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What's New and Relevant in Proximal Tibia Fractures?

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Abstract

Proximal tibia fractures include fractures of the tibia plateau and metaphyses and are relatively common injuries. The goals of treatment follow AO principles of anatomic reduction of the articular surface, restoration of limb alignment, length, and rotation. Despite notable advancements in implant design, management of proximal tibia fractures remains formidable. These fractures manifest as comminuted, intra-articular complexities, compounded by the inherent fragility of the osteoporotic bone, thereby rendering fixation a particularly intricate risk. In the realm of geriatric trauma, where comorbidities abound, therapeutic decision-making becomes a nuanced endeavor. We have aimed to bring together all the recent advances and literature in the management of proximal tibia fractures through this article.

Keywords: Proximal tibia, plating, nailing, prosthesis.

Is there any benefit of Plating with Interlocking Intramedullary Nailing in Proximal Tibia Fractures?

As per the insights from Bogdan and Dedhia scholarly work [1], the integration of nail plate combinations in the management of proximal tibia fractures, has a distinct advantage, particularly in enabling early weight bearing, a critical consideration, especially for the elderly demographic. Biomechanically, the composite configurations exhibit heightened resistance against both axial and torsional forces, surpassing the efficacy of standalone nail or plate fixation. The introduction of a load-distributing device, such as an intramedullary nail, assumes a pivotal role in preserving the reduction of the fracture. Concurrently the inclusion of a plate serves to mitigate additional motion at the articular surface, thereby providing a heightened level of stability.

Wright's study stated that combination plate-nail fixation is a viable option where it prioritizes articular reduction and lateral tibial plate fixation, which is then, followed by placement of an intramedullary nail [2]. The approach offers the advantage of minimizing soft-tissue disruption to the proximal tibia, facilitating precise restoration of alignment, and ensuring a stable fixation. This construct not only exhibits commendable radiographic and clinical outcomes but also demonstrates a noteworthy reduction in post-operative infection rates and incidents necessitating implant removal.

Dunbar et al. initially advocated a distinct procedural approach for managing proximal tibia fractures [3]. Their proposal entails initiating treatment with a 3.5 mm system compression plate, utilizing unicortical purchase to achieve a direct reduction of the fracture at the proximal tibia. Subsequently, the conventional intramedullary nail technique is recommended for the final fixation of the proximal tibia fracture [Fig.1][Fig. 2]. This sequential strategy aims to increase the precision in cortical fixation with stability provided by the intramedullary nail, optimizing the overall management of proximal tibial fractures.

Should We Opt for Suprapatellar Nailing in All Proximal Shaft Fractures?

Orthopedic trauma surgeons have been actively exploring and contrasting various methodologies for inserting tibia nails, particularly the suprapatellar and infrapatellar approaches. The infrapatellar technique involves hyperflexing the knee to establish the correct starting point and trajectory. This heightened flexion, crucial for aligning the guidewire with the medullary canal while navigating around the patella, often results in procurvatum deformity due to the extensor mechanism exerting tension on the proximal segment. As the

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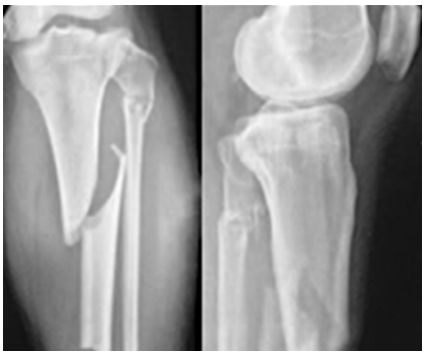

Figure 1: X-ray proximal tibia fracture. (Credits – Yelena Bogdan et al.).

guidewire progresses, escalating degrees of flexion is required, potentially exacerbating the procurvatum deformity when inserting the nail.

Furthermore, the application of fluoroscopic imaging in infrapatellar nailing presents challenges, demanding substantial tilting of the c arm to align with the flexed knee. This not only complicates the procedure but also introduces ergonomic challenges for the surgeon, who may need to work on elevated surfaces or with their arms raised above shoulder height to ream in a superior to inferior direction. These complexities underscore the need for a thorough consideration of the advantages and challenges associated with the chosen technique for tibial nail insertion in orthopedics trauma surgeries.

Ciminero et al. [4] deduced that employing suprapatellar nailing yields superior alignment outcome for both proximal and distal fracture patterns. This

Figure 4: C arm shoots of suprapatellar nailing steps. (Credits – Matthew Ciminero et al.).

Figure 2: Fixed with intramedullary. Interlocking tibia nail and plate. (Credits – Yelena Bogdan et al.).

approach is linked to diminished radiation exposure and shortened operative durations. In addition, it facilitates the alleviation of deforming forces, streamlines imaging processes, and enables a stable positioning of the leg in extension [Fig 3]. These are notably advantageous attributes for both the independent surgeon and those in the early stages of their experience, underscoring the potential for enhanced results and efficiency through the implementation of the suprapatellar method.

Ponugoti et al. [5] in their study observed that the suprapatellar approach is associated with reduced postoperative pain scores when compared to infrapatellar approach. Authors have hypothesised that post-operative knee pain could be linked to factors such as patellar tendon splitting, proximal nail protrusion, intra-articular structural damage, and engagement of the

Figure 5: Post-operative X-ray of suprapatellar nailing. (Credits – Matthew Ciminero et al.).

Figure 3: Incision marking for suprapatellar tibia nailing. (Credits – Matthew Ciminero et al.).

infrapatellar nerve, all of which the suprapatellar approach seeks to mitigate. Below Figure [Fig.4] explains the steps of suprapatellar nailing and post operative xrays are shown. [Fig.5]

Is PMMA Cement a Viable Option in Primary Fixation of Schatzker Type III Tibial Plateau Fractures?

The prevalent form of lateral tibial plateau fracture is the Schatzker Type III [Fig. 6] depressed fracture. Following the reduction and fixation of the fracture, a common consideration is addressing the resultant void. In open procedures, the gold standard involves using a bone graft harvested from the iliac crest. Despite its excellent mechanical and biological properties, this method is accompanied by morbidity concerns.

The utilization of allograft bone is a viable alternative, although percutaneous application poses greater challenges. In addition, allograft bone usage is linked to a heightened risk of non-union. The predominant challenge remains effectively addressing the bone defect in such cases.

Various materials have been proposed, including bone cements (IBCs) and different bone substitutes to address bone defects, Cal-cemex, a novel hybrid bicomponent BSM comprising beta-tricalciphosphate and polymethylymethacrylate, stands out for its combination of biological features and mechanical performance. While not fully reabsorbable, it ensures biocompatibility and osteoconductivity. The beta-tricalciphosphate component contributes to macro and microporosity, facilitating penetration and stimulating bone ingrowth. According to Pizzoli et al. [6] Pizzoli's study, Cal-cemex emerges as a viable option for tibial plateau fractures

Figure 6: Schatzker Type III proximal tibia fracture. (Credits – Andrea Pizzoli et al.).

requiring augmentation and support for early full weight bearing. Its ease of application, the ability to modify its shape, and the absence of major complications make it a promising material for bone augmentation in trauma cases.

As per to Vendeuvre et al. [7] minimally invasive surgery employing balloon reduction emerges as a highly promising approach compared to the gold standard using a bone tamp. This method demonstrates superior reduction and stabilization facilitating early passive and active rehabilitation to mitigate joint stiffness and muscle wasting. The use of a balloon for fracture reduction enables the application of semi-liquid IBC fillers.

Research indicates that the percutaneous balloon approach results in better stability post-reduction compared to the conventional bone tamp method. This improvement is attributed to the multiple metaphyseal trajectories of the bone tamp, extending from metaphyseal corticotomy to epiphyseal depression, allowing for optimal reduction of articular fragments.

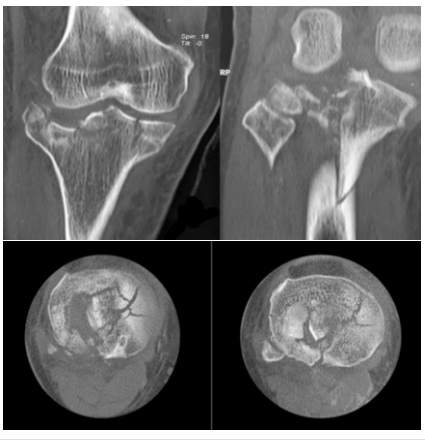

Figure 8: Complex proximal tibia fracture. (Credits – Asikin et al.).

The use of a balloon minimizes the potential for uneven segmental reduction that can occur with repeated passes of a bone tamp, particularly in comminuted fractures, while concurrently preserving superior metaphyseal periosteal vascularization.

IBC is initially in liquid or paste form, facilitating it to be injected into a canal or moulded into the desired configuration. This type of cement is commonly employed for augmenting and stabilizing reduced bone, particularly when osteoporosis is present or after tumor resection. Subsequently, the cement solidifies, conforming to the shape of the implantation site. Solidify secondarily after having taken the shape of the implantation site. Ideally, it will integrate itself into the neighboring cancellous bone. [Fig. 7]

The utilization of a balloon facilitates the safe application of injectable cements, particularly PMMA, enhancing stability significantly. This heightened stability serves to diminish the risk of postoperative mobilization and enables a gradual resumption of weight-bearing activities around the 6-week mark [8].

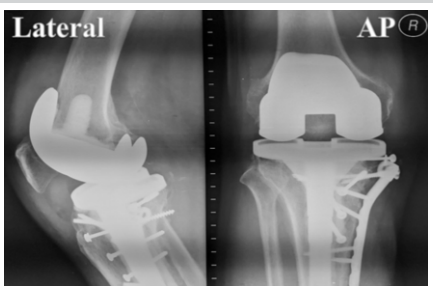

Figure 9: One year follow-up X-ray of the fracture treated with primary arthroplasty and plating. (Credits – Asikin et al.).

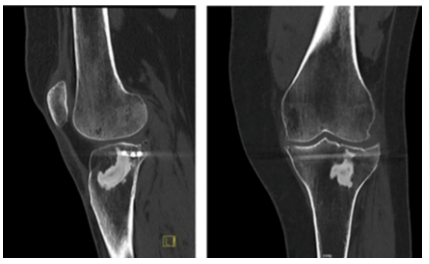

Figure 7: Six-year follow-up CT scan with osteointegration of Cal cemex visible. (Credits – Andrea Pizzoli et al.).

Can Primary Total Knee Arthroplasty in Complex Tibial Plateau Fractures be a Suitable Option?

According to Luigi's literature review, primary total knee arthroplasty (TKA) emerges as a viable option for tibial plateau fractures in elderly patients with pre-existing osteoarthritis and compromised bone quality, where the outcomes of osteosynthesis may be suboptimal. In contrast, to open reduction and internal fixation, primary TKA offers the advantage of immediate weight-bearing and a faster recovery period [9].

It has been hypothesized by many that TKA is a feasible option for managing complex fractures. However, bicondylar tibial plateau fractures were excluded from the study given the complexity of reconstruction. Despite this exclusion, some experts advocate for the use of TKA in case of acute tibial plateau fractures [Fig. 8] with partial articular involvement. The concept of zonal fixation in TKA as derived from Morgan-Jones and his team has been applied to address the complexities associated with challenging tibial plateau fractures.

In Asikin et al. [10] Asikin's case report, the utilization of a proximal tibia condylar plate along with a long tibial stem in treating tibial plateau fractures with metaphyseal extension. It was beneficial as

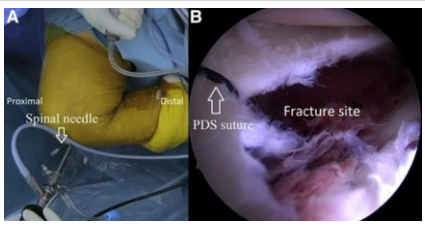

Figure 10: Arthroscopic portals and viewing of the fracture site

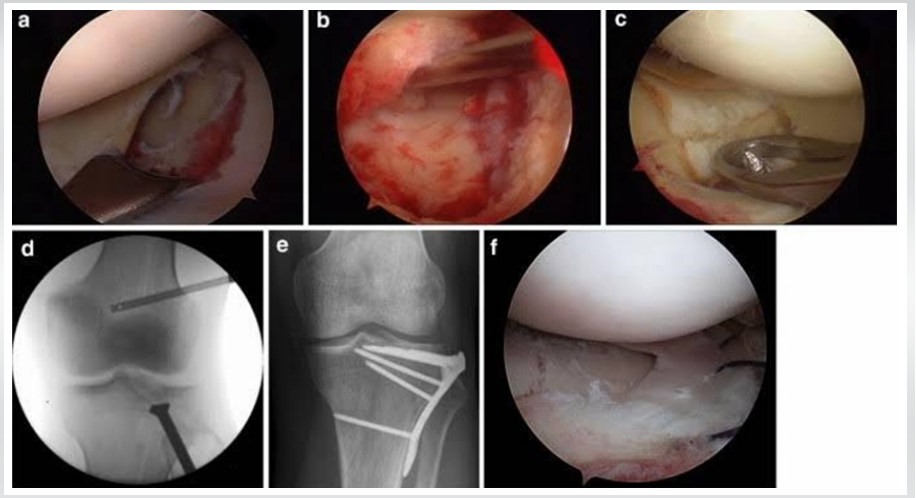

Figure 11: Arthroscopic assisted intra-articular tibia fracture fixation.

it reduced the shearing stress at the metaphyseal region and prevented early failure along with loosening of the implant. He emphasized that the stem should bypass the fracture site by at least 5 cm or at the level of the fracture site. The extended stem plays a crucial role in unloading the metaphyseal region until the union and protects the implant cement interface from failing.

The immediate use of replacement as a management strategy for acute tibial plateau fracture in elderly patients continues to be controversial. While there is emerging evidence supporting the favorable outcomes of primary TKA for tibial plateau fractures, it is crucial to appreciate that performing TKA in the context of acute tibial plateau fracture is a complex undertaking. Many patients in this scenario exhibit significant loss of the articular surface, disrupting normal anatomic references, and compromised soft-tissue due to potential ligamentous injury. Murray advocates that any TKA undertaken in the context of acute tibial plateau fracture should be performed by experienced knee arthroplasty surgeons [11-13].

Although acceptable outcomes may be attained with total knee arthroplasty [Fig. 9] for acute tibial plateau fractures, it is noteworthy that the complication rate associated with this approach is deemed unacceptably high. To establish the ultimate benefits of this treatment strategy, further prospective studies, preferably randomized controlled trials and long-term follow-up data are imperative [14].

Arthroscopic Surgery in Treating Proximal Tibia Intra Articular Fractures. Does it Help?

According to Compagnoni et al., arthroscopy offers precise assessment, anatomical reduction, and tissue-sparing benefits [15]. A notable advantage is the ability to perform extensive joint lavage for evaluating and repairing associated lesions like cartilage or menisci [Fig. 10][Fig.11]. In addition, arthroscopy is associated with a swifter hospitalization and rehabilitation protocol, demonstrating a faster recovery compared to alternative procedures.

The effectiveness of treating tibial plateau fractures using arthroscopic assisted techniques is assessed through radiological and clinical scores, such as the Hospital for Special Surgery (HSS) and Rasmussen clinical score. The existing literature consistently demonstrates excellent clinical outcomes, irrespective of Schatzker classification. Rossi et al. [16] reported an 89% excellent HSS score for Schatzker Type II and III. Chan et al. achieved excellent clinical and radiological scores for Schatzker Type I–VI over 2 and 10-year follow-up periods. Excellent Rasmussen scores post the arthroscopic assisted techniques for patients with Schatzker Type I–V tibial plateau fractures, particularly in Types I and III were found [17,18].

In comparison to alternative methods like

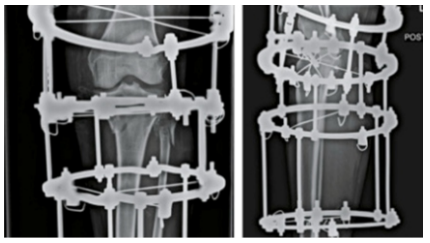

Figure 12: Proximal tibia fracture treated with the Ilizarov method.

open reduction, the literature indicates that the arthroscopic technique is superior, exhibiting fewer complications. This approach is associated with reduced soft-tissue damage, enhanced visualization of the articular surface, an earlier return to physical activities, and a decreased necessity for meniscal detachment repair when contrasted with open approaches.

Cassard et al. [19] observed that an arthroscopic approach led to accelerated rehabilitation, reduced overall hospital length of stay, and lower rate of complications. Alvarez et al. demonstrated the superiority of arthroscopy over fluoroscopy, emphasizing enhanced visualization for more precise tamping and reduction of the tibial plateau. In a case report, Ziogas et al. reported excellent clinical outcomes at 6-, 12-, and 24-week post-operative when utilizing arthroscopy in balloon osteoplasty [20].

How Does the Primary Ilizarov Technique Help in Proximal Tibia Fractures?

The Ilizarov method[Fig.12] employs a minimally invasive strategy, necessitating multiple small stab incisions that mitigate soft-tissue damage and blood loss, compared to other operative techniques which left prominent scars [21]. Beyond its cosmetic benefits, this approach yields mechanical advantages, ensuring increased stability and facilitating precise alignment through adjustable measures during and after surgery. Notably, the Ilizarov method significantly enhances patient mobility by enabling early weight bearing, a key positive factor in post-operative prognostics.

It has been observed that a minimum of 6 weeks is necessary for the formation of soft

callus. The early indications of healing associated with early weight-bearing affirm the previously established theory [22]. The extraction of the femoral ring, especially after the initial 6 weeks, has no adverse impact on knee function and actively supports the healing of the fracture. Usually, patients achieve fracture union within a 4 month period following the application of the Ilizarov method.

In regard to Berven's study, the primary observation is that external fixation of proximal tibia fractures is linked to a higher occurrence of superficial infections while exhibiting a lower frequency of heterotopic ossifications compared to internal stabilization using locking plates [23]. In addition bony consolidation was noted to happen marginally sooner in the plate fixation group.

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