilitating regulatory approvals for promising biologics and devices to expand options for Indian patients.

By integrating contemporary evidence with pragmatic adaptation to Indian healthcare environments, spine surgeons can optimize patient outcomes while reducing morbidity and recovery burden in this growing patient population.

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**Conflict of Interest**
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# Outcomes of arthroscopic meniscal repair in athletes : a five-year single- center experience comparing isolated repairs and combined acl reconstructions

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**Abstract-**Objective: To evaluate and compare the clinical outcomes, return to sport (RTS) rates, and failure rates of isolated meniscal repair (IMR) versus meniscal repair with concomitant anterior cruciate ligament reconstruction (ACLR+MR) in an athletic population treated at a single center.

**Methods:** A retrospective review was conducted on all athletes who underwent primary arthroscopic meniscal repair from January 2019 to December 2023. Patients were stratified into IMR and ACLR+MR cohorts. Data collected included tear characteristics, repair technique, and rehabilitation protocol. Outcomes were assessed using pre- and postoperative Lysholm Knee Scores and Tegner Activity Scales, RTS rates and timelines, and documented complications, including clinical failure defined as the need for reoperation on the ipsilateral meniscus.

**Results:** A total of 135 athletes (98 male, 37 females; mean age 24.2 years) were included, with 58 in the IMR cohort and 77 in the ACLR+MR cohort. At a mean follow-up of 3.1 years, both groups demonstrated significant improvements in Lysholm scores (IMR: 61.5 to 90.8; ACLR+MR: 59.2 to 89.9; p<0.001 for both). The overall RTS rate was 88.1%. The IMR cohort had a significantly shorter mean time to RTS (5.9 months) compared to the ACLR+MR cohort (9.7 months) (p<0.001). The clinical failure rate was significantly higher in the IMR group (20.7%) compared to the ACLR+MR group (11.7%) (p=0.045).

**Conclusion:** Arthroscopic meniscal repair is an effective procedure for athletes, facilitating a high rate of return to sport with excellent functional outcomes. Concomitant ACL reconstruction is associated with a lower meniscal repair failure rate but a significantly prolonged recovery timeline. These findings highlight a clinical trade-off between biological healing potential and the duration of functional recovery, which is critical for patient counseling and managing expectations.

Keywords: Meniscus, meniscal repair, athlete, acl reconstruction, return to sports

## INTRODUCTION

The menisci are C-shaped, fibrocartilaginous structures that are vital to the health and function of the knee joint.[1] Once considered vestigial remnants, they are now understood to be critical biomechanical components that increase femorotibial congruity, provide secondary joint stability, and, most importantly, serve as the primary shock absorbers and load distributors.[3] The menisci transmit over 50% of the tibiofemoral axial load in extension and up to 85% in flexion.[4] Consequently, the loss of meniscal tissue, even from a partial meniscectomy, dramatically decreases the contact area and increases peak contact stresses by up to 350%, creating a joint environment that is highly susceptible to accelerated articular cartilage degeneration and the premature onset of osteoarthritis.[4]

This understanding has driven a paradigm shift in the management of meniscal tears, particularly in young, active patients. The historical approach of meniscectomy has been largely replaced by a philosophy of meniscal preservation, with surgical repair now considered the standard of care for reparable lesions.[8] The primary goal of meniscal repair is to restore the native anatomy and function, thereby protecting the long-term health of the joint.[4]

The success of a meniscal repair is contingent upon a confluence of biological and mechanical factors. The most critical biological determinant is vascularity. The meniscus receives its blood supply from the perimeniscal capillary plexus, which penetrates only the peripheral 10-30% of the tissue.[1] This vascular gradient creates distinct healing zones: the peripheral "red-red" zone with excellent healing potential, the transitional "red-white" zone with moderate potential, and the avascular central "white-white" zone with poor intrinsic healing capacity.[14] Mechanically, the tear pattern is paramount. The meniscal architecture is dominated by circumferentially oriented type I collagen fibers, which are exquisitely designed to convert compressive axial loads into circumferential "hoop"

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stresses.[4] The twisting and compressive forces common in athletic activities often cause these fibers to split along their length, resulting in longitudinal-vertical or bucket-handle tears.[8] These patterns are the most amenable to repair because surgical approximation can effectively restore the tissue's ability to withstand hoop stresses, which is the very foundation of its load-bearing function.

A crucial factor influencing the biological environment of the knee is the presence of a concomitant ligamentous injury. Meniscal repair performed in conjunction with an anterior cruciate ligament reconstruction (ACLR) has been shown to have a higher success rate than isolated repairs.[11] The prevailing theory is that the drilling of femoral and tibial tunnels during ACLR releases bone marrow-derived mesenchymal stem cells, platelets, and growth factors into the joint, creating a "biologically augmented" milieu that enhances the meniscal healing response.[11] However, this biological advantage introduces a clinical paradox. The rehabilitation following ACLR is necessarily more conservative and prolonged to protect the ligament graft, often involving an extended period of restricted weight-bearing and motion.[19] Thus, the knee with the superior biological environment for healing is simultaneously subjected to a slower and more cautious functional recovery.

The purpose of this study is to retrospectively analyze the outcomes of arthroscopic meniscal repair in athletes treated at our institution from 2019 to 2023. The primary objective is to compare the functional results, return to sport rates and timelines, and clinical failure rates between two distinct cohorts: athletes undergoing isolated meniscal repair (IMR) and those undergoing meniscal repair combined with ACL reconstruction (ACLR+MR).

## Materials and Methods

### Study Design and Patient Selection

A retrospective cohort study was performed at a single tertiary care sports medicine center. We defined athlete as self-reported athletes participating in competitive or high-level recreational sports, defined as a pre-injury Tegner activity level of 6 or higher. The institutional review board approved the study. A surgical database was queried to identify all patients who underwent arthroscopic meniscal repair between January 1, 2019, and December 31, 2023. Inclusion criteria were: (1) athletes participating in competitive or high-level recreational sports, defined as a pre-injury Tegner activity level of 6 or higher; (2) primary arthroscopic meniscal repair; and (3) a minimum of two years of clinical follow-up. Patients were excluded if they had undergone revision meniscal surgery, had multi-ligament injuries (other than the ACL), required concomitant cartilage restoration procedures for full-thickness chondral defects (Outerbridge grade III-IV), or had degenerative meniscal tears in the setting of significant pre-existing osteoarthritis. Eligible patients were stratified into two cohorts for comparative analysis: the isolated meniscal repair (IMR) group and the meniscal repair with concomitant ACL reconstruction (ACLR+MR) group.

### Surgical Protocol

All procedures were performed by fellowship-trained sports medicine surgeons. Standard anterolateral and anteromedial arthroscopic portals were utilized. A comprehensive diagnostic arthroscopy was performed to confirm and characterize the meniscal tear.

### Tear Evaluation and Preparation

Tear patterns were classified intraoperatively according to the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) system as longitudinal-vertical, bucket-handle, radial, or complex.[14] The decision to repair was based on tear location (within the vascular red-red or red-white zones), tear length (>1 cm), tissue quality, and the ability to achieve a stable, anatomic reduction.[14] Prior to repair, the tear margins were debrided with a motorized shaver or arthroscopic rasp to expose a fresh, bleeding surface and stimulate a healing response. In select cases, synovial abrasion or microfracture of the intercondylar notch was performed to further promote bleeding.[22]

### Repair Techniques

The choice of surgical repair technique was dictated by the location and morphology of the tear.

- **All-Inside Repair:** This was the most frequently used technique, particularly for tears of the posterior horn and posterior body. It was performed using modern, all-suture-based anchor devices (FiberStich, Smith & Nephew; FastFix 360, Smith & Nephew), allowing for a completely arthroscopic procedure with no accessory incisions.[23]
- **Inside-Out Repair:** Considered the gold standard for its robust fixation, this technique was primarily used for tears located in the meniscal body. It involved passing sutures from within the joint through the meniscus and capsule using zone-specific cannulas. The sutures were then retrieved through a small posteromedial or posterolateral accessory incision and tied over the joint capsule, ensuring protection of the saphenous and common peroneal nerves, respectively.[22]
- **Outside-In Repair:** This technique was reserved for tears of the anterior horn, where portal access for other techniques can be challenging. It involved passing a spinal needle from outside the joint, across the tear, and into the articular space. A suture was then shuttled through the needle and retrieved arthroscopically, with the final knot tied over the anterior capsule.[22]

**Postoperative Rehabilitation Protocols**

Two distinct, criteria-based rehabilitation protocols were implemented based on the surgical procedure performed. The Rehabilitation protocols were similar for both the groups, but the protocol for Meniscal repair with ACL Reconstruction group was more conservative (See Appendix 1)

**Outcome Assessment**

Clinical outcomes were assessed using data collected preoperatively and at the final follow-up visit (minimum 2 years).

**Patient-Reported Outcome Measures (PROMs):** The Lysholm Knee Score and the Tegner Activity Scale were administered. The Lysholm score is an 8-item questionnaire assessing symptoms and function on a scale of 0-100, where a score >94 is considered excellent, 84-94 is good, 65-83 is fair, and <65 is poor.[37] The Tegner scale is a 0-10 scale that quantifies a patient's highest level of physical activity, with level 10 representing participation in elite competitive sports.[37]

**Return to Sport (RTS):** RTS was defined as the patient's ability to participate in their primary sport at their pre-injury level of competition for at least one full season. The rate of RTS and the time from surgery to RTS were recorded.

**Complications and Failure:** All postoperative complications, including persistent pain, arthrofibrosis, and infection, were documented. Clinical failure was defined as the need for a subsequent surgical procedure on the ipsilateral meniscus (i.e., partial meniscectomy or revision repair) due to persistent or recurrent mechanical symptoms, confirmed by new imaging or diagnostic arthroscopy.[40]

## RESULTS

**Patient Demographics and Injury Characteristics**

A total of 135 athletes met the inclusion criteria. The IMR cohort consisted of 58 patients (42 male, 16 female) with a mean age of 25.1 +/- 4.5 years. The ACLR+MR cohort included 77 patients (56 male, 21 female) with a mean age of 23.5 +/- 3.9 years. There were no significant differences between the cohorts in terms of age, sex, or pre-injury Tegner activity score. The most common tear pattern in both groups was a longitudinal-vertical tear. The all-inside repair technique was the most frequently utilized method in both cohorts. Detailed demographic and tear characteristics are presented in Table 1.

**Improvement in Patient-Reported Outcome Scores**

Both cohorts demonstrated statistically significant improvements in functional scores from pre-operation to final follow-up. The mean Lysholm score for the IMR cohort improved from 61.5 ± 9.8 to 90.8 ± 7.5. The ACLR+MR cohort improved from 59.2 ± 10.4 to 89.9 ± 8.1. There was no significant difference in postoperative Lysholm scores between the two groups. These results are consistent with postoperative scores reported in the literature, which typically fall in the high 80s to low 90s, indicating good to excellent outcomes.[7] The improvements are visualized in Figure 1. Tegner activity scores showed a characteristic drop from pre-injury levels to preoperative levels, followed by a substantial recovery postoperatively. For the IMR cohort, the mean Tegner score fell from a pre-injury level of 7.2 +/- 2.4 to a preoperative level of 3.4 +/- 1.5, recovering to 6.6 at final follow-up. The ACLR+MR cohort followed a similar pattern, with scores of 7.4 +/- 1.3 (pre-injury), 3.1 +/- 1.1 (preoperative), and 6.5 +/- 2.1 (postoperative). While postoperative scores approached pre-injury levels, a complete return to the mean pre-injury Tegner score was not observed in either group, a finding consistent with previous studies.7 This pattern is depicted in Figure 2.

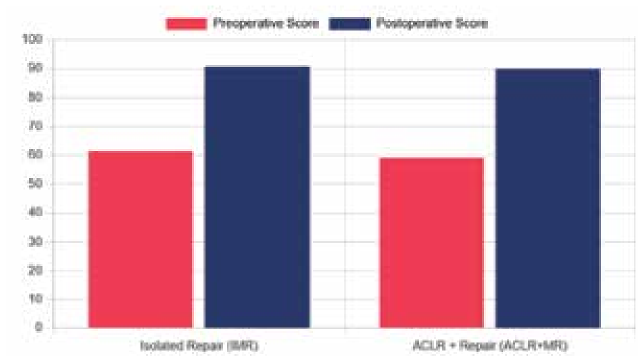


Figure 1: Pre- vs. Postoperative Lysholm Knee Scores by Cohort ( IMR cohort improved from 61.5 ± 9.8 to 90.8 ± 7.5. The ACLR+MR cohort improved from 59.2 ± 10.4 to 89.9 ± 8.1.)

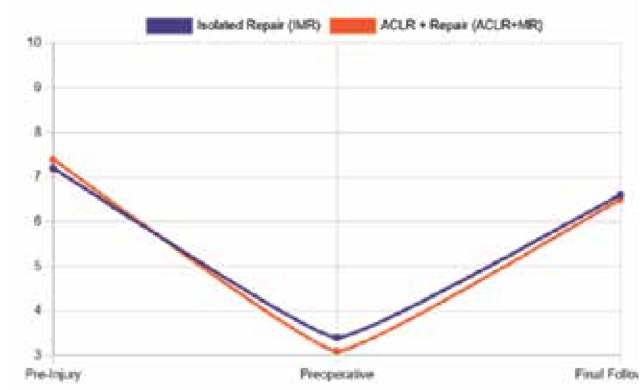


Figure 2: Pre-injury, Preoperative, and Postoperative Tegner Activity Scores (For the IMR cohort, the mean Tegner score fell from a pre-injury level of 7.2 +/- 2.4 to a preoperative level of 3.4 +/- 1.5, recovering to 6.6 at final follow-up. The ACLR+MR cohort followed a similar pattern, with scores of 7.4 +/- 1.3 (pre-injury), 3.1 +/- 1.1 (preoperative), and 6.5 +/- 2.1 (postoperative).

**Return to Sport Analysis**

The overall rate of return to any sport was 91.1%, with 88.1% of athletes returning to their pre-injury level of competition. As detailed in Table 2, the IMR cohort demonstrated a slightly higher rate of return to pre-injury level (91.4%) compared to the ACLR+MR cohort (85.7%), though this difference was not statistically significant (Figure 3). However, there was a highly significant difference in the time required to achieve RTS. Athletes in the IMR group returned to their sport at a mean of 5.9 ± 1.3 months, whereas athletes in the ACLR+MR group required a mean of 9.7 ± 2.4 months. These timelines align with established

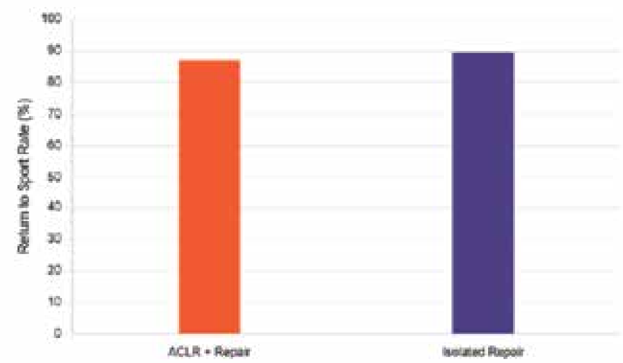


Figure 3 : Post operative return to sports (94.8 % for IMR vs 87 % for ACLR with meniscus repair)

**Complications and Repair Failures**

The overall clinical failure rate, defined as the need for reoperation, was 4.4% (6 of 135 patients). As shown in Table 3, the failure rate was significantly higher in the IMR cohort at 6.8% (4 of 58 patients) compared to 2.5% (2 of 77 patients) in the ACLR+MR cohort. The mean time to failure was 21.5 months post-index surgery. Of the 6 failures, 4 were classified as atraumatic (failure of healing), while 2 were associated with a distinct traumatic re-injury. Other significant complications were rare, with one case of arthrofibrosis requiring manipulation under anesthesia in the ACLR+MR group and one superficial wound infection in the IMR group, which resolved with oral antibiotics.

**DISCUSSION**

This single-center study confirms that arthroscopic meniscal repair is a highly effective procedure for athletes, resulting in significant improvements in knee function and facilitating a high rate of return to sport. The observed improvements in Lysholm scores and the overall RTS rate of 88.1% are consistent with systematic reviews and meta-analyses, which report good to excellent outcomes and RTS rates ranging from 80% to 95%.7 The overall clinical failure rate of 6% in our cohort falls less than the commonly reported range of 15-25% for meniscal repairs at short- to mid-term follow-up, reinforcing the durability of modern repair techniques.[40]

The central finding of this investigation is the distinct profile of outcomes when comparing isolated repairs to those performed with concomitant ACL reconstruction. The ACLR+MR cohort demonstrated a significantly lower rate of clinical failure compared to the IMR cohort. This finding lends strong clinical support to the theory of "biologic augmentation." The surgical trauma of ACLR, specifically the drilling of bone tunnels, introduces a potent cocktail of blood, marrow, and associated mesenchymal stem cells into the joint space.[11] This enriched biological environment appears to confer a protective effect, enhancing the intrinsic healing capacity of the repaired meniscal tissue and leading to a more robust and durable repair construct over time.[17]

This biological advantage, however, comes at a significant functional cost. The analysis revealed a stark contrast in recovery timelines, with athletes in the ACLR+MR group requiring nearly four additional months to return to sport compared to those in the IMR group. This substantial delay is not merely a reflection of the more complex surgery but is overwhelmingly dictated by the stringent, protective rehabilitation protocol necessary to safeguard the maturing ACL graft.19 The prolonged period of non-weight-bearing and restricted motion in the ACLR+MR protocol, while critical for graft incorporation, inevitably leads to greater quadriceps atrophy, delayed restoration of neuromuscular control, and a more protracted recovery course. This creates a clear clinical trade-off: the ACLR+MR group benefits from a superior biological healing environment, leading to a more durable repair, but at the expense of a longer, more arduous rehabilitation and a delayed return to play. This trade-off is fundamental to the preoperative counseling of athletes, who must weigh the long-term benefit of a lower failure risk against the short-term challenge of a prolonged absence from their sport.

Another noteworthy finding is the discrepancy between functional scores and activity levels. While postoperative Lysholm scores in both cohorts reached "excellent" levels, indicating that patients perceived their knees as functioning very well in daily activities, the mean postoperative Tegner scores did not fully return to pre-injury levels. This suggests a more nuanced definition of a "successful" outcome in high-level athletes. A knee can be stable, strong, and pain-free for most activities (a high Lysholm score), yet the athlete may consciously or subconsciously modify their participation in the most demanding pivoting sports (a slightly lower Tegner score). This modification may stem from a psychological fear of re-injury, a subtle loss of the explosive power or confidence required at an elite level, or a strategic decision to reduce risk to prolong a career. Therefore, success in this population is not simply a healed meniscus but a complex interplay of physical capacity, psychological readiness, and long-term activity planning.

The failures observed in this study were consistent with established risk factors. The mean time to failure of approximately 22 months aligns with evidence that the majority of failures occur within the first two years post-surgery, a critical period of tissue remodeling and increasing athletic demand.[40] While not reaching statistical

**Table 1: Patient Demographics and Tear Characteristics**

| Characteristic | Isolated Repair (IMR) | ACLR + Repair (ACLR+MR) | p-value |
|---|---|---|---|
| Number of Patients (n) | 58 | 77 | |
| Age, years (mean SD) | 25.1 / 4.5 | 23.5 / 3.9 | 0.09 |
| Sex (Male / Female) | 42 / 16 | 56 / 21 | 0.81 |
| Pre-injury Tegner Score (mean SD) | 7.2 / 1.1 | 7.4 / 1.3 | 0.43 |
| **Tear Location (n, %)** | | | |
| Medial Meniscus | 35 (60.3%) | 41 (53.2%) | 0.42 |
| Lateral Meniscus | 23 (39.7%) | 36 (46.8%) | |
| **Tear Pattern (n, %)** | | | |
| Longitudinal-Vertical | 31 (53.4%) | 45 (58.4%) | 0.58 |
| Bucket-Handle | 19 (32.8%) | 26 (33.8%) | |
| Radial | 5 (8.6%) | 4 (5.2%) | |
| Complex | 3 (5.2%) | 2 (2.6%) | |
| **Repair Technique (n, %)** | | | |
| All-Inside | 44 (75.9%) | 61 (79.2%) | 0.67 |
| Inside-Out | 11 (19.0%) | 14 (18.2%) | |
| Outside-In | 3 (5.1%) | 2 (2.6%) | |

**Table 2: Return to Sport Rates and Timelines**

| Outcome | Isolated Repair (IMR) (n=58) | ACLR + Repair (ACLR+MR) (n=77) | p-value |
|---|---|---|---|
| Returned to Sport (n, %) | 55 (94.8%) | 67 (87.0%) | 0.11 |
| Returned to Pre-injury Level (n, %) | 53 (91.4%) | 66 (85.7%) | 0.29 |
| Mean Time to RTS, months (mean SD) | 5.9 1.3 | 9.7 2.4 | < 0.001 |

**Table 3: Postoperative Complications and Failures**

| Outcome | Isolated Repair (IMR) (n=58) | ACLR + Repair (ACLR+MR) (n=77) | Overall (n=135) |
|---|---|---|---|
| **Clinical Failure (n, %) need for resurgery** | 4 | 2 | 6 (4.4%) |
| Mean Time to Failure, months | 23.1 +/- 2.7 | 19.3 +/- 3.2 | 21.5 +/-4.7 |
| *Reason for Failure* | | | |
| Atraumatic (n) | 3 | 1 | 4 |
| Traumatic Re-injury (n) | 1 | 1 | 2 |
| **Other Complications (n, %)** | | | |
| Arthrofibrosis | 0 (0%) | 1 (1.3%) | 1 (0.7%) |
| Superficial Infection | 1 (1.7%) | 0 (0%) | 1 (0.7%) |

significance in our cohort, a trend towards higher failure rates in medial versus lateral repairs has been noted in the broader literature, potentially due to the medial meniscus's reduced mobility and different biomechanical loading patterns.[2]

### Study Limitations

This study has several limitations inherent to its design. First, its retrospective nature is susceptible to selection bia and reliance on the accuracy of medical records. Second, as a single-center study, the findings may be influenced by specific surgical preferences and rehabilitation philosophies, potentially limiting their generalizability. Third, the absence of a non-operative control group or a meniscectomy comparison group precludes definitive statements on the superiority of surgical repair over other management strategies. Finally, the heterogeneity of tear patterns, specific sports played, and individual athlete characteristics introduces variables that can influence outcomes but are difficult to control for in a retrospective analysis.

### Directions for Future Research

Prospective, multicenter, randomized controlled trials are needed to further refine treatment algorithms. Future research should focus on comparing outcomes between different modern repair devices, evaluating the efficacy of biologic adjuvants in isolated repairs, and optimizing rehabilitation protocols to safely accelerate recovery without compromising the integrity of the repair.

## CONCLUSION

This five-year single-center experience demonstrates that arthroscopic meniscal repair in athletes provides excellent functional outcomes and facilitates a high rate of return to sport. Meniscal preservation should remain the primary goal for all reparable tears in this active population. When performed with a concomitant ACL reconstruction, meniscal repairs benefit from an enhanced biological healing environment, resulting in a lower clinical failure rate. However, this improved durability is associated with a significantly longer rehabilitation and a delayed return to sport. This critical trade-off between biological advantage and functional recovery time must be a central component of the shared decision-making process between surgeons and their athletic patients to ensure realistic expectations and optimize the chances for a successful, long-term outcome.

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## Appendix 1 : Rehabilitation Protocol

**A. Isolated Meniscal Repair (IMR)**

**Phase I (0–6 weeks)**

- Hinged knee brace locked in full extension for ambulation.
- Partial weight-bearing (25%) with crutches for 2 weeks → weight bearing as tolerated thereafter.
- Knee ROM limited to **0–90° flexion**.

- Goals: pain/effusion control, full passive extension, quadriceps activation (quad sets, SLRs). (28)

**Phase II (6–12 weeks)**

- Discontinue brace and crutches once normal gait achieved.
- Restore full ROM.
- Initiate closed-chain strengthening and proprioceptive training.
- **Avoid active hamstring curls** (posterior horn protection). (29)

**Phase III (3–5 months)**

- Begin graduated return-to-running program.
- Introduce sport-specific agility drills.
- Focus on neuromuscular control, power, endurance. (31)

**Phase IV (>5 months)**

- Gradual, supervised return to sport.
- Criteria: <10% strength deficit vs contralateral limb; pain-free sport-specific movements. (31)

**B. ACL Reconstruction With Meniscal Repair (ACLR+MR)**

**Phase I (0–6 weeks)**

- More conservative progression.
- Brace locked in extension for all ambulation.
- **Toe-touch weight-bearing for 4–6 weeks.**
- ROM limited to **0–90° flexion.**
- Goals: maintain quad control and achieve full passive extension. (19)

**Phase II (6–12 weeks)**

- Gradual weight-bearing progression; crutches weaned by week 8–10.
- Brace typically discontinued around week 8.
- Begin gentle closed-chain strengthening in a protected ROM. (19)

**Phase III (3–6 months)**

- Advance strengthening and proprioception work.
- Return-to-running program initiated later (around 4–5 months), depending on quadriceps strength/control. (19)

**Phase IV (>6–9 months)**

- Begin plyometrics, cutting, and pivoting drills.
- Return to sport considered at **9–12 months**, depending on successful functional sports assessment. (35)

**Appendix 2**

PROMs : Patient reported Outcome Measures

IMR : Isolated Meniscal Repair

ACLR + MR : ACL Reconstruction with meniscal Repair

# A challenging case of recurring multiple intraosseous bone hemangioma in young female with a long term 10 year follow-up

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**Abstract -** Background: Intraosseous hemangioma is a rare benign vascular tumor, accounting for less than 1% of all bone tumors. Although it commonly affects the vertebrae and skull, long-bone or rib involvement is distinctly uncommon, and multifocal recurrence is exceedingly rare.
**Case Presentation:** We report the case of a young female with recurrent multifocal intraosseous hemangiomas initially involving the right 9th rib, followed years later by progressive lesions of the right proximal femur, glenoid bone, and iliac bone. The patient underwent interventions including bone excision, biopsy, dynamic hip screw fixation, and iliac–fibular strut bone grafting. Despite benign histopathology, the lesions demonstrated aggressive radiologic progression over a decade of follow-up.
**Conclusion:** This case highlights the diagnostic and therapeutic challenges of multifocal recurrent intraosseous hemangiomas. Long-term surveillance using multimodal imaging is essential for timely detection of recurrence or dissemination, and a multidisciplinary approach is imperative in managing structurally threatening lesions.

## INTRODUCTION

Intraosseous hemangioma is an uncommon benign vascular tumor arising from blood vessels within the bone. It represents less than 1% of all osseous neoplasms. While vertebrae and craniofacial bones are the most frequently affected sites, involvement of the appendicular skeleton is rare. The natural history is variable, ranging from incidental findings to symptomatic, expansile, or destructive lesions. Multifocal lesions or disseminated involvement remain exceedingly unusual and pose significant diagnostic and therapeutic dilemmas.

We present a rare case of a young female with recurrent, multifocal intraosseous hemangiomas affecting multiple skeletal sites over a span of ten years, emphasizing the importance of vigilant long-term follow-up.

### Case Presentation

A young 23 year old female first presented in 2015 with complaints of right-sided chest pain and swelling. A thorough clinico-radiological evaluation was done and general surgeon consultation sought. Imaging revealed an expansile lytic lesion of the right 9th rib (Fig 1).

Other long bone x-ray evaluation was done and found nabnormalities. We planned for excision biopsy of 9th rib and patient underwent surgical excision (Fig 2).

Histopathological examination confirmed a benign intraosseous hemangioma(Fig 3). Post-operative recovery was uneventful. 6 monthly followed by yearly radiological follow-up was being done till pre-covid period. Patient lost to follow-up during 2020-2022 Covid-19 period.

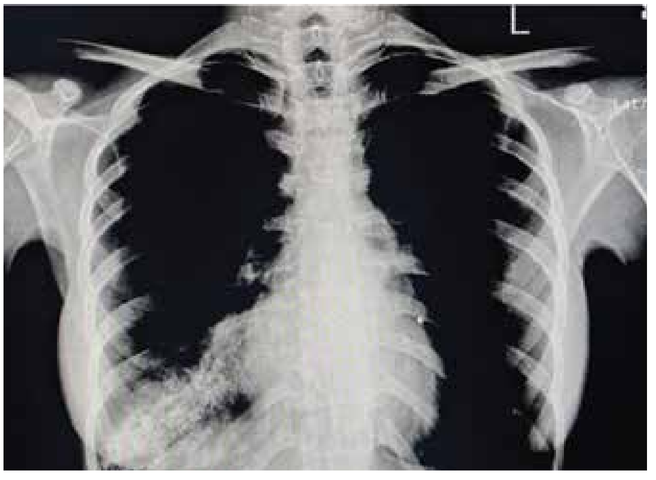

Figure 1- a: Expansile lytic lesion x-ray of 9th right rib lesion with cortical thinning

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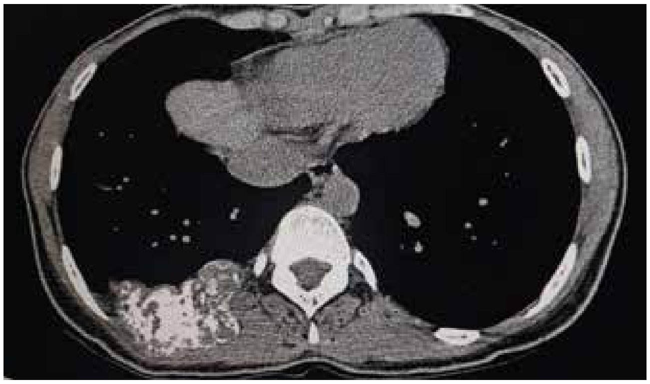

Figure 1: b) Axial CT-cut showing expansile 9th right rib lesion


Figure 2: 4 year follow-up x-ray excision biopsy of 9th right rib

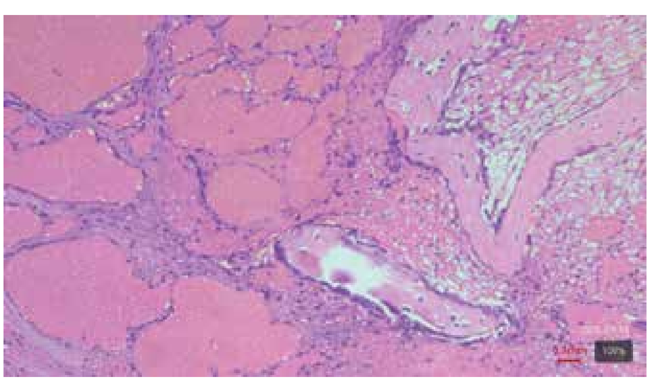

Figure 3 : a) Excision biopsy 9th right rib showing benign vascular channels lined by flattened endothelial cells with no atypia or malignant transformation. B) Biopsy from right proximal femur bone

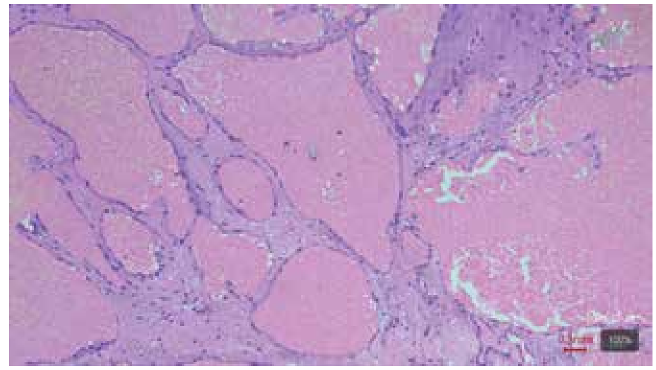

Figure 3:b): Biopsy from right proximal femur bone

In 2022, the patient presented with progressive pain and restricted range of motion of the right hip following minor trauma. She was re-evaluated clinically and imaging was done. Radiographs (Fig 4 ) and MRI (Fig 5) revealed an expansile lytic lesion of the right proximal femur consistent with intraosseous hemangioma. Due to risk of pathological fracture we planned for fixation of right proximal femur. She underwent right proximal femoral bone excision biopsy and dynamic hip screw fixation with iliac–fibular strut bone grafting (Fig 6). Post-operative period was uneventful. Started partial weight bearing after 45 days followed by full weight bearing by 90 days. Very good radiological incorporation of graft noted and fixation was stable radiologically (Fig 7). Histopathology report suggestive of benign bone hemangiomatous tissue without any features of malignancy (Fig 8).


Figure 4 : X-ray showing lytic lesion of right proximal femur

Subsequent follow-up imaging from 2023 to 2025 showed continued multifocal progression. A rapidly enlarging lytic lesion was identified in the right glenoid bone found to regress in follow-up x-ray (Fig 9). An additional lytic foci appeared in the right iliac bone in latest follow-up of 2025 ( Fig 10) when she presented with complaints of mild pain from right groin. Despite the aggressive radiologic appearance, repeat biopsy demonstrated benign hemangiomatous tissue without features of malignancy, hence we did not plan for any intervention.

The patient is kept in long-term surveillance, with stable postoperative hip fixation and no current functional impairment.

## Investigations

**Radiographic Findings**

- **2015**: Expansile lytic lesion of right 9th rib with cortical thinning (Fig 1).
- **2022**: Lytic right proximal femur lesion with risk of pathological fracture (Fig 4).
- **2023–2025**:
  - o Rapidly progressive right glenoid bone lesion regressing in follow-up (Fig 9).
  - o Lytic foci in the right iliac bone (Fig 10).
  - o Postoperative consolidation of proximal femoral graft (Fig 7).

## MRI

MRI of the proximal femur showed characteristic high-flow vascular channels consistent with intraosseous hemangioma (Fig 5).

Figure 5: MRI right proximal femur suggestive of characteristic high-flow vascular channels consistent withintraosseous hemangioma.

## Histopathology

Biopsies demonstrated benign vascular channels lined by flattened endothelial cells with no atypia or malignant transformation. Despite the benign appearance, radiological progression persisted (Fig 8).

## Intervention

The patient underwent **right proximal femur bone excision biopsy, dynamic hip screw fixation, and iliac–fibular strut bone grafting** to prevent structural collapse and improve mechanical stability (Fig 6). Post-operative imaging confirmed adequate consolidation over 3 year follow-up period (Fig 10).

Figure 6: Immediate post-op x-ray Right proximal femoral bone excision biopsy and dynamic hip screw fixation with iliac–fibular strut bone grafting

Figure 7: Follow-up x-ray showing graft incorporation and stable fixation of hip

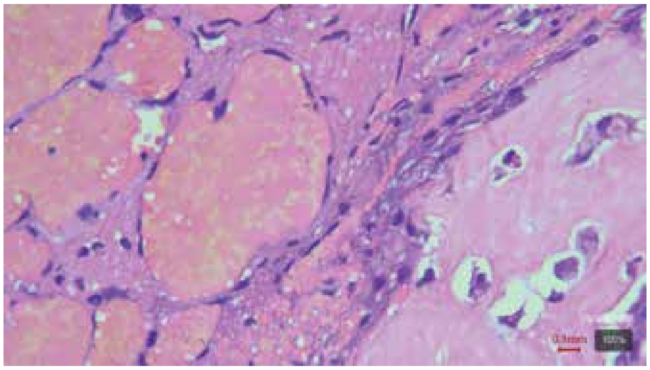

Figure 8: Histopathology suggestive of benign bone hemangiomatous tissue without features of malignancy

**Outcome and Follow-Up**

The patient has been followed over a 1**0-year period** with serial clinical examinations and multimodal imaging. While the proximal femoral reconstruction remains stable, new lesions have continued to appear in the glenoid and iliac bones. At the latest follow-up, the patient remains pain-free with a very-good functional mobility.


Figure 9: X-ray right shoulder i)Suggestive of enlarging lytic lesion right glenoid bone ii)Regression of glenoid bone lesion on follow-up x-ray


Figure 10: Latest follow-up x-ray showing i) Stable right proximal femur fixation with radiological union.
ii) Additional lytic foci in the right iliac bone.

**DISCUSSION**

Intraosseous hemangiomas are rare, and multifocal recurrence involving long bones, pelvis, and ribs is even more uncommon. Although histopathology typically confirms benign behavior, radiological progression—sometimes aggressive—may mimic malignant tumors such as metastasis or sarcoma. This discordance underscores the importance of correlating imaging with pathology and maintaining a high index of suspicion for recurrence.

Management strategies depend on symptoms, lesion location, and risk of fracture. Surgical intervention is warranted when structural integrity is compromised, as in the present case. Long-term follow-up is critical as recurrence or new lesion development may occur years after initial presentation.

Despite benign appearance in HPE, bone hemangioma exhibits unpredictable biological behavior. Recurrence rates exceeds 50% and found metastasizing to lungs>liver> other bones. Hence long-term follow-up becomes necessary for detection of recurrence and dissemination.

**CONCLUSION**

This case demonstrates the complexity of diagnosing and managing recurrent multifocal intraosseous hemangiomas. Despite benign histology, the lesions can behave aggressively radiologically and may recur at multiple skeletal sites over long periods. Comprehensive evaluation using radiological, histopathological, and clinical assessments combined with extended follow-up is necessary to guide treatment and surveillance.

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# Posterolateral Corner Injuries of Knee

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**Abstract:** Posterolateral corner injuries have seen an increasing trend in view of the increased high velocity injuries .Though isolated injuries are rare, it is usually associated with other ligament injuries. A meticulous clinical examination with a high index of suspicion and radiological assessment is needed for the diagnosis, failure of which may lead to chronic pain, chronic knee instability, cartilage damage, and failed cruciate ligament reconstruction. Surgical or nonsurgical intervention are based on the extend of the injuries.
Key words :posterolateral corner,knee,injuries,management

## INTRODUCTION

The posterolateral corner because of its complex structure and biomechanics was once considered the dark side of the knee. Newer research regarding the anatomy and biomechanics has improved the understanding of PLC injuries. PLC injuries are more commonly associated with ACL or PCL injuries and isolated injuries as such are less common. Failure to address a PLC injury may compromise concurrentcruciate ligament reconstructions and alter the knee biomechanics leading to an early degenerative change of the joint[1,2,3]. High index of suspicion is needed for diagnosis. Detailed physical examination and a comprehensive review of radiographic and magnetic resonance imaging (MRI) studies help in determining these injuries better. Management protocol for lower grade injury are conservative, but higher grade injuries require operative interventions.

### Anatomy

The lateral side of the knee is divided into three anatomic layers as described by Seebacher et al[1] . The most superficial layer or layer 1, consists of the lateral fascia, iliotibial (IT) band, and the superficial portion of the biceps femoris tendon. The peroneal nerve is located in the deepest aspect of layer 1. The intermediate layer consists of the retinaculum of the quadriceps and the proximal and distal patellofemoral ligaments. The deep layer or layer 3, includes the lateral part of the joint capsule, the fibular collateral ligament, the fabellofibular ligament, the coronary ligament, the popliteal tendon, and the arcuate ligament[2].

The 3 most important stabilizing structures providing static (passive) and dynamic (active) posterolateral knee stability are the popliteus tendon, popliteo fibular ligament, and fibular collateral ligament

The FCL is the primary Varus stabilizer of the knee. The femoral attachment of the FCL is in a small bony depression slightly proximal and posterior to the lateral epicondyle. The distal insertion is mainly on the distal one-third of the lateral aspect of the fibular head, the remaining insertion blends with the peroneus longus fascia

The femoral insertion of the popliteus constitutes the most anterior femoral insertion of the PLC. After its femoral insertion in the proximal half of the popliteal sulcus, it courses posterodistally in an oblique fashion to insert into the posteromedial tibia

The popliteofibular ligament originates at the musculotendinous junction of the popliteus with its two divisions (anterior and posterior) embracing popliteus musculotendinous junction and inserting distally into the posteromedial aspect of the fibular head.

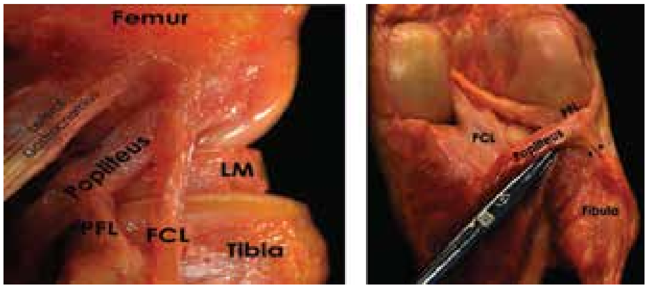


Figure 1 : ANATOMY OF POSTEROLATERAL CORNER- Fibular collateral ligament (FCL) popliteus tendon (PLT) and Popliteofibular Ligament.

Secondary structures help stabilize the knee in a static and dynamic manner. From deep to superficial these structures are:

- The lateral capsular thickening with meniscofemoral and meniscotibial ligaments
- The coronary ligament
- The lateral gastrocnemius tendon
- The fabellofibular ligament
- The long head and short head of biceps femoris
- The iliotibial band

### Biomechanics

The PLC structures provide the primary restraint to varus

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forces of the knee. PLC also resists external tibial rotation, and posterior tibial translation. Additionally, the PLC structures affect the function and loads seen on the cruciate ligaments

**Role of PLC Structures to Varus Motion**

The FCL is the primary restraint to varus stress. Deficiency of FCL causes increases in varus motion in all degrees of knee flexion. Varus stress produces the greatest load on the FCL with the knee in 30 degrees of flexion, and the load subsequently decreases once the knee reaches 90 degrees of flexion. Once the FCL is torn, secondary structures assume the main restraint to varus motion, including the posterior cruciate ligament (PCL), popliteofibular ligament, posterior capsule, mid-third lateral capsule ligament, IT band, and popliteal tendon.

Role of the PLC Structures in Preventing External Rotation
The popliteus tendon and the popliteofibular ligament are the primary restraints to external rotation. FCL plays a primary role in external rotation restraint when the knee is closer to full extension, and the popliteus and popliteofibular ligament assume responsibility with increasing degrees of knee flexion. The PCL also affects external rotation resistance. The PLC and PCL work in concert to resist external rotation stresses. Isolated sectioning of the PCL does not affect external rotation motion of the knee if the PLC is intact. As noted, the PLC experiences greatest external rotation moments at 30 degrees of knee flexion. The PCL does not experience external rotation loads until 80 to 90 degrees of knee flexion, when it becomes a secondary stabilizer to external rotation.

Role of the PLC Structures in Preventing Anterior/Posterior Tibial Translation Injured PLC structures have little effect on total anterior tibial translation if the anterior cruciate ligament (ACL) is intact , but if the ACL is also torn, the combined ACL/PLC injury leads to significantly increased anterior tibial translation. Combined sectioning of the PLC and ACL causes an additional anterior translation. Isolated PLC injuries can cause increased posterior tibial translation, even in the setting of an intact PCL. In the knee with a deficient PCL, the PLC assumes a major stabilizing role, with increases in force load of six to eight times that of the knee with an intact PCL, especially at higher degrees of knee flexion. The total posterior tibial translation increases significantly, when both the PCL and PLC are torn.

**Mechanism of injury**

Common causes of posterolateral corner knee injury are posterolateral force on the anteromedial portion of the tibia, varus angulating force on a flexed knee, any injury that may hyperextend, externally rotate, or force the tibia into a varus angle or a knee dislocation.

**Physical Examination**

Both the knees should be compared. Any gaitabnormalities need to be screened out, like varus thrust of the knee usually seen with chronic posterolateral knee injury. Vascular compromise and neural symptoms need to be evaluated. Several special are described which help confirm a diagnosis. Commonly used are the posterolateral drawer, Dial, external rotation recurvatum, varus stress, reverse pivot-shift, and standing apprehension tests.

The posterolateral drawer test : Patient in supine with the knee flexed to 80° to 90° and the foot externally rotated 15°,foot is stabilised and posterolateral drawer force is applied . A positive posterolateral drawer test, indicated by increased posterolateral rotation compared to the contralateral knee, may implicate injury to the popliteus tendon, popliteofibular ligament, and FCL.

The Dial test : Patient in prone the knee is flexed to 30° and then 90°. The foot is externally rotated, comparing with the uninvolved side. An increase of greater than or equal to 15°, as compared to the contralateral side, is considered positive. A Dial test that is positive at 30° of knee flexion but normal at 90° of knee flexion is indicative of PLC injury. A positive test at both 30° and 90° of knee flexion indicates both a PCL and PLC injury.

The external rotation recurvatum test : Lifting off supine patient's great toe, and observing the relative amount of genu recurvatum present. The test is considered positive if the amount of genu recurvatum measured by either a goniometer or heel height off the examination table is greater than the contralateral knee.

The varus stress test : Patient is supine, with the proximal femur stabilized on the examination table. The tibia is stabilised from unwanted rotation and applies a varus stress is applied 30° of flexion and repeated with the knee extended to 0°. The test is considered positive if translation is more than the opposite knee.

Reverse pivot shift test : Patient supine with the knee flexed to 40° and the tibia in external rotation. As the knee is extended, the tibia is reduced with a clicking sound. The reduction indicate positive test.

Standing apprehension test: The patient stands with his/her weight on the injured (tested) knee and slightly flexes it, while the clinician applies a medially directed force on the anterolateral portion of the lateral femoral condyle. Rotation of the condyle relative to the tibia, in addition to the patient feeling a giving-way sensation, indicates a positive test.

**Investigations**

1) Plain radiography

Plain radiography with anteroposterior (AP), lateral, and axial views is taken to rule out other injuries such as fractures. AP view to assess limb alignment[4].

2) Stress radiography

Varus stress test to assess lateral opening4.

3) Magnetic resonance imaging (MRI)

MRI test helps to identify PLC structures. T2-weighted coronal oblique view is more useful in the evaluation of the posterolateral structures than the traditional coronal or sagittal view. MRI is also helpful to evaluate acute or subacute PLC injuries .

**Arthroscopy**

Arthroscopy provides intraarticular information of posterolateral structures, such as the popliteus complex, coronary ligament of the lateral meniscus, and posterolateral capsule. It helps to decide the appropriate treatment and provides accurate anatomical information in surgical treatment.

A drive-through sign occurs when there is more than 1cm lateral joint opening under varus stress to the knee joint, which can be confirmed with arthroscopy . Also, popliteal hiatus widening during internal rotation of the tibia, tears of the inferior and superior popliteomeniscal fascicle, and abnormal popliteomeniscal motion during rotation may be observed in arthroscopy.

Figure 2 : Drive through sign in arthroscopy

PLC injuries can be classified according to the damage to the posterolateral structures or the degree of posterolateral instability. The following two classifications are most commonly used:

Bleday et al and Fanelli and Larsonn classified the PLC injuries into type A, B, and C based on damage to structures.[56]

The Hughston classification, is based on the assessment of varus instability or rotational instability under varus stress force with the knee in full extension.

Table 2: Classification of Posterolateral Instability

This table details the grading system based on physical exam findings and the status of the posterior cruciate ligament (PCL).

***Table 1: Classification of Damage in Posterolateral Structures***

| Classification | Scale of Damage | Damaged Structure |
|---|---|---|
| **Type A** | 10˚ increase in external rotation of the tibia | PFL, popliteus tendon |
| **Type B** | 10˚ increase in external rotation of the tibia<br>Slight varus relaxation (5 -10mm increase in varus load test) | PFL, popliteus tendon<br>LCL |
| **Type C** | 10˚ increase in external rotation of the tibia<br>severe varus laxity (>10mm increase in varus load test) | PFL, popliteus tendon<br>LCL, capsule avulsion, cruciate ligament |
| **Note:** PFL: popliteofibular ligament; LCL: lateral collateral ligament. | | |

| Classification | Varus or Rotational Instability | PCL Status |
|---|---|---|
| **Grade I** | 0-5mm or 0˚-5˚ | Intact PCL |
| **Grade II** | 5-10 mm or 6˚-10˚ | Intact PCL |
| **Grade III** | >10 mm or >10˚ (soft endpoint) | PCL rupture |
| **Note:** PCL -Posterior Cruciate Ligament | | |

**Treatment**

**1. Non-Operative Treatment**

Grade I and grade II isolated PLC injuries can be treated with non-operative management. Appropriate rehabilitation and gait training may be helpful in treating grade I or grade II injuries. Non-operative treatment may offer good outcomes; however, care should be taken considering non-operative treatment of complete tears involving the PLC has shown poor functional results.

**2. Operative Treatment**

For grade III and grade II PLC injuries accompanied by other structural injuries, surgical management is recommended . The approach to Posterolateral Corner (PLC) injuries is primarily dictated by the chronicity of the trauma and the underlying mechanical alignment of the limb.

**Acute PLC Injuries (Within 3 Weeks)**

For injuries sustained within three weeks of treatment, the gold standard involves a combination of **direct anatomical repair and augmentation** using the Larson method of reconstruction.

- **Key Clinical Note:** Isolated primary repair is generally discouraged, as it is associated with high failure rates; augmentation is essential to provide the necessary stability during the healing process.

**Chronic PLC Injuries**

Chronic cases require a more complex, reconstructive approach, typically utilizing the **anatomic LaPrade technique** to restore the three primary stabilizing structures of the PLC.

In chronic presentations, assessing **lower extremity alignment** and **gait patterns is critical to the success of the surgery:**

- **Varus Malalignment**: If there is a varus deviation exceeding *3°*, or if the mechanical axis (hip-knee-ankle) passes through the medial **30%** of the tibial plateau, the reconstruction is at high risk of failure due to excessive tensile stress. In these instances, a **High Tibial Osteotomy (HTO)** should be performed—either prior to or in conjunction with the reconstruction—to realign the weight-bearing axis and protect the new graft.

**Reconstruction**

There are various methods of reconstruction, which can be divided into anatomic reconstruction and non-anatomic reconstruction.

Non-anatomic reconstruction is to obtain posterolateral stability by applying tension on the uninjured posterolateral structures. Arcuate complex or bone block advancement, extracapsular ITB sling, augmentation technique, and bicep tenodesis are recommended for non-anatomic reconstruction.

Anatomic reconstruction is indicated in cases with significant hyperextension, external rotation recurvatum , proximal tibiofibular instability an concomitant PCL injury.
Anatomical and biomechanical research of posterolateral structures has been conducted recently and precise anatomic reconstruction of the injured LCL, popliteus tendon and PFL is recommended with use of the fibular-based technique and tibiofibular-based technique LaPrade et al., in 2004, introduced the term anatomical reconstruction of the PLC of the knee, based on previous anatomic and biomechanical testing, surgically reproducing the three main structures of this complex: the fibular collateral, popliteofibular ligament and polpliteuss tendon.The technique was tibio-fibular based anatomic reconstruction technique, which included :Tibial tunnel ,fibular tunnel ,2 femoral tunnels for the LCL & popliteus. The graft preferred was Achilles tendon graft.

For all chronic cases—defined as injuries persisting for more than three weeks—we employ a modified LaPrade technique, which is a tibio-fibular based anatomic reconstruction. Unlike the original technique described by LaPrade et al., which utilizes two femoral tunnels, our modification utilizes a single femoral tunnel alongside one tibial and one fibular tunnel to reconstruct the fibular collateral ligament (FCL), popliteus tendon, and popliteofibular ligament. The graft we used is the semitendinosus and gracilis graft.

Anatomic tunnel placement is guided by specific bony landmarks: the fibular tunnel is positioned at the FCL insertion by identifying the small sulcus distal and posterior to the fibular styloid, while the femoral tunnel is placed proximal and posterior to the lateral epicondyle. Finally, the tibial tunnel for the popliteus is drilled from the midpoint between the tibial tuberosity and Gerdy’s tubercle, exiting at the popliteus sulcus."

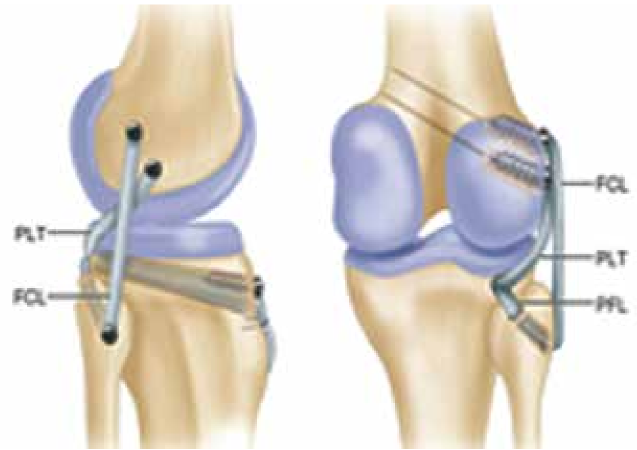


Figure 3: LaPrade technique

Figure 4: Modified LaPrade Technique


Figure 5: Anatomical Reconstruction of the PLC: Single-Tunnel Modified LaPrade

Yoon and Stannard described similar methods .Franciozi described similar method with hamstring grafts.

Larsen et al described a fibular sling procedure which made the popliteal complex and LCL balanced . This method is commonly used as it is a simple procedure that provides good results.

For acute injuries, we prefer the Larsen technique utilizing a semitendinosus autograft; however, a gracilis graft is often sufficient to provide adequate stability.

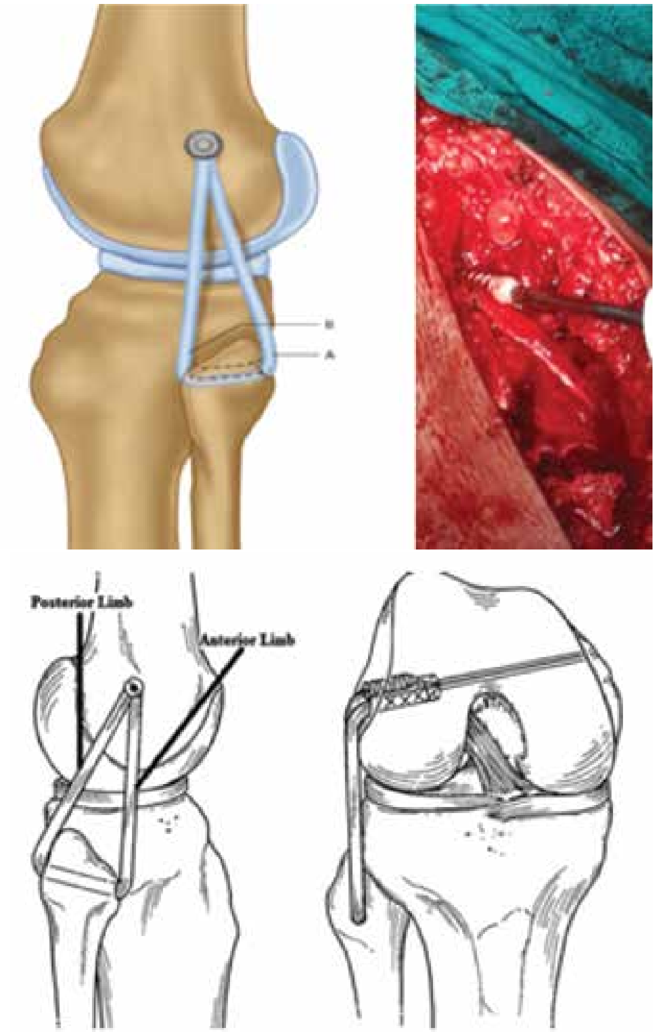


Figure 6: Posterolateral corner reconstruction using the Larsen technique with a semitendinosus autograft.

YANG ET AL focused on reconstruction of the lateral collateral ligament and the popliteofibular ligament using a single hamstring autograft tendon.

The varus and external rotation were reduced significantly in the anatomic reconstruction group compared to the non-anatomic reconstruction group. The tibiofibular-based technique seems to be advantageous since it allows for anatomic reconstruction of the three important structures. However, this method is somewhat difficult to perform and may excessively limit the posterolateral motion. Yoon et al. reported that there was no significant difference between the group that had all three structures reconstructed and the group where the popliteus tendon was not reconstructed.

Despite a majority of studies presenting similar results comparing non-anatomic to anatomic PLC reconstructions, it is important to note that some biomechanical and clinical studies present superior results favouring anatomical PLC reconstructions.

In cases of bicruciate reconstruction associated with PLC the PCL should be tensioned and fixed first maintaining step off manually followed by the ACL and finally the PLC (fixation of the FCL at 30° of knee flexion applying a valgus force, followed by the remaining PLC structures at 60° of flexion and neutral rotation).

**Postoperative Rehabilitation**

Postoperative rehabilitation emphasises on protection of the reconstructed or repaired ligament structures initially and then gradually leads to muscle strengthening, functional exercises, and daily activities so that the patient may eventually participate in sports activities. Training is focused on first developing a muscular endurance base and then progressing to muscular strength and power development. Return to sports or activity is allowed once strength, stability, and knee range of motion becomes comparable with opposite side. (usually between 6 to 9 months and based on concurrent cruciate ligament or other ligament surgery).

In short PLC reconstruction is preferred compared to direct repair in surgical treatment of PLC injuries especially for chronic cases. Anatomic reconstruction is better compared to non-anatomic reconstruction. Currently, fibular-based reconstruction are preferred.

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# Beyond the Ankle Fracture: Understanding the Complex Challenges of Diabetic Ankle Fractures

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**Abstract:** Ankle fractures in patients with diabetes represent a complex and high-risk subset of orthopaedic injuries, influenced by systemic and local disease factors. Diabetes, particularly when complicated by neuropathy, peripheral vascular disease, or chronic kidney disease, impairs bone metabolism and fracture healing. Furthermore, diabetic patients are predisposed to impaired wound healing, infection, and Charcot neuroarthropathy, which collectively complicate both operative and nonoperative management. Evaluation of diabetic ankle fractures requires comprehensive assessment of comorbidities, neurovascular status, and glycaemic control to stratify risk and guide management. Nonoperative strategies, including prolonged immobilisation and strict non-weightbearing, are associated with high complication rates, particularly in displaced or unstable fractures, and may contribute to malunion or development of Charcot arthropathy. Contemporary management favours operative intervention for unstable fractures, often employing augmented fixation strategies such as "ORIF plus" to optimize mechanical stability while preserving soft tissue integrity. Locking plates, multiple syndesmotic screws, minimally invasive techniques, and, in complex cases, primary tibio-talo-calcaneal arthrodesis are increasingly used to improve outcomes. Diabetic ankle fractures carry substantial risks of complications, including infection, impaired fracture healing, Charcot joint formation, and, in severe cases, amputation. These risks are heightened in patients with complicated diabetes, emphasizing the need for individualized, multidisciplinary management. Strategies such as the "rule of two" (doubling fixation, non-weightbearing duration, and follow-up frequency) are frequently applied to mitigate adverse outcomes. This review synthesizes current understanding of the pathophysiology, clinical evaluation, management strategies, and complications associated with diabetic ankle fractures. It underscores the importance of meticulous preoperative planning, patient-specific surgical approaches, and vigilant postoperative care to optimize fracture healing and improve overall patient outcomes. Recognition of the unique challenges posed by diabetes is essential to ensure safe, effective, and evidence-based care in this high-risk population.

## INTRODUCTION

Ankle fractures are among the most commonly encountered orthopaedic injuries, comprising approximately 9% of all fractures, with their incidence increasing in the elderly population in parallel with rising life expectancy.[1,2] A Finnish predictive model has estimated a threefold increase in the incidence of ankle fractures by 2030, although the underlying reasons for this rise remain unclear.[3] Diabetic patients constitute approximately 12% of all ankle fractures, and the management of this subgroup has attracted particular attention owing to its association with higher complication rates and increased overall healthcare costs.[4] Diabetes is an escalating global epidemic and a leading contributor to both mortality and morbidity, significantly driving up healthcare costs worldwide.[5] India ranks second in the world for the number of people with diabetes, with an estimated prevalence rate of 16.1 percent.[6] Elevated blood glucose levels promote the increased production of advanced glycation end products, reactive oxygen species, and inflammatory mediators. Collectively, these factors enhance osteoclast activity while suppressing osteoblast function and bone formation, thereby increasing fracture risk and impairing fracture healing.[7] Most of these patients also have concomitant comorbidities, including peripheral vascular disease and diabetic neuropathy, which further complicate the management of ankle fractures.[8] Impaired wound healing and an increased risk of infection may influence the decision to pursue surgical treatment,[9] whereas conservative management carries a risk of loss of reduction and delayed or impaired fracture union, potentially resulting in additional complications.[10] Nonoperative management was associated with a 21-fold higher odds of complications compared with operative treatment.[11] Moreover, both operative and non-operative treatment strategies in diabetic patients may increase the likelihood of developing Charcot neuroarthropathy, culminating in joint destruction,

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bone loss, and deformity.[12,13] Patients with diabetes mellitus, especially those with diabetes-related comorbidities, may experience severe consequences following foot and ankle fractures. Notably, individuals with diabetes have been reported to carry a 7.4-fold higher risk of amputation after ankle fracture surgery compared with nondiabetic patients.[14,15] This article provides an overview of ankle fractures in patients with diabetes, outlines the management strategies for this population, and further examines the associated complications.

## 2. Impact of diabetes on bone tissue and physiology of fracture healing

Both type 1 and type 2 diabetes share key pathophysiological features affecting bone, including hyperglycaemia and increased production of advanced glycation end products (AGE), reactive oxygen species (ROS), and inflammatory mediators. Together, these factors enhance osteoclast activity, suppress osteoblast function and bone formation, thereby increasing fracture risk and impairing fracture healing.[7] Hyperglycaemia adversely affects bone remodelling by altering osteoclast and osteoblast differentiation and by promoting a pro-inflammatory state through increased release of cytokines such as TNF-α, IL-1β, and IL-6. IL-6 enhances osteoclastogenesis and disrupts bone mineralisation. While excessive TNF-α promotes osteoclast activity and impairs fracture repair by reducing mesenchymal stem cell proliferation, inducing chondrocyte apoptosis, and inhibiting angiogenesis, resulting in cartilage resorption and impaired endochondral ossification.[16–18] Hyperglycaemia also leads to the accumulation of AGE, which disrupt bone homeostasis by upregulating inflammatory cytokines and further driving osteoclastogenesis.[7] In parallel, increased production of ROS induces oxidative stress, enhances RANKL-mediated osteoclast formation, and negatively impacts osteocytes and mesenchymal stem cells. Collectively, these mechanisms accelerate bone resorption and compromise overall bone health.[1]8 Insulin exerts anabolic effects on bone through osteoblast insulin receptors and their substrates [Insulin Receptors (IRS-1 and IRS-2)] promoting osteoblast proliferation and bone homeostasis.[19] Diabetes-associated peripheral vascular disease, vascular calcification, and impaired angiogenesis lead to tissue ischaemia and reduced delivery of oxygen and nutrients, thereby compromising wound and fracture healing.[20] Loss of protective pain sensation from peripheral neuropathy results in an inability to perceive repetitive trauma, deep infection, ulceration, and wound complications.[21]

## 3. Evaluation

Complicated diabetes is defined by the presence of end-organ damage, including neuropathy, peripheral arterial disease, and/or chronic kidney disease, and its differentiation is crucial as it significantly influences treatment decision-making, complication rates, and overall clinical outcomes.[22] The initial assessment should include a detailed medical history, evaluation of diabetes-related complications, thorough neurovascular examination of the affected limb, adjunctive vascular assessment when pulses are not palpable, and review of baseline investigations, including relevant blood tests, to identify features of complicated diabetes.[23]

## 4. Management of diabetic ankle fracture

Nonoperative management of ankle fractures involves closed contact casting with strict non-weightbearing until fracture union is confirmed. This is followed by a period of protected weight-bearing in a brace or boot for a further 2–3 months.[24,25] In patients with diabetes, immobilisation may be required for up to three times longer than in nondiabetic patients to reduce the risk of malunion and Charcot arthropathy.[26] Prolonged casting, however, increases the risk of cast-related ulceration and infection. Recognition of these complications is often delayed due to peripheral neuropathy.[11] This treatment strategy requires strict patient compliance, close clinical observation, and serial radiological assessment to monitor skin integrity and detect early displacement. The treating surgeon should maintain a low threshold to abandon nonoperative care and proceed with surgical intervention if early complications or failure of conservative management are identified.24,25

Historically, operative management of ankle fractures in patients with diabetes was approached with caution.27 However, nonoperative treatment of unstable or displaced ankle fractures in this population has consistently been associated with unfavourable outcomes, leading most contemporary authors to advocate for open reduction and stable fixation. Lovy et al. reported a complication rate of approximately 75% following conservative management of displaced ankle fractures in diabetic patients, with higher incidences of malunion, loss of reduction, development of Charcot arthropathy, cast-related ulceration, deep infection, and unplanned surgical intervention compared with surgically treated cases.[11] Similarly, Flynn et al. demonstrated increased infection rates among diabetic patients managed nonoperatively,28 while McCormack and Leith observed a high prevalence of malunion and loss of reduction following conservative treatment of displaced ankle fractures.[27] This unacceptably high complication rate indicates that surgical fixation is justified to stabilise unstable fractures, despite the associated risk of perioperative complications.[11]

Guidelines from the British Orthopaedic Foot & Ankle Society do not support nonoperative casting for unstable ankle fractures in patients with diabetes. In cases of complicated diabetes, augmented fixation—commonly referred to as "open reduction and internal fixation (ORIF) plus"—is regarded as the preferred treatment strategy.[29] The principles of ORIF plus include enhanced mechanical stability through the use of multiple syndesmotic screws, longer segment fixation, locking plate constructs, and, when indicated, transarticular pinning. Wukich et al. first described and categorised this approach in a comparative study of fixation methods, where ORIF plus emerged as the most commonly employed technique in diabetic patients.30 Importantly, it was associated with significantly lower complication rates than standard ORIF, despite being used more frequently in patients with complicated diabetes. Conversely, the addition of a supplementary external fixator to ORIF was associated with substantially higher complication rates. Collectively, these findings support the routine use of ORIF plus in diabetic ankle fractures, particularly in patients with complicated disease, over alternative fixation strategies.[30]

Schon et al. recommended that diabetic patients with peripheral neuropathy who sustain ankle fractures should be managed as Stage 0 Charcot neuroarthropathy, advocating prolonged non-weightbearing, augmented fixation, and extended immobilisation until clinical signs of inflammation have resolved.[31] Prolonged immobilisation has traditionally been recommended to reduce complication rates in diabetic ankle fractures.[32–34] However, emerging evidence has challenged this practice, proposing that early protected weight-bearing may help limit deconditioning and perioperative complications. Bazarov et al. reported a 25% complication rate in [48] surgically managed diabetic ankle fractures permitted protected weight-bearing at two weeks, which was lower than rates reported with conventional 6–8 weeks of non-weightbearing. Despite the limited sample size, these preliminary findings indicate a potential role for early weight-bearing in carefully selected patients; however, larger, methodologically robust studies are required to validate its safety, define appropriate selection criteria, and establish evidence-based protocols.[35]

Additional considerations include obesity and upper limb deconditioning, which are common in patients with diabetes and can make adherence to lower extremity weight-bearing restrictions difficult. Chiodo et al. reported that 27.5% of patients were non-compliant with postoperative non-weightbearing instructions, with nearly half of these patients experiencing an adverse event as a result. Consequently, meticulous discharge planning and postoperative care are essential in this high-risk population, and many patients may require additional support or supervised post-discharge placement to minimise non-compliance and associated complications.[36] In summary, management is often guided by the "rule of two," which emphasises doubling the degree of fixation, the duration of non-weightbearing, and the frequency of follow-up in patients with diabetic ankle fractures.

## 5. Fixation choices

Given that the most severe complications following ORIF of diabetic ankle fractures include the development of Charcot neuroarthropathy or progression to amputation, it is logical to apply principles commonly used in Charcot reconstruction and limb salvage to this patient population. Accordingly, a "modified super construct" or "ORIF plus" strategy has been adopted for the fixation and management of diabetic ankle fractures. Sammarco et al. originally described the super construct concept in Midfoot Charcot surgery as fixation that extends beyond the zone of injury, incorporates bone resection to facilitate deformity correction and reduce soft-tissue tension, employs the strongest fixation tolerated by the soft-tissue envelope, and is applied to optimise mechanical stability.[37] These principles should be adapted to diabetic ankle fractures by extending fixation beyond the immediate fracture zone, carefully planning incisions to allow fixation in areas with lower risk of wound complications, utilising the most robust fixation constructs available, and applying them in a mechanically advantageous manner, such as antiglide plating.[38] The introduction of locking plate technology has significantly improved fixation in this setting by providing enhanced mechanical stability while preserving periosteal blood supply, which is critical for fracture healing, often without increasing implant bulk. In addition, the use of multiple tricortical/ quadricortical syndesmotic screws has been advocated. In neuropathic ankle fractures, it is routine practice to place three to four syndesmotic screws irrespective of initial evidence of syndesmotic injury, with the aim of maximising construct stability (Fig 1)


Figure 1 : Preoperative and postoperative radiographs demonstrating fixation of a diabetic ankle fracture using a modified superconstruct strategy.(a) Lateral and (b) anteroposterior preoperative radiographs showing an unstable ankle fracture in a neuropathic diabetic patient.(c) Lateral and (d) anteroposterior postoperative radiographs illustrating fixation with a locking fibular plate and multiple syndesmotic screws consistent with modified superconstruct principles.

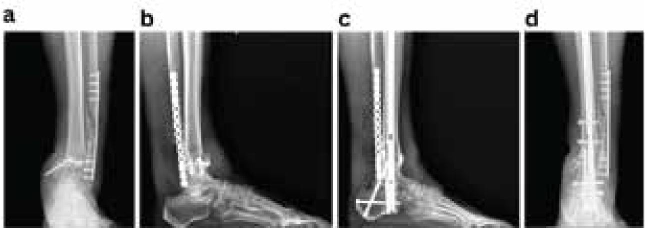


Figure 2 : Radiographic sequence demonstrating failure of standard ankle fracture fixation and subsequent revision surgery using the superconstruct principle.(a, b) Anteroposterior and lateral radiographs showing failure of conventional ORIF.(c,d) Post-revision lateral and anteroposterior radiographs illustrating revision surgery performed with a superconstruct principle to achieve stable fixation and limb salvage

Ankle fracture fixation using standard ORIF techniques is prone to failure when fundamental fixation principles are not rigorously followed. In such cases, limb salvage is best achieved through application of the superconstruct principle, with hindfoot arthrodesis (Fig 2).

The British Orthopaedic Foot & Ankle Society also advocates consideration of minimally invasive techniques, such as fibular nailing or cannulated screw fixation, in selected fracture patterns where soft-tissue compromise is a concern. Ashman et al. demonstrated the effectiveness of percutaneous fibular nail fixation in unstable Weber B and C fractures among diabetic patients, reporting a low rate of wound complications while maintaining adequate fracture stability.[40]


Figure 3: Preoperative and postoperative radiographs demonstrating limb salvage using primary tibio-talo-calcaneal (TTC) arthrodesis in a complex ankle fracture.(a) Anteroposterior and (b) lateral radiographs showing a severely unstable ankle fracture-dislocation in the setting of complicated diabetes.(c) Lateral and (d) anteroposterior postoperative radiographs illustrating primary TTC arthrodesis performed using a hindfoot intramedullary nail, achieving stable fixation and alignment as a limb-salvage strategy.

For more complex cases, particularly in the setting of complicated diabetes especially severe neuropathy, BOFAS recommends primary arthrodesis using tibio-talo-calcaneal (TTC) nailing as a limb-salvage strategy (Fig 3). Ebaugh et al. reported high limb salvage rates following primary TTC arthrodesis with retrograde hindfoot nails, with most patients maintaining ambulatory function despite a moderate complication rate. The ability to allow earlier weight-bearing with retrograde hindfoot nails, compared with prolonged immobilisation required by other fixation methods, likely contributed to favourable union rates and reduced certain complications. This approach should therefore be strongly considered in complex or limb-threatening presentations.[41]

Overall, there is no uniform treatment strategy for diabetic ankle fractures. Optimal management requires an individualized approach that accounts for fracture pattern, injury severity, soft-tissue condition, and patient-specific factors, particularly the presence and extent of complicated diabetes (Fig 4).

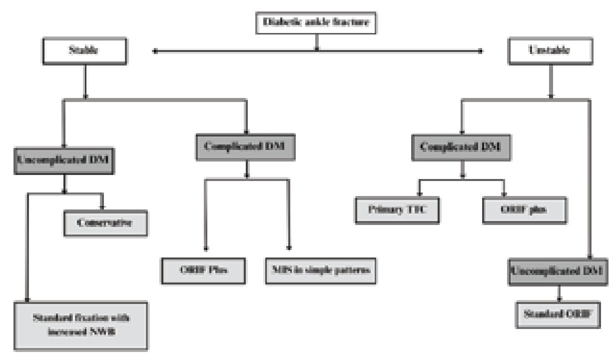


Figure 4: Proposed management algorithm for diabetic ankle fractures based on fracture stability and diabetic status.

## 6. Complications of Ankle Fractures in Diabetes

### 6.1 Infection

Surgical site infection is the most frequently reported complication following ankle fractures in patients with diabetes. Both superficial and deep infections occur at significantly higher rates compared with nondiabetic patients, particularly in those with complicated diabetes.[42] Large cohort studies demonstrate that complicated diabetes markedly increases both the severity and likelihood of postoperative infection, whereas uncomplicated diabetes does not appear to confer a comparable risk.[43]

### 6.2 Impaired fracture healing

Diabetes adversely affects fracture union, with a substantially increased risk of delayed union, non-union, and malunion.[44] Peripheral neuropathy, poor glycaemic control, and prolonged operative duration are consistently identified as major predictors of impaired bone healing, reflecting the detrimental effects of hyperglycaemia and neuropathy on bone metabolism and repair mechanisms.[45]

**6.3Amputation**

Although relatively uncommon, amputation represents the most severe complication following ankle fracture surgery in diabetic patients. The risk is significantly higher than in nondiabetic populations and is further amplified in open fractures, which are considered limb-threatening due to high rates of infection and wound complications.46 Population-based studies consistently report increased rates of reoperation, readmission, mortality, and amputation, particularly among insulin-dependent patients.[14]

**6.4 Charcot neuroarthropathy**

Although patients with neuropathy who sustain ankle fractures are thought to be at increased risk of developing a Charcot event, further studies are required to confirm this association. Features of Charcot arthropathy may be present at initial presentation, and surgeons should maintain a high index of suspicion, particularly in the presence of neuropathy, atypical comminution, unusual fracture patterns, or poor bone quality. Early recognition is critical, as timely identification of Charcot changes has been shown to play a key role in preventing progression to severe foot and ankle deformity.[47]

**7. Clinical implications**

These findings underscore that diabetes is a heterogeneous condition, with complication risks varying according to disease severity, insulin dependence, and the presence of end-organ damage. Individualised treatment strategies that account for complicated diabetes and associated comorbidities are therefore essential to minimise complications, optimise outcomes, and maximise the potential for limb salvage.

CONCLUSION

Clinical challenge: Diabetic ankle fractures are complicated by neuropathy, vascular disease, altered bone metabolism, and systemic comorbidities.

Healing risks: These factors increase the likelihood of delayed healing, malunion, nonunion, infection, Charcot arthropathy, amputation, and mortality.

Assessment: Comprehensive preoperative evaluation is essential for accurate risk stratification and planning.

Management approach:

- Stable fractures in uncomplicated diabetes may be treated conservatively.
- Unstable fractures usually require augmented fixation (“ORIF plus”).
- Multidisciplinary approach

Guiding principle: The “rule of two” supports stronger fixation, longer non-weightbearing, and closer follow-up.

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# Functional outcome of arthroscopic Eden–Hybinette procedure with iliac-crest bone graft in recurrent anterior shoulder instability

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**Abstract -** Glenoid bone defects play a significant role in anterior shoulder instability. Critical anterior glenoid bone loss is a recognized cause of failure after soft-tissue stabilization and often requires bone-augmentation procedures. Arthroscopically modified Eden-Hybinette procedures using iliac crest bone graft are gaining popularity as effective options in recurrent anterior shoulder instability with critical glenoid bone loss especially after failed Bankart repair or Latarjet procedure. This paper reports the mid-term clinical and functional outcomes of arthroscopic Eden-Hybinette procedure with iliac crest autograft in patients with recurrent anterior shoulder instability.

**Materials and methods**: Retrospective analysis of a case series of 18 patients with recurrent anterior shoulder instability and critical glenoid bone loss who underwent arthroscopic Eden–Hybinette procedure with iliac crest autograft between January 2018 and February 2025 was done. Glenoid and humeral bone defects were quantified using pre-operative CT scans. Data on patient demographics, pre-operative and post-operative clinical assessments, radiographic findings, and complications were analysed. Clinical assessment was done using the WOSI (Western Ontario Shoulder Instability) index and the Rowe scores pre-operatively and post-operatively at 3 months, 6 months, 12 months and 2 years.

**Results:** The mean age was 33.5 years. The mean number of preoperative dislocations was 4.1. The mean interval from first dislocation to surgery was 4.6 years. The mean operative time was 80 minutes and the mean duration of hospital stay was 2.5 days. The mean follow-up period was 38 months (ranging from 6 months to 7 years). The mid-term results indicate significant improvement in shoulder stability and function post-operatively. The mean post-operative Rowe score improved to 78.75 ± 12.24 (P-value<0.05) and the mean post-operative WOSI score improved to 23.86 ± 4.48 (P-value<0.05). No post-operative re-dislocation episodes were noted till the last follow up. One patient had a single subluxation episode at 2 years of follow up which settled with physiotherapy and did not recur. Fourteen patients (77.78%) regained normal range of motion (ROM). The four patients with remplissage had less than 25° loss of external rotation. Complications included two superficial wound infections and donor-site sensory disturbances.

**Conclusion**: The arthroscopic Eden-Hybinette procedure with iliac crest bone graft is an effective option for recurrent anterior shoulder instability with significant bone loss, yielding favourable functional outcomes and improved quality of life of patients. In this series with mid-term follow-up, arthroscopic Eden–Hybinette procedure with iliac-crest autograft yielded significant improvement in shoulder stability and function with low recurrence and acceptable complication rates. It is a viable alternative to the Latarjet procedure in selected patients with critical glenoid bone loss, preserving options for revision with Latarjet if needed. Larger comparative and longer-term studies are recommended.

## INTRODUCTION

Recurrent anterior shoulder instability with critical glenoid bone loss is increasingly recognized as a factor predicting failure after arthroscopic Bankart repair. Bone-augmentation procedures like Latarjet, Eden–Hybinette (free bone block) and distal tibial allograft aim to restore glenoid articular surface and stability. The Eden–Hybinette procedure, historically an open bone block technique, has evolved to an all-arthroscopic approach with modern fixation options using cerclage tape or screws, and uses iliac-crest cancellous autograft which may favour graft incorporation. This manuscript presents outcomes from 18 patients treated with arthroscopic Eden–Hybinette procedure for glenoid bone loss of 20% or more at a single centre.

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Many bone augmentation procedures have been developed to treat recurrent anterior shoulder instability. The success of these procedures depends on several factors such as the patient's age, level of athletic participation, involvement in contact sports before and after surgery, presence of joint hyperlaxity, and the degree of bone loss in the glenoid or humeral head. These parameters play a critical role in determining outcomes after soft-tissue arthroscopic Bankart repair [1,2]. Recurrent shoulder dislocations may lead to a spectrum of injuries, from a soft-tissue Bankart lesion of the anterior glenoid labrum to variable glenoid bone loss, sometimes associated with a Hill-Sachs defect. Accurate identification of these risk factors through CT and MRI imaging is crucial for evaluating the extent of glenoid bone loss, measuring Hill-Sachs lesion depth, and determining whether the lesion is "off-track," all of which guide appropriate treatment planning.

Surgical procedures aimed at restoring glenoid bone structure include the Eden-Hybinette, Latarjet, J-bone graft, and distal tibial allograft techniques. The Latarjet procedure is most frequently used as a revision operation following a failed Bankart repair but can also be selected as a primary procedure in patients with a high instability severity index score. Glenoid bone loss is generally considered significant when more than 20% of the inferior glenoid is affected [3] or when the defect's supero-inferior dimension exceeds half the glenoid's maximum antero-posterior diameter. Radiographic findings such as disappearance of the sclerotic glenoid line on AP radiographs, as described by Jankauskas et al, can indicate anterior glenoid bone loss [4]. These findings typically warrant further cross-sectional imaging to evaluate the extent of critical bone loss.

Long-term results of the Latarjet procedure show a recurrence rate of approximately 5–6%, motivating surgeons to adopt more comprehensive reconstructive options to reduce the likelihood of failure [5]. The Eden-Hybinette procedure has proven particularly effective in cases of failed Latarjet procedures or when the glenoid bone defect is too large for a coracoid graft. It is also useful when the coracoid process is abnormally shaped or when glenoid fractures are not repairable. The success of this procedure lies in its ability to restore the glenoid's bony anatomy by matching the inner surface of the iliac crest bone graft precisely to the glenoid defect. Initially introduced as a bone grafting procedure combined with capsulorrhaphy, it has evolved significantly since its inception in 1917 into an all-arthroscopic technique with modern fixation options like cerclage tape or screws. This modern approach preserves the coracoid process and minimizes damage to the subscapularis muscle, offering clear advantages over other bone block methods.

## MATERIALS AND METHODS

The data on eighteen patients satisfying the inclusion and exclusion criteria who were diagnosed with recurrent anterior shoulder instability with critical bone loss and treated surgically with arthroscopic bone block procedure with iliac crest autograft at a single centre between January 2018 and February 2025 was retrospectively analysed. Patients with recurrent anterior shoulder instability and glenoid bone loss of 20% or more underwent the arthroscopic bone block procedure. In patients with an engaging/off-track Hill–Sachs lesion, remplissage was added to the bone block procedure to prevent engagement. Patients with bone loss less than 20%, multidirectional instability, rotator cuff tear, generalised ligamentous laxity, glenohumeral arthritis, fracture-dislocation, prior shoulder surgery, failed previous stabilization procedure, and associated neurological pathology were excluded from the study.

This retrospective cohort study was conducted after obtaining approval from the institutional ethics committee, and all procedures were performed in accordance with the ethical standards laid down in the Declaration of Helsinki. Demographic data including age, sex, side involved, dominance, number of instability episodes, mechanism of injury, and duration of symptoms were collected from hospital records. The indication for surgery was based on recurrent symptomatic instability associated with critical glenoid bone loss, with or without a concomitant Hill–Sachs lesion.

Glenoid and humeral bone defects were quantified using pre-operative CT scans with the best fit circle method. Three-dimensional computed tomography images were reviewed to accurately assess the extent of glenoid bone loss and to classify the Hill–Sachs lesion according to the glenoid track concept as on-track or off-track. The decision to add remplissage was made pre-operatively based on imaging findings and confirmed intra-operatively by assessing engagement in the functional position of abduction and external rotation.

All operations were performed by the same team of surgeons. The arthroscopic Eden–Hybinette procedure was performed using a standardized surgical technique. Adequate graft positioning, flush alignment with the native glenoid surface, and restoration of the glenoid arc were ensured under arthroscopic visualization. When indicated, remplissage was performed by tenodesis of the posterior capsule and infraspinatus tendon into the Hill–Sachs defect. The patients were followed-up post-operatively according to a standardized protocol. Postoperative rehabilitation was uniform for all patients and included initial immobilization in a sling, followed by progressive passive and active-assisted range-of-motion exercises, and subsequent strengthening exercises. Return to sports and heavy activities was permitted based on clinical recovery and functional assessment.

Clinical assessment was done using the WOSI (Western Ontario Shoulder Instability) index and the Rowe scores pre-operatively and post-operatively at 3 months, 6 months, 12 months and 2 years. These validated outcome measures were used to assess pain, function, stability, and quality of life. Complications such as recurrent instability, graft-related problems, infection, and stiffness were documented.

The follow-up protocol involved clinical examinations using the apprehension, Jobe's relocation, and load-and-shift tests to assess shoulder stability and rule out laxity. Range of motion (ROM) was evaluated for both active and passive movements in flexion, abduction, and internal/external rotation at 0° and 90° abduction. Comparisons were made with the contralateral shoulder where appropriate to identify any clinically significant restriction, particularly loss of external rotation. Recurrence of instability was defined as any episode of dislocation or symptomatic subluxation during the follow-up period.

**Surgical technique**

All patients underwent an arthroscopic Bone Block Cerclage procedure for anterior shoulder instability with glenoid bone loss. Four patients with engaging Hill-Sachs lesions underwent concomitant remplissage. The patient is positioned in the beach-chair position. The shoulder and arm are prepared and draped in the standard sterile fashion. Diagnostic arthroscopy is performed through a posterior portal to assess the extent of glenoid bone loss and to confirm the presence of any capsulo-labral deficiency. A tricortical iliac crest autograft of desired size, is harvested using osteotomes, maintaining the concavity of the inner table to match the contour of the glenoid articular surface. A standard anterior portal is established to allow instrument access for debridement and graft placement. The glenoid defect is prepared to obtain a flat, bleeding surface to promote graft healing. An accessory posterior portal is made to pass the glenoid guide jig [figure 1].

Figure 1: Placement of accessory posterior porglenoid guide

The glenoid guide is then introduced through the posterior portal. Under direct visualization, the guide sleeve is positioned on the glenoid face, ensuring that the planned tunnel exits at the centre of the anterior defect. Two parallel guide pins are then drilled from posterior to anterior through the glenoid, spaced appropriately to match the graft size. The drill is removed, and the cerclage passing wires or polypropylene threads are advanced through the tunnels. The bone block - iliac crest autograft - is trimmed to the desired dimensions and predrilled to match the spacing of the glenoid tunnels [Figure 2]. Two high-strength cerclage sutures are loaded into the passing wires and shuttled from posterior to anterior [Figure 3]. The tapes are retrieved through the anterior portal. The bone block is attached to the cerclage tapes and gently introduced through the anterior portal [Figure 4]. Using the tapes as guides, the graft is advanced into position against the anterior glenoid defect. Once seated flush with the native articular surface, the cerclage tapes are tensioned sequentially using the cerclage tensioner device. This step compresses the graft uniformly against the glenoid rim, providing strong fixation without the need for metal screws. The tension is maintained as the locking mechanism is engaged, and the excess tape is cut flush to the bone. The technique sought a flush graft-to-glenoid articular surface and restoration of the glenoid arc. Final arthroscopic inspection confirms the graft's position and stability [Figure 5]. The glenoid contour is restored, and the construct demonstrated excellent compression and alignment. The capsulo-labral tissue is repaired to the graft using suture anchors to re-establish the soft-tissue restraint. The shoulder is taken through a full range of motion to confirm construct stability. The portals are closed in standard fashion, and a sterile dressing is applied. Post-operatively, the patient is placed in a sling for protection, and a structured rehabilitation program is initiated to restore motion and strength gradually - passive abduction and forward flexion to 90 degrees started on day one, pendulum exercises at four weeks, active range of motion exercises at six weeks and weight training at three months. The bone block cerclage technique offers stable fixation, facilitates graft incorporation, and eliminates hardware-related complications.

Figure 2: The iliac crest bone graft trimmed to desired size and predrilled to match the spacing of the glenoid tunnels.

Figure 3: Two high-strength cerclage sutures are loaded into the passing wires and shuttled from posterior to anterior

**Statistical analysis**

Statistical analysis was performed using SPSS software version 29. The Mann–Whitney test was applied for nonparametric data, while unpaired t-tests were used for parametric data. The Pearson correlation coefficient was calculated wherever applicable. A p-value of < 0.05 was considered statistically significant.

## RESULTS

Among the 18 patients there were 14 males (78%) and 4 females. The dominant side was affected in 13 cases (72%) and the non-dominant side in 5 cases. The mean age of the patients in this series was 33 years and 6 months. The mean number of dislocations before the surgery was 4.1. The mean time period between initial dislocation and surgery was 4.6 years. The mean duration of surgery was eighty minutes. The average length of hospital stay was 2.5 days. The average follow-up period in this series was 38 months, the longest follow-up being 7 years and shortest being 6 months. There were no immediate post-operative complications. Two patients developed superficial surgical-site infections which settled with oral antibiotics, four patients reported donor-site sensory disturbances at the iliac crest. No cases of re-dislocation were noted. One patient had a single subluxation episode at two years which required rehabilitation alone and did not recur

**Functional outcome**

The modified Rowe score improved from 29.16 ± 14.1 (pre-operative) to 78.25 ± 14.23 at 24 months, ranging from 65 to 100, a significant improvement of 169% (p<0.001) [Figure 6]. The mean pre-operative functional, pain, stability and mobility scores were 12.24, 6.82, 10.52 and 2.5 respectively. At final follow-up the mean scores improved to 40.5, 8.16, 22.25 and 8.53 respectively. The results based on the modified ROWE score are presented as Mean ± Standard Deviation, and statistical comparison between pre-operative and postoperative groups was performed using the paired t-test [Table 1]. There was no significant relationship between the age of patients and the number of dislocations (r=- 0.12; p=0.72). There was no significant correlation of age of patient (r=0.16; p=0.11) or the number of prior dislocations (r=-0.08; p=0.19) with the final Rowe score.

Figure 4: The bone block is attached to the cerclage tapes and gently introduced through the anterior portal.

Figure 5: Stable graft with flush graft-to-glenoid articular surface.

The WOSI index improved from 76.52 ± 3.62 (pre-operative) to 24.56 ± 4.53 at 24 months ranging from 17.5 to 27.5 (p<0.001) [Figure 7]. The mean pre-operative physical symptoms, sports, life style and emotion scores were 78.99,76.99, 73.5 and 72.75 respectively. At final follow-up the mean scores improved to 40.5,8.16, 21.25, 8.33 respectively. The results for the individual parameters of the WOSI score are presented as Mean ± Standard Deviation, and statistical comparison between preoperative and postoperative values using the paired t-test revealed significant differences across all domains [Table 2]. There was no significant relationship of age of patient (r=0.23; p=0.18) or the number of previous dislocations (r=0.16; p=0.27) with the final WOSI score. The mean post-operative Rowe score was inversely correlated with the mean post-operative WOSI score (r = −0.66).

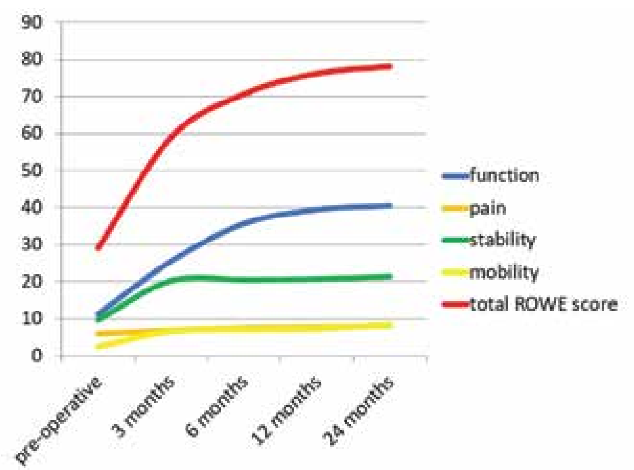


Figure 6: Depicting significant improvement in function, pain, stability and mobility components of ROWE score after Eden-Hybinette procedure

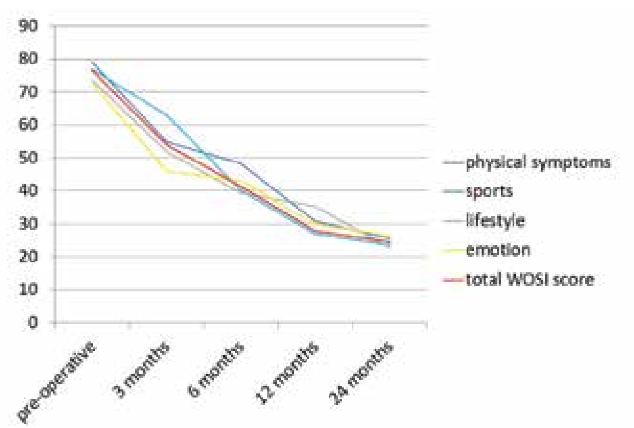


Figure 7: Depicting improvement in physical symptoms, sports, lifestyle and emotion components of WOSI index after Eden-Hybinette procedure

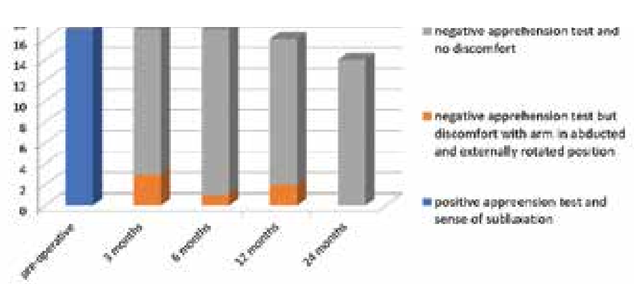


Figure 8: Depicting stability after Eden-Hybinette procedure

Stability was defined by a negative apprehension sign and good functional range of motion. All 18 patients had positive apprehension test and a sense of subluxation pre-operatively. At three months 14 patients had negative apprehension test, 4 patients had negative apprehension test but some discomfort when the arm was placed in abducted and externally rotated position and none had a positive apprehension test. At six months 1 6 patien ts had negative apprehension test, 2 patients had negative apprehension test but some discomfort when the arm was placed in abducted and externally rotated position and none had a positive apprehension test. At twelve months 15 patients had negative apprehension test, 2 patients had negative apprehension test but some discomfort when the arm was placed in abducted and externally rotated position and none had a positive apprehension test. At two years all 15 patients completing follow-up had negative apprehension test [Figure 8]. There was significant improvement in mobility with 14 patients regaining normal range of motion and 4 patients in whom remplissage was added having a loss of external rotation of less than 25 degrees.

## DISCUSSION

High energy traumatic shoulder dislocation can result in significant glenohumeral bone deficiency leading to subsequent multiple low energy or spontaneous events. Also, recurrent shoulder instability may lead to erosion or impaction resulting in bone loss. Burkhart et al. [6], in a case series involving 194 consecutive arthroscopic Bankart repairs performed using the suture anchor technique, observed that significant bone defects were present in 66.67% of patients with recurrent shoulder instability - either as an inverted pear-shaped glenoid or an engaging Hill-Sachs lesion. They concluded that arthroscopic Bankart repair yields optimal outcomes in patients without substantial bone loss. On reviewing the literature, bony Bankart lesions are present in approximately 20% of first-time shoulder dislocations and in up to 90% of recurrent dislocations [7]. Hill-Sachs lesions are observed in nearly 100% of patients with recurrent dislocations, compared to about 67% in those experiencing a first-time dislocation [8,9,10]. In our study four patients with engaging Hill-Sachs lesions underwent concomitant remplissage.

The Eden-Hybinette procedure, first described in 1932, involved the use of an L-shaped iliac crest bone graft placed between the anterior glenoid and its periosteum, with a small portion of the graft intentionally overhanging the anterior glenoid margin and without any fixation. De Palma later modified the technique by introducing screw fixation to achieve stable graft consolidation [11].

This case series demonstrates that arthroscopic Eden–Hybinette with iliac crest bone graft can restore stability and function in patients with critical glenoid bone loss. Over a mean follow-up of 38 months, there were no re-dislocations and only one episode of subluxation, suggesting the procedure reliably restored stability in this cohort. This aligns with other reports of free bone-block procedures showing low recurrence when graft positioning and fixation are adequate. Significant, clinically meaningful improvements in both modified Rowe and WOSI scores were seen. Tahir M et al, in their systematic review of clinical and radiological outcomes concluded that arthroscopic bone block stabilisation is associated with high rates of graft union, significant improvements in the WOSI and Rowe scores, and a low rate of complications, including re-dislocation in the short to mid-term [12]. Sayegh T E et al have observed similar results in their systematic review of bone block procedures for recurrent anterior shoulder instability, using allografts [13]. In our series, the modified ROWE score and WOSI scores revealed excellent to good functional outcome. The total ROWE score improved by 168% while the total WOSI index ameliorated by 67.9% following the Eden-Hybinette procedure. Both the objective scoring criteria were inversely correlated. Lunn et al [14], demonstrated objective good to excellent outcomes as per the modified ROWE scoring in 82% of patients with 12% rate of re-dislocation and 6% rate of recurrent dislocation. In our study none of the patients had re-dislocation. Hazra S et al, have reported similar results in their case series including patients undergoing open or arthroscopic Eden-Hybinette procedure for recurrent instability after an index procedure [15]. Majority (77.78%) of the patients in our series regained normal ROM. The limited loss of less than 25 degrees in a minority, when remplissage was added, is an important consideration when compared to coracoid transfer techniques which may impose greater external rotation loss. Iliac crest bone graft offers cancellous bone favourable for incorporation. The operative time in our series (80 min) is shorter than most Latarjet series [16], and revision to Latarjet remains possible if needed. In this series, the use of cerclage tape fixation appears to provide stable fixation with low hardware-related morbidity, though longer-term radiographic graft incorporation data would strengthen this conclusion. Donor-site sensory disturbances in four and superficial infections in two cases were the principal complications. Donor-site morbidity remains a

| ROWE score Mean ± SD | Function | pain | stability | Mobility | total score |
|---|---|---|---|---|---|
| pre -operative | 12.24 ± 3.1 | 6.82 ± 1.2 | 10.52 ± 2.1 | 2.5 ± 0.8 | 29.16 ± 6.1 |
| 3 months | 25.56 ± 4.5 | 6.75 ± 1.3 | 20.25 ± 3.1 | 6.5 ± 1.2 | 59.06 ± 8.5 |
| 6 months | 35.65 ± 5.2 | 7.45 ± 1.4 | 20.5 ± 2.8 | 7.1 ± 1.3 | 70.7± 9.1 |
| 12 months | 39.5 ± 4.1 | 7.66 ± 1.2 | 20.75 ± 2.7 | 7.33 ± 1.2 | 76.25 ± 8.2 |
| 24 months | 40.5± 3.5 | 8.16 ± 1.1 | 22.25 ± 2.5 | 8.53 ± 1.1 | 78.25 ± 7.2 |
| % change | +231.1% | +19.6% | +111.6% | +241.2% | +168.4% |
| p-value | <0.001 | <0.01 | <0.01 | <0.001 | <0.001 |

Table 1: Rowe scores depicted as mean with significant improvement in function, pain, stability and mobility scores after Eden-Hybinette procedure

| WOSI index Mean ± SD | physical symptoms | Sports | lifestyle | emotion | total score |
|---|---|---|---|---|---|
| pre -operative | 78.99 ± 8.1 | 76.99 ± 7.5 | 73.5 ± 7.2 | 72.75 ± 7.1 | 76.52 ± 7.5 |
| 3 months | 54.89 ± 6.5 | 62.89 ± 7.1 | 51.89 ± 6.5 | 45.89 ± 6.2 | 53.89 ± 6.8 |
| 6 months | 48.25 ± 6.2 | 40.25 ± 6.5 | 39.25 ± 6.1 | 43.25 ± 5.8 | 41.25 ± 6.2 |
| 12 months | 30.86 ± 5.5 | 26.86 ± 5.4 | 35.25 ± 5.5 | 29.86 ± 5.2 | 27.86 ± 5.5 |
| 24 months | 25.56 ± 5.1 | 23.56 ± 4.9 | 22.56 ± 4.4 | 26.56 ± 4.8 | 24.56 ± 4.8 |
| % change | -67.6% | - 69.4% | - 69.3% | 63.5% | - 67.9% |
| p-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

Table 2: Improvement in physical symptoms, sports, lifestyle and emotion components of WOSI index after Eden-Hybinette procedure

consideration when harvesting Iliac crest bone graft and should be discussed during consent. Additionally, subtle pre-operative glenohumeral arthriti s should b e carefully excluded thorough clinical evaluation and appropriate investigations.

## CONCLUSION

Arthroscopic Eden–Hybinette procedure using an iliac crest autograft is an effective option for managing recurrent anterior shoulder instability with critical (≥20%) glenoid bone loss. In this series of 18 patients, the procedure resulted in significant and clinically meaningful improvements in shoulder stability and functional outcomes at mid-term follow-up, with a low rate of recurrence and acceptable complications. Restoration of the glenoid arc allowed conversion of off-track Hill–Sachs lesions to on-track lesions while preserving shoulder range of motion in most patients. Arthroscopic Eden–Hybinette represents a reliable alternative to coracoid transfer procedures in selected patients, particularly when preservation of the coracoid is desired. Further prospective studies with larger cohorts and longer follow-up are warranted to confirm these findings.

### Limitations

This study presents the mid-term outcomes of a bony augmentation technique based on a retrospective analysis. The sample size is relatively small given the study duration, as this procedure is infrequently performed as a primary surgical option for recurrent shoulder dislocations. Larger cohorts and longer follow-up periods are needed to better assess potential complications and their impact on clinical outcomes, quality of life, and functional activities. Additionally, this study did not assess radiographic parameters such as graft union or resorption.

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Ethical Approval: The study was approved by the Institutional Ethics Committee. Informed consent was obtained from all subjects.

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# Functional and Radiological Outcomes of Proximal Femoral Nail Antirotation 2 (PFNA2) Fixation for Intertrochanteric Femur Fractures in an Asian Population: A 3-year Retrospective Analysis.

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**Abstract -** Background: Intertrochanteric femur fractures are a common orthopedic injury in the elderly population, often resulting from low-energy trauma. Achieving stable fixation that allows early mobilization remains a key goal of management. The Proximal Femoral Nail Antirotation 2 (PFNA2) system offers enhanced rotational stability and better anatomical compatibility for Asian individuals. This study aimed to evaluate the functional and radiological outcomes of PFNA2 fixation in patients with intertrochanteric femur fractures treated at MOSC Medical College, Kolenchery,Ernakulam, Kerala, India.
**Materials and Methods:** A retrospective study was conducted on 120 patients, aged 50–90 years, who underwent PFNA2 fixation for intertrochanteric femur fractures at MOSC Medical College, Kolenchery, Ernakulam, between January 2021 and December 2023. Fractures were classified according to the Boyd and Griffin classification. Functional outcomes were assessed using the Harris Hip Score (HHS), and radiological evaluation was done for fracture union, implant position, and complications. Patients were followed up for a minimum of 12 months. Results: The mean age of patients was 72.4 years, with a male-to-female ratio of 1:1.3. The average time to radiological union was 14.8 weeks. Based on the Harris Hip Score, 80% of patients achieved good to excellent outcomes, 15% had fair results, and 5% had poor outcomes. Complications observed included varus malalignment in 4%, superficial infection in 3%, and limb shortening in 2% of cases. No cases of implant failure or cut-out were reported. Conclusion: PFNA2 fixation provides reliable and excellent functional and radiological outcomes in the management of intertrochanteric femur fractures, especially in elderly patients. The implant design allows for stable fixation, early rehabilitation, and a low complication rate, making it a preferred choice for treating these fractures.
Keywords: PFNA2, Intertrochanteric femur fracture, Harris Hip Score, Functional outcome, Radiological outcome, Elderly patients.

## INTRODUCTION

Intertrochanteric femur fractures are a significant public health burden, primarily affecting the elderly population due to osteoporosis and a predisposition to falls[1],[2]. With the global increase in life expectancy, the incidence of these fractures continues to rise, placing substantial demand on healthcare systems. The primary goals of treating these fractures are to achieve stable internal fixation, facilitate early mobilization, minimize complications, and restore pre-injury function[3].

Surgical management, typically involving internal fixation, is the gold standard for most intertrochanteric fractures. Intramedullary nailing, such as the Gamma Nail and the Proximal Femoral Nail (PFN), has gained popularity due to its biomechanical advantages, including a shorter lever arm and central load-bearing, which is particularly beneficial in osteoporotic bone [4].

The Proximal Femoral Nail Antirotation 2 (PFNA2) system is a second-generation cephalomedullary nail. Its design incorporates a large-diameter single helical blade, which is intended to compact cancellous bone, thus providing high primary stability and improved resistance to cut-out[5]. Furthermore, its specific design features, such as a narrow nail tip and an anatomical curvature, are often better suited for the smaller and straighter femur commonly observed in Asian populations[6].

This study aimed to retrospectively evaluate the functional and radiological outcomes of PFNA2 fixation in a cohort of elderly patients with intertrochanteric femur fractures treated at a tertiary care center in South India,

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focusing on union rates, functional recovery measured by the Harris Hip Score (HHS), and the incidence of complications.

## Materials and Methods

### Study Design and Population

This was a retrospective study. We reviewed the medical records of all patients who underwent surgical fixation with the PFNA2 system for intertrochanteric femur fractures at the Department of Orthopaedics, MOSC Medical College, Kolenchery, Ernakulam, Kerala, India, between January 2021 and December 2023.

Inclusion and Exclusion Criteria

Inclusion Criteria:

1. Age between 50 and 90 years.
2. Unilateral, closed intertrochanteric femur fractures (Type A1, A2, or A3 according to the AO/OTA classification, or Boyd and Griffin Types I-IV).
3. Treatment with the PFNA2 intramedullary nail system.
4. Minimum post-operative follow-up period of 12 months.

Exclusion Criteria:

1. Open fractures.
2. Pathological fractures (excluding senile osteoporosis).
3. Pre-existing ipsilateral hip joint diseases (e.g., severe arthritis, previous hip surgery).
4. Polytrauma patients with other unstable long bone fractures.
5. Patients lost to follow-up before 12 months.

A total of 120 patients meeting the inclusion criteria were included in the final analysis.

### Surgical Technique

All surgeries were performed by experienced orthopedic surgeons under spinal or general anesthesia, typically on a fracture table in a supine position. The standard minimally invasive technique for PFNA2 insertion was employed.

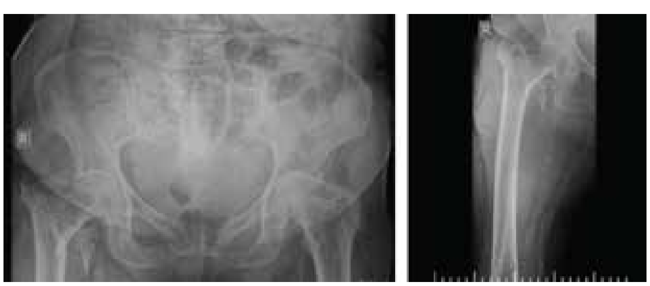

Figure 1: Pre operative x rays

1. Reduction: Closed reduction was attempted under fluoroscopy guidance. Open reduction was performed only if closed reduction failed to achieve acceptable alignment.
2. Nail Insertion: A standard lateral incision was made, and the entry point was centered on the tip of the greater trochanter. The nail was inserted after sequential reaming of the medullary canal.
3. Helical Blade Insertion: The single helical blade was inserted into the femoral head, aiming for a Tip-Apex Distance (TAD) of less than 25 mm, a critical parameter for preventing cut-out[7].
4. Distal Locking: Static distal locking was performed using the jig or freehand technique.


Figure 2: Immediate post operative X ray (AP view)

### Fracture Classification

Fractures were classified pre-operatively based on the Boyd and Griffin classification from plain radiographs (anteroposterior and lateral views) and corroborated by intraoperative fluoroscopy (Table 1).

| Fracture Type | Description | Number of Patients (n) | Percentage (%) |
|---|---|---|---|
| Type I | Simple, stable, two-part fracture | 25 | 20.8 |
| Type II | Stable, multi-fragmentary, with intact lesser trochanter | 40 | 33.3 |
| Type III | Unstable, multi-fragmentary, with comminution of posterior-medial wall | 35 | 29.2 |
| Type IV | Unstable, involving subtrochanteric region/reverse obliquity | 20 | 16.7 |
| Total | | 120 | 100.0 |

Table 1: Distribution of Intertrochanteric Fractures by Boyd and Griffin Classification

### Outcome Assessment

All patients were followed up at 6 weeks, 3 months, 6 months, and 12 months post-operatively.

### Functional Outcome

Functional outcome was assessed at the 12-month follow-up using the Harris Hip Score (HHS)[8]. The HHS ranges from 0 to 100 points and was categorized as follows:

- Excellent: 90–100 points
- Good: 80–89 points
- Fair: 70–79 points
- Poor: <70 points

### Radiological Outcome

Radiological union was defined as the presence of continuous bridging bone across the fracture site on both anteroposterior and lateral radiographs, with obliteration of the fracture line and absence of pain at the fracture site upon weight-bearing. The time to radiological union was recorded. Implant position, specifically the TAD, was measured on the immediate post-operative radiographs.

### Complications

Intraoperative and post-operative complications were recorded, including deep vein thrombosis (DVT), infection (superficial or deep), varus malalignment (defined as a collapse of >5 degree or loss of neck-shaft angle), implant cut-out, implant failure, and non-union (absence of union by 9 months).

### Statistical Analysis

Descriptive statistics, including mean and standard deviation (SD) for continuous variables and frequencies and percentages for categorical variables, were calculated. Data analysis was performed using SPSS statistical software (version 25.0).

### Post-operative Rehabilitation

A standardized, protocol-based rehabilitation program was followed for all patients.

Immediate Post-operative Phase (Days 1–7)

- Weight-Bearing: Touch-down weight-bearing (TDWB) was initiated on the operated limb using a walker or crutches, depending on the stability of the fixation and patient tolerance. Non-weight bearing was reserved only for severe comminution or unstable fixations.
- Physiotherapy: Passive and active-assisted range of motion (ROM) exercises for the hip and knee were started on Day 1. Isometric quadriceps and gluteal muscle strengthening exercises were also initiated.
- Deep Breathing Exercises: Encouraged to prevent pulmonary complications.

Intermediate Phase (Weeks 2–6)

- Progression of Weight-Bearing: Patients progressed from toe touch weight bearing to partial weight-bearing (PWB) whwn pain reduced and muscle control improved. The goal was to attain about 25% of body weight.
- Strengthening: Progressive resistive exercises for hip abductors, extensors, and knee flexors/extensors.
- Gait Training: Focus on proper gait pattern with assistive devices like walkers.

Late Phase (Weeks 7–12)

- Radiological Assessment: Follow-up X-rays were taken at 6 weeks. If adequate callus formation and early union signs were present, PWB was increased to 50% of body weight.
- Full Weight-Bearing: Typically initiated between 8 and 12 weeks, contingent on clinical and radiological signs of union.
- Functional Training: Stair climbing, balance exercises, and endurance training.

Maintenance Phase (After 3 Months)

- The goal was to achieve maximum functional recovery.
- Patients were advised to continue home exercise programs and transition away from walking aids as tolerance allowed. Final functional outcome assessment (HHS) was performed at 12 months.

**Immediate phase: Toe touch weight bearing, ROM**

↓

**Intermediate phase: PWB, Strengthening**

↓

**Late phase : FWB, Gait training**

↓

**Maintenance Phase : Maximal function**

Flow Chart 1: Post-operative Rehabilitation Protocol

## RESULTS

### Demographic and Clinical Characteristics

The study included 120 patients. The mean age was 72.4 +/- 8.6 years (range, 50–90 years). There was a female predominance, with a male-to-female ratio of 1:1.3 (52 males, 68 females). The average duration of surgery was 60 ± 15 minutes, and the mean estimated blood loss was 200 +/- 50 ml. The average Tip-Apex Distance (TAD) achieved was 18+/- 2 mm.

### Radiological Outcomes

The average time to radiological union for the entire cohort was 14.8 +/-2.1 weeks (range, 12–24 weeks). Complete radiological union was achieved in 118 out of 120 patients (98.3%). Two patients were diagnosed with delayed union but eventually united after 6 months with focused physiotherapy and non-surgical management. No cases of non-union (absence of union at 9 months) were reported.

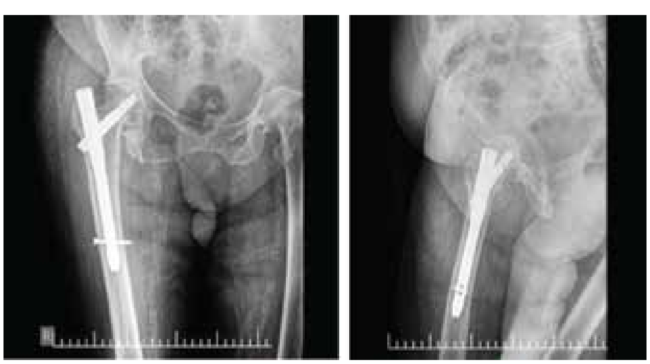

Figure 3 : 6 months post operative X ray (AP& Lateral)

Figure 4 : 1 year post operative X ray

### Functional Outcomes

The mean Harris Hip Score (HHS) at the 12-month follow-up was 86.5+/- 9.5 points. The functional results, categorized according to the HHS, were excellent in 40 patients (33.3%), good in 56 patients (46.7%), fair in 18 patients (15.0%), and poor in 6 patients (5.0%). Overall, 80% of patients achieved a good to excellent functional outcome.

Table 2: Functional Outcome Assessment using Harris Hip Score (HHS) at 12 Months

Figure 5 : Distribution of Functional Outcomes (Harris Hip Score) at 12 Months

### Complications

The overall complication rate was low, with a total of 9 patients (7.5%) experiencing minor or local complications (Table 3).

Table 3: Summary of Complications

The most common complication was varus malalignment, observed in 4.2% of cases. All five cases were minor (collapse <10 degree) and did not necessitate revision surgery; they were managed conservatively. Superficial surgical site infection occurred in 3.3% of patients and resolved completely with a short course of oral antibiotics. Importantly, no cases of implant failure, helical blade cut-out, or deep infection requiring hardware removal were recorded, which is a key finding for the biomechanical stability of the PFNA2.

## DISCUSSION

The management of intertrochanteric femur fractures in the elderly is challenging. Our findings demonstrate that PFNA2 fixation provides excellent to good stability and reliable outcomes in this challenging patient population especially elderly patients.

The mean time to radiological union in our study was 14.8 weeks, which is consistent with the other general literatures on intramedullary fixation for these fractures, often cited

| **HHS Category** | **HHS Score (Points)** | **Number of Patients (n)** | **Percentage (%)** |
|---|---|---|---|
| **Excellent** | 90 – 1 00 | 40 | 33.3 |
| **Good** | 80 – 89 | 56 | 46.7 |
| **Fair** | 70 – 79 | 18 | 15.0 |
| **Poor** | <70 | 6 | 5.0 |
| **Total** | | **120** | **100.0** |

Table 2: Functional Outcome Assessment using Harris Hip Score (HHS) at 12 Months

| **Complication** | **Number of Patients (n)** | **Percentage (%)** | **Management** |
|---|---|---|---|
| **Varus Malalignment** | 5 | 4.2 | Managed conservatively with continued physiotherapy. |
| **Superficial Surgical Site Infection** | 4 | 3.3 | Treated with oral antibiotics and local wound care. |
| **Limb Shortening (>1 cm)** | 2 | 1.7 | Managed with shoe lift; patient satisfaction was high. |
| **Implant Cut out/Failure -** | 0 | 0.0 | None reported. |
| **Non-union** | 0 | 0.0 | None reported. |
| **Deep Venous Thrombosis (DVT)** | 1 | 0.8 | Managed with anticoagulants. |
| **Total Patients with Complication** | **9** | **7.5** | |

Table 3: Summary of Complications

between 12 and 20 weeks [9]. The high union rate (98.3%) and the absence of implant cut-out or mechanical failure are the biomechanical advantages of the PFNA2 system. The single, large-diameter helical blade is proved to provide superior rotational stability and better purchase in osteoporotic bone compared to screws of conventional PFN, thus reducing hardware migration and subsequent cut-out[5]. This excellent hardware performance is likely due to meticulous surgical technique, with an average Tip-Apex Distance of 18.5 mm, well below the critical threshold of 25 mm[7].

The functional outcome, as measured by the Harris Hip Score (HHS) [8], showed that 80% of our patients achieved good to excellent results. This is comparable to many published series using various intramedullary nails, where good-to-excellent results often range from 70% to 85% [10]. The emphasis on a structured, early mobilization rehabilitation protocol likely contributed significantly to this favourable functional recovery, as delayed weight-bearing can lead to prolonged hospitalization, muscle wasting, and loss of independence in the elderly[11].

The low complication rate (7.5% overall) further supports the efficacy of the PFNA2 system. The absence of deep infection or implant failure is a critical indicator of success.

A notable strength of this study is the focus on an Asian population. Anatomical studies suggest that Asian femur may be smaller, straighter, and have a more prominent anterior bow than their Caucasian counterparts, which can complicate the insertion of some Western-designed intramedullary nails[6].

**Limitations**

The main limitation of this study is its retrospective nature, which is susceptible to selection and information bias. The lack of a direct comparative group (e.g., against DHS or PFN) limits the ability to draw definitive conclusions about the PFNA2's superiority. Furthermore, relying on the HHS alone may not capture the full extent of patient-reported quality of life.

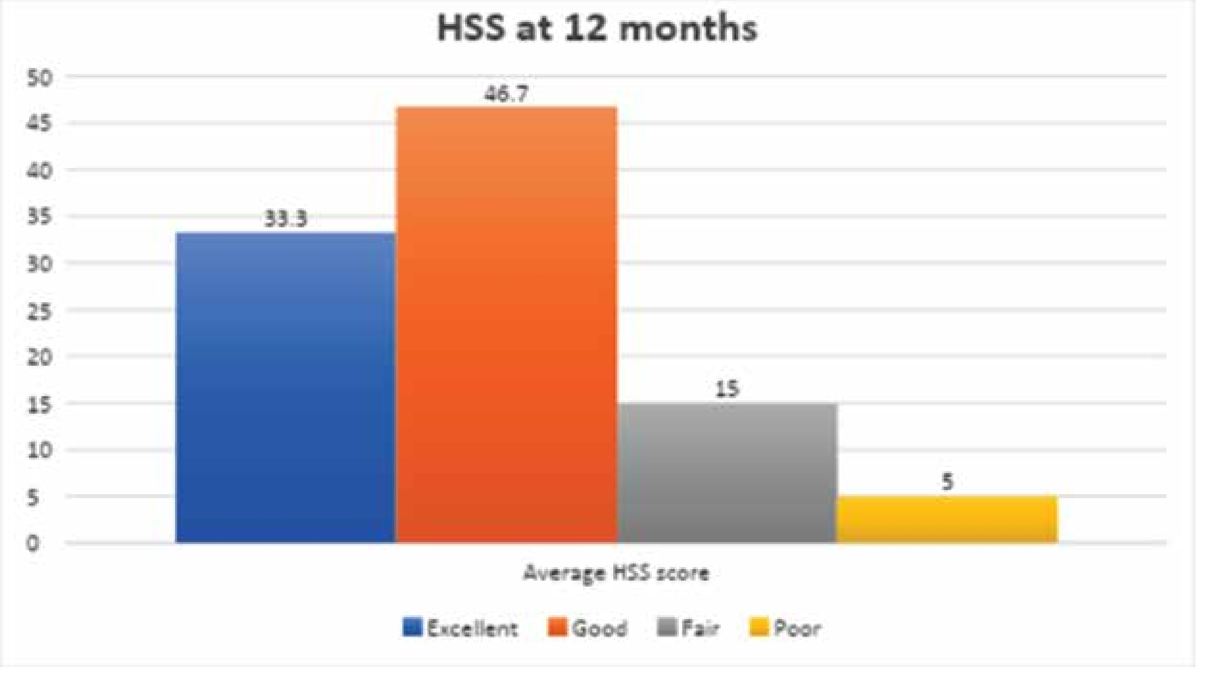


Figure 5 : Distribution of functional outcome at 12 months

## CONCLUSION

The Proximal Femoral Nail Antirotation 2 (PFNA2) system provides Good to excellent functional and radiological outcomes in the management of intertrochanteric femur fractures in the elderly population. Based on our 12-month follow-up data, the PFNA2 remains a preferred and effective choice for the surgical treatment of intertrochanteric femur fractures especially in osteoporotic bones.

Conflict of interest
The authors declare that they have no conflict of interest.
Funding
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Ethical approval
Ethical approval was not required.
Informed consent
Written informed consent was obtained from the patient.

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# Mid-Term Outcomes of Shoulder Resurfacing Arthroplasty for Glenohumeral Osteoarthritis

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**Abstract -** Introduction: Shoulder resurfacing arthroplasty has gained popularity as a bone-preserving alternative to conventional total or hemi shoulder arthroplasty in patients with glenohumeral osteoarthritis. By maintaining native humeral head geometry and bone stock, resurfacing facilitates easier future revisions and potentially restores more natural joint kinematics. This study evaluates the mid-term clinical, functional, and radiological outcomes of humeral head resurfacing using the Global® CAP® (DePuy Synthes, Warsaw, IN, USA) prosthesis performed at a single centre, with a average follow-up of about 6 years.

**Materials and Methods**: A retrospective observational study was conducted of 18 shoulders (15 patients) who underwent shoulder resurfacing arthroplasty between 2014 and 2020 for primary glenohumeral osteoarthritis. Inclusion criteria included intact rotator cuff, adequate humeral head bone stock (>60%), and minimum 4 year follow-up. All procedures were performed through a deltopectoral approach by a single surgeon. The Global® CAP® humeral resurfacing prosthesis was implanted; no glenoid component was used. Clinical evaluation included active range of motion (ROM), Visual Analogue Scale (VAS) for pain, and Constant–Murley score (CMS). Radiographs were assessed for component positioning, loosening, and glenoid erosion. Statistical analysis was performed using the SPSS software.

Results: The mean patient age was 55.4 years (range 38–70). The average follow-up duration was 6.2 years (range 4–9). Mean active forward flexion improved from 94° ± 16° preoperatively to 150° ± 12° at final follow-up ($p < 0.05$); abduction increased from 87° ± 18° to 140° ± 15° ($p < 0.05$); and external rotation from 10° ± 8° to 45° ± 10° ($p < 0.05$). Mean VAS pain score decreased from 7.1 ± 1.2 to 1.3 ± 0.7 ($p < 0.05$). Mean CMS improved from 31.2 ± 7.8 to 78.5 ± 9.2 ($p < 0.05$). Radiographically, all implants demonstrated stable fixation without radiolucent lines or loosening. Mild varus positioning (mean neck-shaft angle 133° ± 3°) was noted in approximately one-third of cases, but without clinical consequence. No patient required revision surgery, and there were no cases of infection, periprosthetic fracture, or glenoid medialization.

Conclusion: Mid-term outcomes following shoulder resurfacing arthroplasty using the Global® CAP® prosthesis for glenohumeral osteoarthritis demonstrated good pain relief, functional improvement, and implant survivorship. The procedure offers predictable results when performed in appropriately selected patients with preserved rotator cuff function and adequate humeral bone stock. Humeral resurfacing remains a reliable, bone-conserving alternative to stemmed arthroplasty for younger and active patients, with the added benefit of simple future conversion if required.

Keywords: Shoulder resurfacing arthroplasty, Global CAP, Glenohumeral osteoarthritis, Bone preservation

## INTRODUCTION

The practice of shoulder arthroplasty has evolved markedly over more than a century. The first shoulder prosthesis was implanted by French surgeon Péan in 1893, but it was Neer's pioneering work in the 1950s that popularized shoulder replacement for fractures and osteoarthritis[1]. Early designs were simple hemiarthroplasties or total shoulder replacements (TSA), each with drawbacks such as glenoid wear or component loosening. These limitations spurred interest in joint-surface-preservingimplants (surface11replacements) to better restore anatomy and preserve bone stock[2]. Humeral head resurfacing arthroplasty (HRA) involves reaming only the epiphyseal surface of the humeral head and capping it with a prosthetic "cap", avoiding a stemmed humeral implant [(3)]. In contrast to stemmed arthroplasties, resurfacing retains the native humeral neck and most of the head, preserving bone and the native head-shaft angle[(1)(4)]. Modern resurfacing designs have benefited from advances in hip resurfacing: first-generation models used cement fixation, followed by implants with a central stem and porous or

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hydroxyapatite-coated surfaces for bone ingrowth[5]. Contemporary devices (e.g. Copeland, Global CAP) offer various sizes and offsets, with improved fixation. The goal of shoulder resurfacing is to reproduce the patient's native anatomy (head size, version, offset) and kinematics. Biomechanical studies suggest resurfacing can restore normal rotation centers and avoid joint "overstuffing" if correctly sized[6].

The theoretical advantages of humeral resurfacing arthroplasty include preservation of proximal humeral bone stock (beneficial for younger patients) and simpler revision if needed [7]. Resurfacing avoids complications of stems (e.g. humeral shaft fracture) and may yield faster recovery with less blood loss. Moreover, resurfacing allows easier conversion to anatomic or reverse TSA if glenoid arthritis or cuff failure later develops. However, shoulder resurfacings have a reported high revision rate: they account for about one-third of shoulder arthroplasties and have the highest revision rates of any shoulder procedure[6].

Mid-term outcome data for resurfacing arthroplasty are still emerging. In a multicenter review, Ingoe et al. found that Global® CAP® (DePuy) hemi-resurfacing had 80% implant survival at 7 years, comparable to other resurfacing results [6]. Giannotti et al. (2023) recently reported excellent functional recovery and minimal loosening over 11-year follow-up in 33 HRA cases [8].. To our knowledge, no study has yet reported outcomes of Global® CAP® resurfacing from our region. We therefore performed a single-center retrospective cohort analysis of patients with glenohumeral osteoarthritis treated with Global® CAP® resurfacing. We hypothesized that, at mid-term (mean >5 years) follow-up, patients would show significant pain relief and functional gains without major implant problems.

## Materials and Methods

We retrospectively reviewed all patients who underwent humeral head resurfacing arthroplasty for primary glenohumeral osteoarthritis at our institution between January 2014 and December 2020. The study was approved by the institutional review board (IRB approval was waived given the retrospective design). Informed consent for data collection was obtained from all patients.
Inclusion criteria were:[1] primary glenohumeral osteoarthritis (Walch A1/A2 type glenoid or B1, according to preoperative imaging), [2] intact rotator cuff,[3] sufficient humeral head bone stock (>60% of articular surface) for resurfacing, [4] age 18–70 years, and [5] available follow-up of 4≥ years. Exclusion criteria included inflammatory arthritis, large rotator cuff tears, glenoid erosion requiring anatomic TSA, prior shoulder arthroplasty, or insufficient bone stock. We identified 15 patients (18 shoulders) meeting these criteria. Of these, 8 were male and 7 female, with mean age 55.4 years (range 38–70). Three patients had bilateral procedures (one simultaneously in a staged manner, two sequentially).

Surgical Technique: All operations were performed by a single shoulder surgeon. A standard deltopectoral approach was used in all cases. The subscapularis tendon was exposed, tagged and tenotomized approximately 1 cm from its insertion on the lesser tuberosity. The long head of the biceps was tenotomized in all cases without tenodesis. The humeral head was dislocated anteriorly and surrounding osteophytes were removed to outline the neck and anatomic landmarks. Care was taken to achieve appropriate version and inclination matching the patient's anatomy.

With the arm in neutral rotation, a guide pin was placed centrally through the humeral head parallel to the native neck. A cannulated reamer was then used over the guide pin to sequentially remove articular cartilage and shape the residual subchondral bone. A central peg hole was drilled. Trial cups were placed to verify sizing, offset, and stability of trial reductions. The definitive Global CAP (DePuy Synthes) humeral resurfacing prosthesis was then inserted. The glenoid was denervated and all glenoid osteophytes were removed. The subscapularis tendon was re-approximated with multiple non-absorbable sutures. The wound was closed in layers. A schematic of these operative steps is summarized in Figure 1.

Postoperatively, the arm was supported in a shoulder sling in internal rotation for 3 weeks. Pendulum and passive motion exercises of flexion and abduction were initiated on postoperative day one under sling protection. Active-assisted elevation and abduction were allowed after 3 weeks, progressing gradually. External and internal rotations were delayed until after 6 weeks. Active strengthening was begun around 6–8 weeks post-op. Patients were advised to avoid heavy lifting or strenuous activities for 3 months. Weight training was started at 3 months. All patients were evaluated preoperatively and at regular intervals postoperatively (6 weeks, 3 months, 6 months, 1 year, and then annually). Clinical assessment included active range of motion (ROM) measured with a goniometer (forward flexion, abduction, external rotation at side, internal rotation recorded as the highest vertebral level reached). Pain was quantified by a 10-point visual analogue scale (VAS). Shoulder function was assessed by the Constant–Murley score (absolute score out of 100). Pre and postoperative Constant scores, VAS and ROM were recorded and compared. Standard anteroposterior and axial shoulder radiographs were obtained at each follow-up. Humeral component position was assessed by measuring the neck-shaft angle to detect varus or valgus inclination. Central peg seating and any radiolucent lines were noted. The glenoid was inspected for erosion or medialization of the humeral head. Radiographic osteolysis or loosening (periprosthetic lucencies) was defined if present.

Statistical Analysis: Continuous variables are presented as means with standard deviations or ranges. Paired comparisons of pre- and post-operative scores (Constant, VAS) and ROM were performed comparison Student's t-test, with p<0.05 considered significant. No patients were lost to follow-up for functional assessment; all were contacted for any history of further shoulder procedures.


Figure 1 : A) Exposed humeral head with arthritic changes. B) Guide to place central pin. C) Cannulated reamer used over guidepin to remove articular cartilage. D) Central peg hole drilled. E) Global CAP prosthesis inserted.

**Results**

The study cohort included 15 patients (18 shoulders; 11 right, 7 left). The mean patient age was 55.4±9.8 years (range 38–70) at the time of surgery. Indication was primary glenohumeral osteoarthritis in all cases. The mean follow-up duration was 6.2±0.8 years (range 4.0–9.0 years), with 14 shoulders (78%) followed >5 years All patients demonstrated substantial improvements in shoulder mobility. Mean active forward flexion increased from 94°±16° preoperatively to 150°±12° at final follow-up (p<0.05). Active abduction improved from 87°±18° to 140°±15° (p<0.05). External rotation at the side improved from a mean of 10°±8° pre-op to 45°±10° post-op (p<0.05). Internal rotation (measured by highest vertebral level) improved from the sacrum (mean L5 level) up to approximately T8–T7 in most shoulders. All ROM gains were statistically significant. Patients reported marked pain relief. The mean VAS pain score decreased from 7.1±1.2 (severe pain) preoperatively to 1.8±0.7 (mild pain) postoperatively (p<0.05). Correspondingly, the mean Constant–Murley shoulder score improved significantly from 31.2±7.8 (range 18–45) before surgery to 78.5±9.2 (range 65–95) at final follow-up (p<0.05). At the latest follow-up, all implants appeared well-positioned without signs of loosening or migration. No radiolucent lines were visible around any humeral component. The mean humeral neck-shaft angle was 132°±3° postoperatively (6° varus from the standard 138°), indicating that a subset of implants (approximately 6/18, 33%) were placed in slight varus (neck-shaft <130°). This varus placement rate is similar to what has been noted by others. No progressive glenoid erosion or medialization was observed on serial radiographs. One patient had a subtle 3 mm medial shift of the center of rotation at 5-year film ,without clinical symptoms.

There were no intraoperative complications such as fracture or neurovascular injury. Postoperatively, one patient developed a wound hematoma that resolved with aspiration. There were no infections, no glenoid bone loss requiring treatment, and no postoperative scapular fractures. Importantly, no shoulder required reoperation or revision arthroplasty during the follow-up period. One patient sustained a minor subscapularis strain 2 years post-op during heavy lifting, managed conservatively, but with stable function thereafter.

**DISCUSSION**

This single-center series demonstrates that shoulder resurfacing arthroplasty with the DePuy Global CAP prosthesis yields good mid-term results in carefully selected patients. By 4–9 years postoperatively, patients had dramatic improvements in pain and function, comparable to those reported in the literature for humeral resurfacing. Mean Constant scores rose from poor preoperative levels (~31) into the "good"/"excellent" range (~79), and VAS pain scores showed substantial pain relief, indicating good quality-of-life gains. These outcomes align with previous reports: for example, Giannotti et al. noted an increase in Constant score from 29.9 to 81.2 (p<0.05) in their HRA series (8), and Chillemi et al. reported significant improvement in Constant, VAS, and ROM in mid-term follow-up (9).

The improvements in range of motion also confirm the effectiveness of preserving native joint anatomy. Forward flexion and abduction gains (>50° increase) restored near-normal overhead motion, and external rotation averaged 45° post-op, sufficient for most daily activities. These ROM gains exceeded those reported for stemmed hemiarthroplasty in some series, suggesting that resurfacing may better maintain anatomy (10). We did not formally measure scapulothoracic motion, but no patient exhibited significant scapular dyskinesia at follow-up. Preoperatively, impaired internal rotation (reaching only the sacrum) improved to around T7–T8 level in most patients, suggesting relief of posterior cuff tightness and anterior pain.No cases required revision surgery, conversion to TSA, or suffered catastrophic implant failures. Ingoe et al. found a 7-year survival of 80% (20% revision) for Global CAP, and Giannotti et al. (mean 11-year follow-up) reported only 2 of 78 shoulders revised (3%) (6) (8). Our lack of revisions likely reflects both the younger patient age (mean 55) and rigorous selection (intact cuff, adequate bone stock). A notable concern with resurfacing is glenoid degeneration over time. We saw no clinically significant glenoid wear yet, though one shoulder showed minimal medial shift. This mirrors Giannotti's finding of no "clinically relevant central migration" in any implant at 11 years (8). Ongoing surveillance is needed, as long-term glenoid arthrosis could emerge. Radiographically, all humeral components remained well-fixed with no osteolysis or radiolucencies.


Figure 2 : A) Anteroposterior xray of glenohumeral osteoarthritis. B) Axillary view. C) MRI imaging to confirm intact rotator cuff. D) Immediate postoperative xray. E.) 5-year followup xray.

We did observe a tendency for slight varus inclination in some implants (average neck-shaft angle ~133°). Varus positioning has been described as a risk factor for later failure. Lebon et al. noted a "tendency towards varus positioning" and increased offset as possible prognostic factors for failure (11). In our series, despite mild varus in ~30% of cases, none have failed within 5 years. We attribute this to overall surgical technique and patient selection, but we remain cautious. Surgeons performing resurfacing must ensure accurate sizing and alignment to avoid 'overstuffing' the joint. Our results support the notion that shoulder resurfacing is especially advantageous in younger or middle-aged patients with isolated humeral-sided arthritis. By preserving bone stock, these patients retain the option of future revision to stemmed TSA or reverse arthroplasty if needed (12). Both Giannotti et al. and others emphasize that conversion from a resurfacing to a stemmed arthroplasty is relatively straightforward because the humeral canal is untouched (8). Compared to stemmed hemiarthroplasty or TSA, resurfacing may reduce certain risks. We observed negligible blood loss and none required transfusion. Our operative times averaged around 60 minutes, which is on par or shorter than reported for stemmed implants (13). The absence of a stem also avoids stress risers in the humeral shaft (14). In this series, no intraoperative humeral fractures occurred, whereas fracture rates of ~2–5% have been reported for some stemmed procedures (15). Furthermore, the bone-preserving nature may explain the absence of humeral osteolysis or subsidence on follow-up X-rays. From a literature standpoint, our findings are generally concordant with prior reports on humeral resurfacing. Levy and Copeland's classic series reported excellent pain relief and satisfaction with the Copeland resurfacing (the predecessor to Global CAP) (16). Long-term studies (20+ years) of Copeland resurfacings have shown ~96% prosthesis survival and high patient satisfaction, underscoring durability (17). Chillemi et al. (9) also concluded that mid-term revision rates for uncemented resurfacing are relatively low, suggesting it as a viable alternative to TSA in selected cases. Notably, our implant survival (no failures at 5+ years) is as good as most published cohorts. This may reflect shorter follow-up (mean 5.2y) or smaller sample, but it is encouraging.

Limitations of this study include its retrospective design and small sample size. Being a single-center case series, our findings may not generalize to all populations. Also, follow-up (mean 6 years) is still mid-term; longer-term surveillance is required to detect late failures or glenoid wear. Despite these limitations, the consistency of outcomes across patients and alignment with existing literature suggest the results are robust.

## CONCLUSIONS

In this series of 15 patients (18 shoulders) who underwent shoulder resurfacing arthroplasty for glenohumeral osteoarthritis, we found significant improvements in shoulder pain, range of motion and function at mid-term follow-up (mean 6.2 years). Resurfacing with the Global® CAP® (DePuy Synthes) prosthesis provided durable fixation with no aseptic loosening or implant revisions observed. These results align with recent literature on humeral resurfacing. Humeral head resurfacing should be considered a viable bone-conserving option for younger patients with isolated shoulder arthritis and intact soft tissues. Careful surgical technique (correct component sizing and alignment) is critical to avoid issues like varus malposition. Longer-term studies are required to assess the ultimate durability of these implants and the fate of the glenoid joint surface.

Ethical approval for this retrospective study was waived by our IRB.

Funding: None.

Conflict of Interest: The authors declare no conflicts of interest.

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# "She Baked It Too Long": Unusual Presentation of Migrating Giant Baker's Cyst

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Abstract-Introduction:Baker's cysts are synovial fluid–filled distensions of thesemimembranosus bursa, commonly associated with intra-articular knee pathology. gastrocnemio-semimembranosus bursa, commonly associated with intra-articular knee pathology. Inferior migration of a giant Baker's cyst into the leg is rare and may mimic other conditions such as deep vein thrombosis or soft tissue tumours.

**Case Presentation:** A 46-year-old female with long-standing rheumatoid arthritis presented with a progressively enlarging swelling in the posterior aspect of the left leg for one year. Clinical examination and imaging revealed a large cystic mass extending from the popliteal fossa into the lower third of the leg. Magnetic resonance imaging confirmed the diagnosis of a giant migrating Baker's cyst.

Management and Outcome:

The patient initially underwent diagnostic knee arthroscopy, which revealed severe degenerative changes and an identifiable cyst communication. Thorough arthroscopic debridement was performed. Owing to the large size and extensive distal migration of the cyst, open excision was subsequently undertaken with closure of the communicating neck. The postoperative course was uneventful, and no recurrence was noted at two-year follow-up.

**Conclusion:** Giant migrating Baker's cysts are uncommon and should be considered in the differential diagnosis of posterior leg swellings, particularly in patients with inflammatory knee disease. MRI is crucial for diagnosis and surgical planning. A combined approach of arthroscopic management of intra-articular pathology followed by open excision for large cysts yields excellent outcomes with minimal recurrence

Keywords:
Baker's cyst; Popliteal cyst; Rheumatoid arthritis; Migrating cyst; Giant cyst; Pseudothrombophlebitis

## INTRODUCTION:

Migrating or giant Baker's cysts may mimic other conditions such as deep vein thrombosis, soft tissue tumors, or compartment syndrome. Magnetic resonance imaging (MRI) plays a crucial role in confirming the diagnosis and delineating the extent of the cyst[3]. Management strategies increasingly emphasize treatment of the underlying intra-articular pathology, with arthroscopic techniques shown to reduce recurrence rates by addressing synovitis and the cyst communication[4,5]. However, arthroscopy alone may be insufficient in cases of large or extensively migrating cysts. We report a rare case of a giant migrating Baker's cyst extending into the lower third of the leg, managed successfully with combined arthroscopic treatment and open excision

### Case Presentation:

A 46-year-old female, a known case of rheumatoid arthritis, presented with pain and swelling in the left calf region for one year. The swelling had gradually increased in size and was associated with dull aching pain. There was no history of trauma, fever, loss of appetite, or weight loss.

On clinical examination, a large cystic swelling was noted extending from the posteromedial aspect of the knee to the lower one-third of the leg. There was no local rise in temperature or tenderness. Knee range of motion was 0–110°, limited by pain. Distal neurovascular examination was normal, and distal pulses were palpable (Figure 1).

### Investigations:

Ultrasonography: Anechoic cystic lesion in the posterior aspect of the knee extending into the leg along the intermuscular plane, with no internal vascularity.

Colour Doppler: No evidence of deep vein thrombosis.

MRI: A giant cystic lesion with mild diffusion restriction originating from the popliteal fossa and extending inferiorly up to the lower one-third of the leg, located between the medial head of gastrocnemius and soleus muscles, measuring 27 × 8.5 cm—consistent with a giant Baker's cyst.

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Figure 1:

**Surgical Technique:**

The procedure was performed under regional anesthesia with the patient in the supine position. A diagnostic knee arthroscopy was first carried out through standard anterolateral and anteromedial portals. Arthroscopic evaluation revealed Outerbridge grade 2 degenerative changes, with inflamed synovium. The mouth of the Baker's cyst.

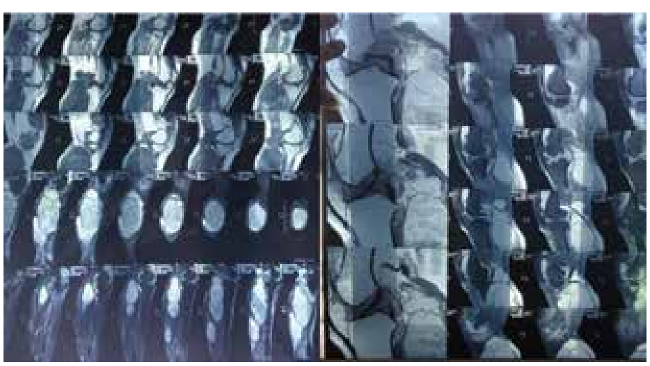

Figure 2:

Based on clinical and radiological findings, a diagnosis of migrating giant Baker's cyst was made communicating with the knee joint was identified in the posteromedial compartment. Arthroscopic decompression was attempted but failed because the cyst contents were thick and could not be decompressed. A thorough arthroscopic debridement was performed, including synovectomy and lavage, to address intra-articular pathology and reduce synovial fluid production. Given the large size and extensive distal migration of the cyst, and in view of the unsuccessful arthroscopic decompression, an open excision was planned. A 15-cm vertical incision was made which was further extended 5 cm caudally later, along the posteromedial aspect of the left knee extending into the lower leg. The medial head of the gastrocnemius was exposed, revealing a well-encapsulated cystic lesion located between the gastrocnemius and soleus muscles (Figure 3). Because the cyst was tense, complete dissection could not be achieved without drainage. The cyst contained thick synovial fluid with degenerated synovial tissue(Figure 4).

Figure 3:

The cyst wall was meticulously dissected and excised in toto.

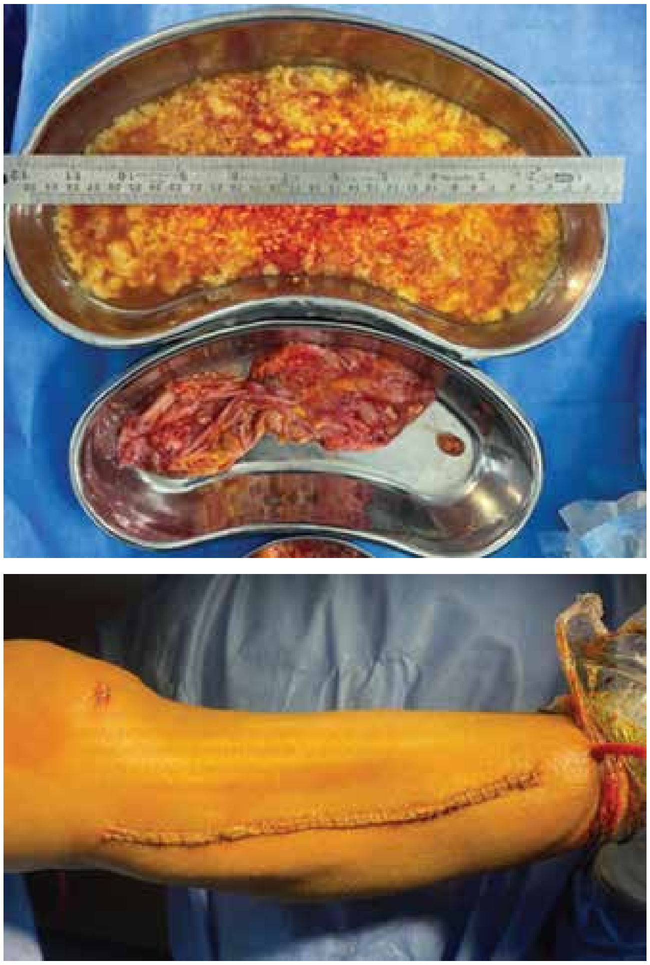

Figure 4:

Samples sent for study. The communicating neck between the cyst and the knee joint was identified and closed using non-absorbable sutures to prevent recurrence (Figure 5). Hemostasis was achieved, and the wound was closed in layers over a suction drain.

### Postoperative Course and Follow-up

The postoperative period was uneventful. Sutures were removed at two weeks. The histopathology report shows synovitis with giant cell reaction and necrosis. Microscopy shows hyperplastic synovium with inflammatory cells. Follow-up at 6 weeks, 3 months, and 6 months demonstrated good wound healing and restoration of knee function(Figure 6). At two-year follow-up, there was no recurrence of swelling or symptoms.

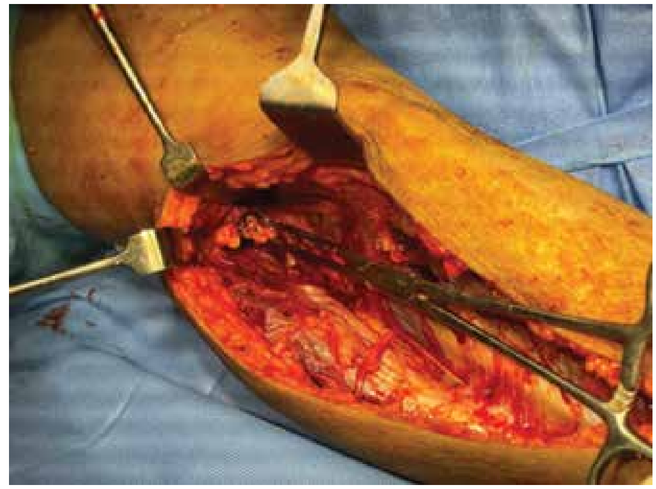

Figure 5:

## DISCUSSION

Baker's cysts are synovial-lined fluid collections that arise between the medial head of the gastrocnemius and the semimembranosus tendon, first described in the 19th century[1,2]. They are commonly associated with underlying intra-articular knee pathology, particularly inflammatory and degenerative conditions, which create a one-way valve mechanism allowing synovial fluid to accumulate within the cyst[1–3].

Although most Baker's cysts remain confined to the popliteal fossa, rare cases demonstrate marked enlargement with distal migration along intermuscular planes. Such atypical presentations are uncommon and may mimic conditions such as deep vein thrombosis or soft-tissue neoplasms, leading to diagnostic challenges[1–3]. In the present case, the cyst extended well beyond the popliteal fossa into the lower third of the leg, representing a rare and unusual manifestation.

Current treatment strategies emphasise addressing the underlying intra-articular pathology to reduce synovial fluid production and minimise recurrence. Arthroscopic management allows identification and treatment of the cyst communication, synovitis, and associated degenerative changes, and is often sufficient for symptomatic relief in typical cases[4,5]. However, in giant or extensively migrating cysts, arthroscopy alone may be inadequate to achieve complete decompression or sustained symptom resolution.

In this case, arthroscopy revealed severe intra-articular degenerative changes, and thorough debridement was performed. Despite this, adequate decompression could not be achieved arthroscopically due to the cyst's large size, distal extension, and thick contents. Consequently, open excision was required to allow complete removal of the cyst and secure closure of its communicating neck. This combined arthroscopic and open approach addressed both

Figure 6:

the intra-articular pathology and the extra-articular cyst, resulting in excellent functional recovery with no recurrence at two-year follow-up

**CONCLUSION:**

Giant migrating Baker's cysts are rare and can present as posterior leg swellings that mimic other serious pathologies, particularly in patients with inflammatory or degenerative knee disease. Magnetic resonance imaging is essential for accurate diagnosis and assessment of cyst extent. A combined approach addressing intra-articular pathology through arthroscopy, followed by open excision for large or extensively migrating cysts, provides excellent clinical outcomes with a low risk of recurrence.

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# Muscle Advancement and Suprascapular Nerve Release for Massive IrreparablePosterosuperior Rotator Cuff Tears: Functional and Clinical Outcomes

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**Abstract** - Introduction: The management of massive irreparable posterosuperior rotator cuff tears (MIRCTs) without significant glenohumeral arthritis remains challenging. Conventional repairs often fail due to tendon retraction, fatty atrophy, and chronicity. Muscle advancement (MA) allows anatomical reduction and tension-free repair, potentially improving reparability and outcomes.

**Purpose**: To assess the clinical and functional outcomes of patients with massive irreparable cuff tears who underwent rotator cuff repair with Muscle Advancement.

**Methods**: This was a retrospective case series of 26 patients with massive irreparable posterosuperior cuff tears who underwent the arthroscopic muscle advancement technique between January 2022 and August 2024, with a minimum follow-up of 12 months. Preoperative MRI evaluated tear chronicity, tendon retraction, and Goutallier grade. Patients were assessed using the Constant-Murley (CMS), American Shoulder and Elbow Surgeons (ASES) scores, Visual Analogue Scale (VAS) for pain, and range of motion (ROM) at baseline and 12 months postoperatively.

**Results**: The mean CMS improved from 40 preoperatively to 74 at 12 months, while the ASES improved from 39 to 68. VAS scores decreased significantly from 7.2 to 2.1. Mean active forward elevation improved from 90° to 150°, and external rotation from 20° to 45°. No clinical evidence of retears were observed during followup. .

**Conclusion**: Arthroscopic muscle advancement with suprascapular nerve release provides a reliable, joint-preserving option for MIRCTs, restoring function and reducing pain without graft augmentation.

Keywords: Irreparable rotator cuff tear; muscle advancement; suprascapular nerve release;

## INTRODUCTION

Massive irreparable posterosuperior rotator cuff tears (MIRCTs) represent one of the most complex clinical challenges in shoulder surgery . These injuries, typically involving two or more tendons, lead to a profound disruption of the glenohumeral joint's biomechanics, often resulting in significant pain, loss of strength, pseudoparalysis, and progressive superior humeral head migration.[1] This condition, if left uncorrected, can lead to advanced cuff tear arthropathy and poor shoulder function.[2]

The primary challenge in managing MIRCTs is the high failure rate associated with conventional repair techniques. Reported retear rates range from 40% to over 80% in general population.[3] Factors causing the failure of repair include chronic tendon retraction, poor tendon tissue quality, and advanced fatty infiltration of the cuff musculature, as described by Goutallier.[4] In cases where the rotator cuff tendon is markedly retracted but demonstrates adequate muscle bulk, achieving mobilization of the tendon to its anatomic footprint can be challenging. Under such circumstances, the conventional surgical options considered are partial repair, medialized repair, or single-row repair performed under high tension on the cuff muscles..

In response to these poor outcomes, numerous alternative surgical strategies have been developed.These include Superior capsular reconstruction,Tendon transfers ,Patch augmentation,Subacromial balloon spacers. Superior capsular reconstruction (SCR) aims to restore the superior constraint of the humeral head, and has shown good outcomes but relies on costly allografts or autografts, which have their own failure modes and potential for non-integration.[5],[6] Tendon transfers, such as the Latissimus dorsi, teres major and Lower trapezius transfer are non-anatomic procedures that attempt to restore the external rotation force-couple. However, these are technically demanding, associated with donor site morbidity, and require extensive rehabilitation for

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neuromuscular re-education.[7],[8]Other options, such as partial repair[9] or graft augmentation, have also met with mixed success.

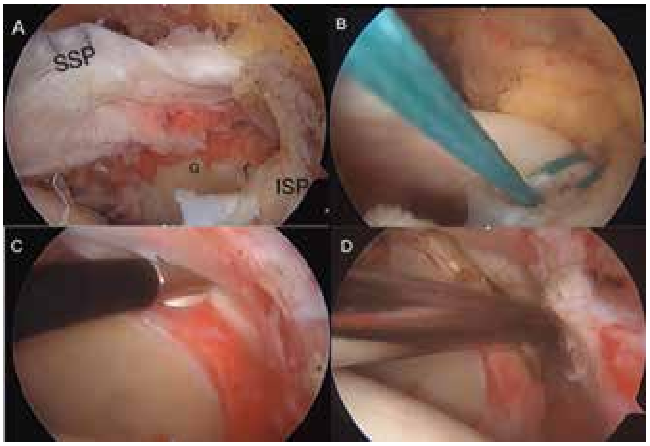


Figure 1:A) Arthroscopic view demonstrating a massively retracted supraspinatus (SSP) and infraspinatus (ISP) tendons retracted up to the level of the glenoid (G).
(B) Traction sutures applied to the SSP tendon to assess tendon reducibility to the greater tuberosity footprint.
(C, D) Following confirmation of inadequate reducibility, intra-articular tendon release was performed using a radiofrequency probe and blunt dissector to improve tendon mobilization.

Anatomic muscle advancement (MA) has emerged as a biologic solution. First described in an open fashion by Debeyre et al.,[10] this technique involves mobilizing the entire supraspinatus and infraspinatus muscle-tendon units from their scapular fossae. By releasing the muscles from their origin, the surgeon can gain significant length, allowing for a tension-free, anatomic restoration of the tendon-to-bone footprint.[8] This converts a biomechanically "irreparable" tear into a reparable one .

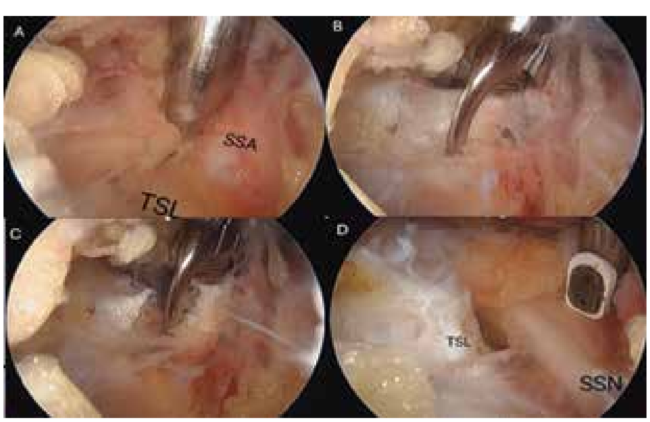


Figure 2:A) Blunt dissection is performed through the G portal, medial to the coracoclavicular ligaments. The transverse scapular ligament (TSL) is identified at the suprascapular notch, with the suprascapular artery visualized coursing over the ligament.
B, C) Suprascapular nerve scissor is used to carefully divide the TSL under direct visualization.
D) The suprascapular nerve (SSN) is visualized free and decompressed following ligament release.

A critical component of this pathology, and of the advancement procedure itself, is the suprascapular nerve (SSN). Chronic, massive retraction of the supraspinatus can place the SSN under traction at the suprascapular notch, leading to a traction neuropathy that exacerbates muscle atrophy and weakness.[12] Furthermore, the surgical act of advancing the supraspinatus muscle laterally can create an acute iatrogenic traction injury if the nerve is not protectively released. Therefore, a prophylactic release of transverse scapular ligament at the suprascapular notch is an essential step to both treat pre-existing neuropathy and prevent iatrogenic nerve injury.[13]

This study aims to analyse the functional and clinical outcomes of arthroscopic muscle advancement with suprascapular nerve release for MIRCTs. We hypothesized that this combined approach would achieve tension free double row repair and effectively improve shoulder function.

**Materials and Methods**

Study Design and Patient SelectionThis is a retrospective case series (Level IV evidence).Following Institutional Review Board (IRB) approval, we conducted a retrospective review of 26 patients treated by the senior author between January 2022 and August 2024.


Figure 3 :A) A vertical 2-cm portal is created just medial to the medial angle of the scapular spine to facilitate muscle advancement.
B) A Cobb elevator is used for blunt dissection and elevation of the supraspinatus (SSP) and infraspinatus (ISP) muscles from their respective fossae.
C) The greater tuberosity footprint is prepared for anchor insertion.

D) A standard double-row repair of the SSP and ISP is performed without undue tension following adequate muscle advancement.

Inclusion criteria were: (1) symptomatic MIRCTs involving both supraspinatus and infraspinatus tendons, with Patte 3 retraction (2) tears confirmed to be irreparable intraoperatively, defined after complete arthroscopic release and mobilization as the inability of the torn tendons to be advanced to within 10 mm of the native greater tuberosity footprint or to achieve >50% footprint coverage without excessive tension, (3) moderate fatty infiltration of Goutallier </=3 (4) absence of advanced glenohumeral arthritis (Hamada grade <3) (5) Functional or repairable Subscapularis tear (6) minimum of 12 months' clinical follow-up.

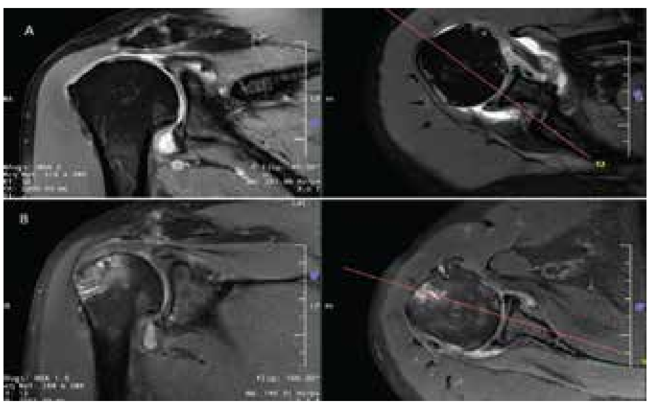


Figure 4: A Preop MRI right shoulder coronal and axial images showing Supraspinatus tear with Patte 3 retraction ,Infraspinatus tear .

B) Postop mri - Repaired SSP after Muscle advancement appears intact and well-tensioned, with continuous low-signal fibers extending from the muscle belly to the greater tuberosity footprint.Anchors are seen in situ at the greater tuberosity, well-positioned without surrounding marrow edema or loosening.

Exclusion criteria included: (1) prior shoulder arthroplasty or rotator cuff surgery; (2) active or recent infection; (3)Isolated Infraspinatus / Subscapularis tear (4) significant pre-existing neurological deficits affecting the extremity; and (5) advanced cuff tear arthropathy (Hamada grade 3 or higher).

**Preoperative Evaluation**

All patients underwent a comprehensive preoperative evaluation, including a standardized history and physical examination. Clinical assessment included documentation of active and passive range of motion (ROM), strength testing for forward elevation and external and internal rotation, and evaluation for lag signs (external rotation lag sign, Hornblower's sign).

Standardized shoulder radiographs (true anteroposterior, outlet and axillary lateral views) were obtained to assess for glenohumeral arthritis (Hamada grade). All patients received a preoperative 3T Magnetic Resonance Imaging (MRI) scan to confirm the diagnosis and evaluate tear characteristics. A fellowship-trained musculoskeletal radiologist assessed all MRIs to determine tendon retraction (Patte classification) and the degree of fatty infiltration of the rotator cuff muscles (Goutallier classification)

Preoperative functional status was quantified using the Constant-Murley Score (CMS),[15] the American Shoulder and Elbow Surgeons (ASES) score,[16] and a Visual Analogue Scale (VAS) for pain (0-10)[3].

**Surgical Technique**

All procedures were performed by the senior author with the patient in beach chair position under general anesthesia and an interscalene block.

1. Diagnostic Arthroscopy & Assessment: Under general anaesthesia with an interscalene block, the patient is placed in a beach-chair position using an open-backed shoulder positioner table attachment with head support . The involved extremity is placed in a pneumatic arm holder (Spider; Smith & Nephew). Surgical preparation to the midline posteriorly is performed and draping of the entire ipsilateral half of the back allows easy access to the medial border of the scapula . Standard posterior,anterosuperior and subacromial portals were established. Diagnostic arthroscopy was performed to confirm the tear pattern. A standard subacromial decompression and bursectomy were performed. An extensive arthroscopic release (adhesiolysis) was then performed, releasing the supraspinatus and infraspinatus tendons from any adhesions to the glenoid, coracoid, and joint capsule.
2. Assessment of Irreparability: Traction sutures (No. 2 high-strength Ethibond suture) were placed in the tendon edges to assess mobility. The tear was confirmed as "irreparable" if the tendon edge could not be mobilized to the medial margin of the greater tuberosity footprint despite the extensive arthroscopic release.
3. Suprascapular Nerve Release: Attention was turned to the suprascapular notch. Using the subacromial portal for visualization and an accessory portal (e.g., Neviaser portal) for instrumentation, the base of the coracoid was identified. Medial to coracoclavicular ligament ,the transverse scapular ligament (TSL) was identified spanning the suprascapular notch. Suprascapular nerve scissors was used to cut the Transverse scapular ligament freeing the Suprascapular nerve . This step was performed before muscle advancement to prevent iatrogenic nerve traction.
4. Muscle Release and Advancement: An "arthroscopic-assisted" approach was used. A 2-cm vertical skin incision was made along the medial border of the

**Table 1. Comparison of Preoperative and 12-Month Postoperative Clinical and Functional Outcomes**

| Parameter | Preoperative (Mean ± SD) | 12 Months Postoperative (Mean ± SD) | p-value |
|---|---|---|---|
| Constant–**Murley Score** | 40 ± 6 | 74 ± 8 | < 0.001 |
| **ASES Score** | 39 ± 7 | 68 ± 9 | < 0.001 |
| **VAS Pain Score** | 7.2 ± 1.1 | 2.1 ± 0.8 | < 0.001 |
| **Active Forward Elevation (°)** | 90 ± 25 | 150 ± 20 | < 0.001 |
| **Active External Rotation (°)** | 20 ± 10 | 45 ± 15 | < 0.001 |

ASES = American Shoulder and Elbow Surgeons; VAS = Visual Analogue Scale.
Statistical significance was set at p < 0.05.

scapular spine. Care must be taken not to go more medial to avoid injury to the spinal accessory nerve, typically found 4 cm medial to this point. A Cobb elevator is used to bluntly dissect and completely free the supraspinatus medial attachment superior to the scapular spine and infraspinatus inferior to the spine. This "outside-in" dissection was carried laterally to meet the previously performed arthroscopic release, creating a single, fully mobilized muscle-tendon unit.

5. Rotator Cuff Repair: After adequate release and tendon advancement, tension-free mobilization was achieved,and standard double row repair was done after preparing the greater tuberosity footprint.

### Postoperative Rehabilitation

All patients followed a standardized, protection-based rehabilitation protocol.

- Phase I (Protection, Weeks 0-6): The arm was immobilized in an abduction splint at 60 degrees for the first 3 weeks, then adjusted to 30 degrees for the next 3 weeks. This position was chosen to minimize tension on the repaired muscle-tendon units. Passive ROM, including pendulum exercises and gentle forward elevation, began at 3 weeks.
- Phase II (Active-Assist, Weeks 6-12): The splint was discontinued. Active-assisted ROM was initiated, progressing to full active ROM as tolerated. Isometric strengthening began.
- Phase III (Strengthening, Weeks 12+): Progressive resistive strengthening was initiated, focusing on the rotator cuff and periscapular stabilizers. Shoulder rehabilitation programme was then initiated with Therabands .A return to heavy lifting or overhead activities was not permitted for at least 6 months.

### Outcome Measures and Statistical Analysis

Functional outcomes (CMS, ASES), VAS pain score, and active ROM (forward elevation, external rotation) were recorded preoperatively and at the 12-month postoperative visit.

Statistical analysis was performed using SPSS Statistics Version 28.0. Descriptive statistics (means, standard deviations [SD]) were calculated. Paired t-tests were used to compare pre- and postoperative values for all continuous outcome measures. A p-value of < .05 was considered statistically significant.

## RESULTS

### Patient Demographics and Preoperative Data

A total of 26 patients (16 males, 10 females) met the inclusion criteria and completed the minimum 12-month follow-up . The mean age at the time of surgery was 63 years (range, 55–72 years). The dominant arm was involved in 20 patients (77%) . The mean duration of symptoms prior to surgery was 10 months (Range of 6-18 months).

Preoperative MRI analysis confirmed massive retracted tears in all patients. The mean Goutallier grade was 2 for the supraspinatus .

### Functional and Clinical Outcomes

At the 12-month follow-up, all functional outcome scores and range of motion measurements showed statistically significant improvements compared with preoperative baseline values. The mean Constant–Murley Score (CMS) increased from 40 ± 6 preoperatively to 74 ± 8 at 12 months, with a mean improvement of 34 points (95% CI, 29–39; p < .001). Similarly, the American Shoulder and Elbow Surgeons (ASES) score improved from 39 ± 7 to 68 ± 9, corresponding to a mean increase of 29 points (95% CI, 24–34; p < .001).

Pain intensity, assessed using the Visual Analog Scale (VAS), demonstrated a significant reduction from a preoperative mean of 7.2 ± 1.1 to 2.1 ± 0.8 at final follow-up, representing a mean decrease of 5.1 points (95% CI, 4.4–5.8; $p < .001$).

Range of motion also showed significant improvement at 12 months. Mean active forward elevation increased from 90° ± 25° to 150° ± 20°, with a mean gain of 60° (95% CI, 48°–72°; $p < .001$). Mean active external rotation at the side improved from 20° ± 10° to 45° ± 15°, corresponding to a mean increase of 25° (95% CI, 18°–32°; $p < .001$).

### Complications

There were no intra-operative complications. No patient experienced postoperative infection or nerve palsy (SSN ). One of the patient developed terminal stiffness during the postoperative period which could be corrected with prolonged physiotherapy but none of them had significant stiffness requiring manipulation under anaesthesia. At the final follow-up, no patient had undergone or was scheduled for revision surgery, and there were no clinical signs of retear like return of pain, loss of strength, or positive lag signs.

## DISCUSSION

This study demonstrates that an arthroscopic-assisted muscle advancement combined with a prophylactic suprascapular nerve release is a safe and effective technique that yields significant improvements in pain, function, and range of motion for patients with MIRCTs. The primary finding is that this anatomic, joint-preserving procedure successfully addresses the challenges of high-tension repairs, resulting in excellent clinical outcomes at short-term follow-up.

The concept of releasing the entire supraspinatus muscle from its scapular attachment and advancing it laterally was first introduced by Debeyre et al. in 1965.[10] Their technique involved an extensive open approach utilizing an acromial osteotomy, which was associated with a relatively high incidence of osteotomy nonunion. In recent years, many arthroscopically assisted muscle advancement techniques have evolved , demonstrating lower failure rates and significant improvements in shoulder function.›Morihara et al.[6] reported favorable clinical outcomes in a series of 34 patients, supporting the feasibility and efficacy of this minimally invasive approach.
The technique described in our study modernizes this concept by using an "arthroscopic-assisted" approach. The 2-cm incision made medial to medial border of Scapula provides the direct access to muscle belly of Supraspinatus and Infraspinatus muscles. This helps in safe and rapid subperiosteal elevation of the muscle with minimal stripping and morbidity.

Our results compare favourably to other contemporary MIRCT treatments. The 29-point improvement in our mean ASES score is clinically significant and compares well with outcomes reported for both SCR[5],[17] and tendon transfers.[7] However, MA offers distinct advantages over these alternatives. Unlike SCR, MA is a purely biologic, anatomic repair that uses the patient's native, vascularized muscle-tendon units, avoiding allograft costs, potential disease transmission, and graft-related healing complications. Unlike tendon transfers, MA restores the original muscle-tendon units to their anatomic insertion, preserving normal joint kinematics and avoiding the donor site morbidity and complex neuromuscular re-education associated with transfers.

Modern arthroscopic or assisted-advancement techniques have shown good results . Kim et al.[19] and Morihara et al.[11] reported high healing rates and significant functional improvements with similar "muscle-advancing slide" techniques. Our study contributes to this body of evidence, reinforcing that gaining length from the muscle belly's origin is a viable and effective strategy. The absence of clinical retears in our series although in short term, suggests that the tension-free nature of the repair provides a favourable environment for tendon-to-bone healing.

A unique and critical component of our technique is the prophylactic SSN release done in all cases. The SSN is notoriously vulnerable in MIRCTs due to chronic medial traction.[12] Furthermore, the act of advancing the muscle laterally by 2-3 cm can place acute, traction on the nerve. We believe the SSN release serves a dual purpose: (1) it treats any pre-existing occult, traction neuropathy, and (2) it protects the nerve from iatrogenic injury during advancement. Meticulous dissection to prevent iatrogenic injury is paramount, but in our view, releasing the nerve is safer than creating tension blindly.

### Limitations

We acknowledge several limitations. First, this study is a retrospective case series done in a single centre . Without a comparative control group, we cannot definitively claim superiority over other techniques. Second, our follow-up period is short-term (minimum 12 months). While the results are excellent, longer-term follow-up is necessary to assess the durability of the repair and the potential for late failure or the onset of arthritis. Third, repair integrity was evaluated clinically, as routine postoperative MRI imaging was not performed. Consequently, the reported absence of retear is based on clinical assessment alone, which may underestimate the true rate of structural failure when compared with radiographic evaluationFinally, all procedures were performed by a single, experienced surgeon, which may limit the generalizability of these results.

Further comparative studies with larger sample sizes and longer follow-up periods are required to accurately assess the efficacy and long-term outcomes of this procedure. Multi-centre studies would help validate these findings and enhance the generalizability of the results.

Conclusion

Arthroscopic-assisted muscle advancement combined with routine suprascapular nerve release is a feasible and reproducible joint-preserving technique for the management of massive irreparable posterosuperior rotator cuff tears in patients without advanced glenohumeral arthritis. In this case series, the technique enabled anatomical tendon mobilization, improved footprint coverage, and tension-free double-row repair, with encouraging short-term functional and clinical outcomes.

By preserving the native shoulder joint and avoiding grafts or tendon transfers, this technique will be useful in carefully selected patients. However, larger comparative studies with longer follow-up are required to validate its effectiveness, durability, and to define its role relative to other reconstructive procedures.

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# Comparison of functional & radiological outcomes of patients undergoing single sitting bilateral total knee replacement vs staged bilateral total knee replacement

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**Abstract** - Background: The incidence of Osteoarthritis knee is increasing every year world over. Total knee replacement is a very established procedure done for osteoarthritis of the knee joint which is associated with deformities such as varus or valgus knee, fixed flexion deformities, hyperextension of knee. However the researches that compare both the functional and radiological outcomes in single sitting and staged total knee replacement are few.

The diagnosis is confirmed by both clinical and radiological studies. Total knee replacement is done in patients with Kellgren and Lawrence stage 3 and stage 4 osteoarthritis of the knee joint. In cases of bilateral osteoarthritis knee Total knee replacement can be done as a single sitting procedure or can be done as a staged procedure.

**Methods:** This study compares the functional and radiological outcomes in 48 patients, i.e. 24 from each category who underwent total knee replacement under the same surgeon with similar techniques using Oxford knee score, knee society score, WOMAC score and LDFA, MPTA, coronal alignment and sagittal alignment respectively.

**Results:** The functional outcomes were found to be similar in both groups with better outcomes at 6 weeks in patients who underwent staged total knee replacement although the values were statistically comparable at 3 months, 6 months and 1 year (p=0.01). The radiological outcomes were also comparable between the two groups with slight deviation of radiological parameters from mean in the 2nd knee in cases of single sitting Total knee replacement.

**Conclusions:** Total knee replacement can be done as a single sitting or a staged procedure with no difference in functional and radiological outcome at 3 months and 6 months follow-up.

Keywords: Total knee replacement, osteoarthritis, functional outcome ,knee society score, oxford knee score

## INTRODUCTION

Osteoarthritis is a musculoskeletal degenerative condition that affects weight bearing joints, predominantly the hip and knee joints and thus modifying the articular cartilage and the subchondral bone with associated changes to the Hoffa's fat pad, synovium, muscles and ligaments[1].Sir Archibald Edward Garrod, Albert Hoffa and R. Llewellyn Jones first described osteoarthritis as a degenerative disease of the knee joint in 1890 and this was further classified by Dr. Kellgren into four different types based on the radiographic appearance of the joint (Fig 1.)[2]. The main goal of total knee replacement was restoration of knee alignment with the mechanical axis passing through the center of hip joint , knee joint and ankle joint[3]. However not just the mechanical alignment, the component alignment has also been recently considered to be important, an idea known as kinematic alignment[3].

Significant collaborations between doctors and engineers has helped in the development of improved designs of knee replacement ranging from resurfacing prosthesis to the constrained prosthesis and meniscal bearing prosthesis. Patient specific cutting guides have also been introduced recently that helps in improving the accuracy and reproducibility of bone resection and soft tissue balancing[4].

Complications that can occur following a knee replacement can include knee stiffness, periprosthetic fractures (Fig 2), prosthetic joint infection, aseptic loosing, patellar mal-tracking and heterotrophic ossification with joint infection or bacteremia being an absolute contraindication

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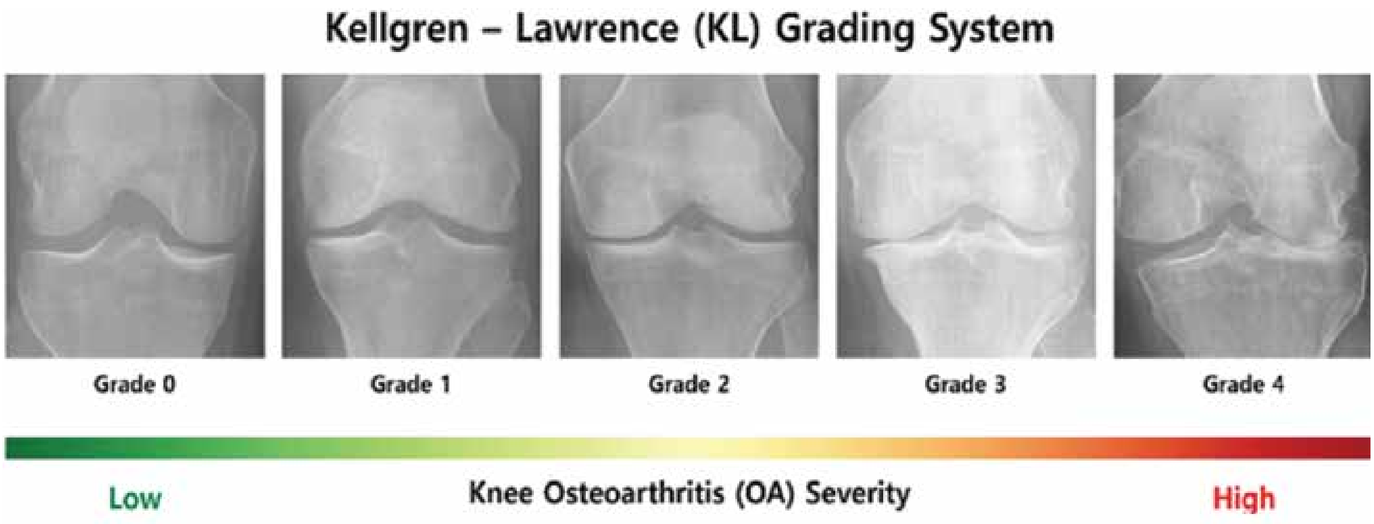


Figure 1: Kellgren and lawrence staging of osteoarthritis knee

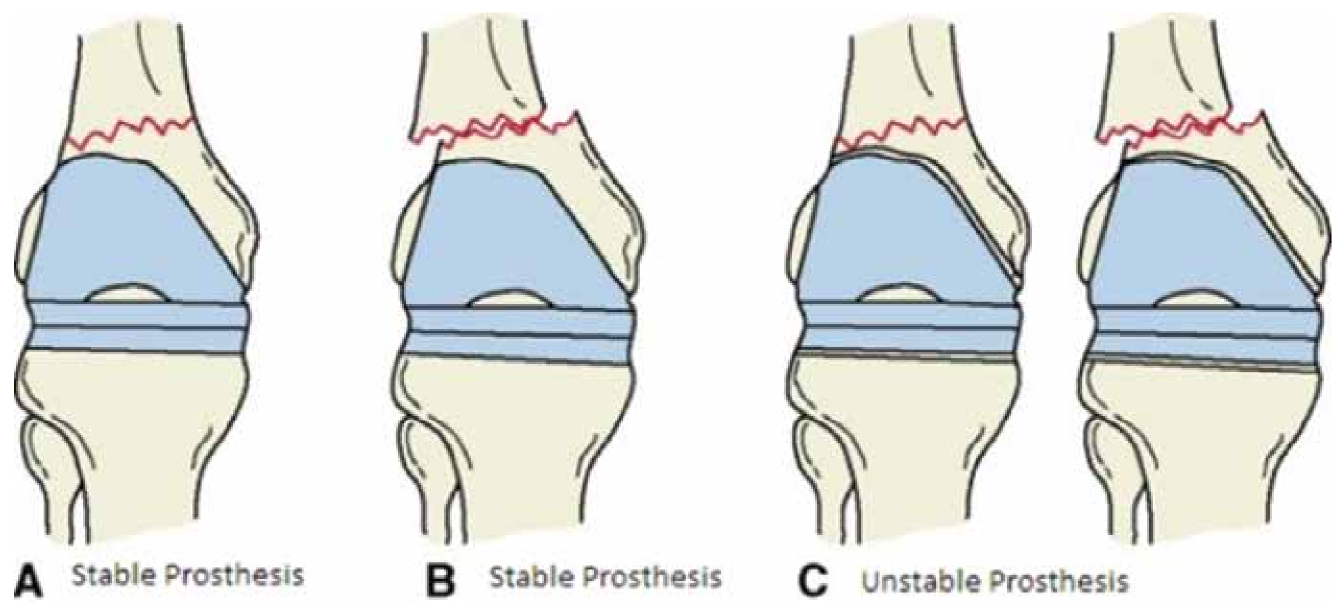


Figure 2: Lewis- Rorabeck classification of supracondylar fractures of femur post TKR

for the procedure. The designs of implants used for total knee replacement can vary from unconstrained or cruciate retaining to partially constrained implants to fully constrained implants[5].

Nowadays there is an argument going on whether the bilateral joint replacement shoulder be done as a single procedure or in a stage manner. In patients with bilateral end stage arthritis of the knee, as a single knee replacement doesn't restore complete function, some advocate about the need for staged total knee replacement6 There are both advantages and disadvantages for both with the disadvantages of staged procedure being separate anesthesia exposure, increased cost because of separate procedures and separate rehabilitation programs and the advantage being lesser requirement of blood transfusion and lesser incidence of fat embolism[6].

**Materials and Methodology**

The study was approved by the institutional review board and the institutional ethics committee. Informed consent was obtained from all patients who participated in the study. All the patients who underwent total knee replacement at this hospital under the same surgeon using similar surgical techniques within the age group of 50 -80 between September of 2022 to august of 2024 were taken for the study. In cases of staged TKR, the surgery on the 2$^{nd}$ knee was performed with in a gap of 1 week to 1 month post the first surgery.

Patents with BMI > 35, patients with h/o any major knee

surgeries and patients with osteoarthritis of the hip and ankle joints were excluded. Cruciate retaining type of implants (fig 3) were used for all patients selected for the study and medial Parapatellar approach to knee (Fig 4) used in all cases. For closure Number 2 vicryl for the capsule and subcutaneous tissue and staples used for skin. Post-operative mobilization was started on post op day 2.
To assess the functional outcome Pre-operative Oxford knee score, knee society score and WOMAC scores were compared to the post-operative values at 6 weeks, 3 months, 6 months and 12 months. Radiological outcome was measured by comparing the pre-operative and post-operative LDFA, MPTA, coronal alignment and sagittal alignment and also comparing them to the mean values.

## RESULTS

In terms of the functional outcome, preoperatively the Oxford knee scores were 17.8 for the single sitting TKR group and 19.2 for the staged TKR group, showing no significant difference. At 6 weeks, the scores improved to 28.6 and 29.8 respectively. By 3 months, both groups had nearly identical scores of 35.3 and 35.4. However, by 6 months, a statistically significant difference emerged, with the single sitting TKR group scoring 38.7 and the staged TKR group scoring 40.2 (Table 1).

In terms of the Knee Society scores, preoperative values were 43.3 for the single sitting TKR group and 45 for the staged TKR group. At 6 weeks, scores were 69.7 and 69.2 respectively. By 3 months, both groups scored 77.2 and 77.1, showing no significant difference. At 6 months, the scores were 83.6 for the single sitting TKR group and 85.3 for the staged TKR group (Table 1).

The WOMAC scores showed a significant preoperative difference (78.8 vs. 81.3). However, at 6 weeks and 3 months, both groups had identical scores (44.4 and 33.2 respectively). By 6 months, scores were 23.7 for the single sitting TKR group and 24.2 for the staged TKR group, indicating similar outcomes (Table 1).

The improvement in the functional score was significant in the post-operative period as compared to the pre-operative values and the results were comparable between bilateral staged and single sitting groups.

On assessing the radiological outcome, in the bilateral single sitting TKR group (N=24), radiological parameters exhibited notable changes postoperatively. The lateral distal femoral angle (LDFA) increased significantly from 85.3 to 87.7. Although the medial proximal tibia angle (MPTA) improved from 85.9 to 87.5, this change was not statistically significant. Coronal alignment showed a substantial improvement, decreasing from 9.5 preoperatively to 2.0 postoperatively. Additionally, sagittal alignment improved significantly, reducing from 9.6 preoperatively to 8.1 postoperatively. These results suggest that single sitting TKR leads to significant enhancements in radiological parameters, particularly in alignment (Table 2).

The change in radiological parameters for the staged bilateral TKR group (N=24) demonstrated significant improvements postoperatively. The lateral distal femoral angle (LDFA) increased from 86.2 preoperatively to 88.2 postoperatively. The medial proximal tibia angle (MPTA) showed a slight increase from 82.9 to 83.7, which was not statistically significant. Coronal alignment improved markedly, decreasing from 9.5 preoperatively to 2.5 postoperatively. Similarly, sagittal alignment showed significant improvement, reducing from 9.3 preoperatively to 7.9 postoperatively. These findings indicate substantial postoperative radiological improvements in alignment following staged bilateral TKR (Table 3).

The change in radiological parameters assessed based on the post-operative x-rays pointed towards a good outcome in both categories of patients and the results were comparable among both groups.


Figure 3: Cruciate retaining type of TKA

## DISCUSSION

Knee pain can be due to a wide range of causes. The pain if it's a chronic one (> 3 months) especially a bilateral knee pain, the most common etiology i.e. Osteoarthritis has to be ruled out. Most cases of osteoarthritis are bilateral and the common etiology could be obesity, secondary to inflammatory arthritis, post-traumatic arthritis. The condition can be divided into 4 stages based on x-ray findings. Stages 3 & 4 are indicative of total knee replacements unless there are absolute medical or surgical contraindications.

A spectrum of imaging modalities are available to assess the derangements of the knee joint. It could include X-rays, CT, USG & MRI. MRI however is the most sensitive investigation to grade the severity of the cartilage lesions. Invasive diagnostic modalities like a diagnostic arthroscopy can also be performed to know the status of the cartilage lesions.

Based on the prospective observational studies that was conducted in the department of orthopedics, patients who presented to the outpatient department or referred from elsewhere with complaints of bilateral knee pain and difficulty in walking affecting activities of their daily living were assessed. The people who were diagnosed to have either a stage 3 or 4 osteoarthritis knee. All surgically fit patients meeting the inclusion and exclusion criteria underwent either a bilateral single sitting or a staged bilateral total knee replacement based on their general health conditions. After obtaining the waiver of consent, information was gathered using a structured study proforma.

Figure 4: Medial parapatellar approach to TKR

The female population was significantly more affected compared to the male population at 85.5 % vs 14.5 % respectively. This may be contributed by increased hormonal changes in older women and increased incidence of obesity. Around 52 % of our patients belonged to the age group of 61-70 years, with 23 % under 60 years and 25 % above 70 years. So that would mean that the majority of people in our study would be in the age group of 61-70 years. None of the patients included in the study had any other joint involvement.

In our study the patients had gone through conservative management which included both anti-inflammatory drugs as well as observed physiotherapy. The patients who underwent total knee replacement were the ones with no improvement in pain and function even after conservative management.

## CONCLUSION

The minimum and maximum age in our study were 49 and 79 respectively. The gender factor when considered, it was found that females were significantly more affected compared to males. All the 48 cases under the study had pain and difficulty in performing day to day activities and x-ray findings suggestive of either a stage 3 or stage 4 osteoarthritis of bilateral knees. The OKS, The Knee Society Score and the WOMAC score showed significant improvement in the post-operative follow-up and the results were comparable between the 2 groups of patients. The mobilization was slower in the initial weeks in bilateral single sitting group. Although the single sitting bilateral Total Knee replacement patients showed a faster recovery and better functional results at 6 weeks, the functional results at 3 months and 6 months were similar. The radiological parameters also significantly improved in the post-operative assessment and no significant difference were found between the single sitting group and the staged group. The second knee of patients who underwent Single sitting bilateral TKR showed slight radiological deviations from the mean, but it was not statistically significant.

To conclude, Total knee replacement can be done as a single sitting or a staged procedure with no difference in functional and radiological outcome at 3 months and 6 months follow-up.

| Oxford knee score | | | |
|---|---|---|---|
| | **B/L single sitting TKR** | **Staged bilateral TKR** | **P value** |
| **Preoperative** | 17.8 (2.8) | 19.2 (2.8) | 0.12 |
| **6 weeks** | 28.6 (2.5) | 29.8 (2.4) | 0.11 |
| **3 months** | 35.3 (1.8) | 35.4 (1.8) | 0.87 |
| **6 months** | 38.7 (1.5) | 40.2 (2.3) | 0.01 |
| | **Knee society score** | | |
| **Preoperative** | 43.3 (8.7) | 45 (6.7) | 0.46 |
| **6 weeks** | 69.7 (7.4) | 69.2 (4.4) | 0.75 |
| **3 months** | 77.2 (6.5) | 77.1 (3.9) | 0.91 |
| **6 months** | 83.6 (5.5) | 85.3 (3.4) | 0.21 |
| | **WOMAC score** | | |
| **Preoperative** | 78.8 (3.5) | 81.3 (2.3) | 0.006 |
| **6 weeks** | 44.4 (5.0) | 44.4 (5.0) | 1.00 |
| **3 months** | 33.2 (3.8) | 33.2 (3.8) | 1.00 |
| **6 months** | 23.7 (4.0) | 24.2 (4.5) | 0.67 |

Table 1: Comparison of functional scores between the 2 groups

| | **B/L single sitting TKR** | **Staged bilateral TKR** | **P value** |
|---|---|---|---|
| **LDFA** | 85.3 (2.8) | 87.7 (1.7) | 0.003 |
| **MPTA** | 85.9 (3.1) | 87.5 (1.4) | 0.11 |
| **Coronal alignment** | 9.5 (3.4) | 2.0 (0.7) | <0.001 |
| **Sagittal alignment** | 9.6 (1.8) | 8.1 (0.9) | 0.007 |

Table 2: Change in radiological parameters in single sitting group

| | **Preoperative** | **Post - operative** | **P value** |
|---|---|---|---|
| **LDFA** | 86.2 (2.9) | 88.2 (1.6) | 0.007 |
| **MPTA** | 82.9 (17.8) | 83.7 (16.1) | 0.88 |
| **Coronal alignment** | 9.5 (3.5) | 2.5 (0.8) | <0.001 |
| **Sagittal alignment** | 9.3 (1.8) | 7.9 (0.9) | 0.004 |

Table 3: Change in radiological parameter in Staged group

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ACADEMY OF CADAVERIC TRAINING COCHIN ORTHOPAEDIC SOCIETY

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SREE NARAYANA INSTITUTE OF MEDICAL SCIENCES SNIMS

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# Cochin Cadaveric Course

# ACADEMY OF CADAVERIC TRAINING

## COS - ACT

**Sree Narayana Institute of Medical Sciences**
Chalakka, Ernakulam

**Highlights**

- **Limited delegates per station**
- **Eminent & experienced faculty**
- **Arthroscopy, Arthroplasty & Trauma workshops**

Dear Doctor,

We are delighted to inform you that the Cochin Orthopaedic Society has initiated an Academy for Cadaveric Training titled COS-ACT (Cochin Orthopaedic Society – Academy for Cadaveric Training), in collaboration with Sree Narayana Institute of Medical Sciences, Chalakka, at their premises with effect from 2025. This initiative by the Cochin Orthopaedic Society is unique, as it is the first cadaveric academy in India to be run by an orthopaedic society, with the objective of training orthopaedic surgeons in a wide range of basic and advanced surgical procedures at affordable costs.

We are also proud to be the first cadaveric academy in South India to offer robotic-assisted surgery training in workshops. We have successfully completed several cadaveric courses and have received excellent feedback from delegates, with high levels of satisfaction and strong interest in participating in our future programs. This year, the Cochin Cadaveric Course (CCC) will be focus on Arthroscopy, Arthroplasty and Trauma.

Please contact our office for registration & program details - 9048075999 / cochinortho@gmail.com

THE COCHIN ORTHOPAEDIC SOCIETY

CIOS

# CIOS 2027

## 6th Biennial Cochin International Orthopaedic Summit

Conducted by: The Cochin Orthopaedic Society

**Theme:**
**"Evolving Frontiers in Orthopaedics"**

## October 2027

**Grand Hyatt, Kochi**

### Highlights

1. Preconference Hands-on Cadaveric Workshops
2. Three exclusive delegates per cadaver station
3. Skill Training Workshops
4. Insights from Pro-Implant Foundation, Germany
5. Dr. Lazar J. Chandy  Memorial Oration
6. Dr. A. A. John Gold Medal Competition
7. Cash Prizes for Paper, Video  & Poster Presentations
8. Eminent International, National & State Faculty
9. World-class entertainment at a 5-star luxury venue

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