

Potpourri – Recent and Relevant Literature in Periprosthetic Fractures Around the Knee

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Abstract

Knee replacement stands as an effective treatment for alleviating pain and restoring function in cases of degenerative joint conditions. The escalating prevalence of knee replacements reflects their acknowledged success. Despite being a relatively uncommon complication, periprosthetic fractures surrounding total knee arthroplasties present intricate challenges, demanding proficiency in both arthroplasty and trauma reconstructive techniques from treating surgeons. The confluence of increased life expectancy and elevated functional expectations among elderly individuals may contribute to a heightened occurrence of periprosthetic fractures. Among these fractures, supracondylar fractures of the femur emerge as the most prevalent. This comprehensive review delves into the classification and diverse treatment modalities available for addressing periprosthetic fractures around total knee arthroplasties.

Keywords: Total Knee Arthroplasty, Replacement, Femur, Periprosthetic fractures

Introduction

The escalating frequency of knee replacement procedures is emblematic of a profound trend in orthopedic practice. Notably, the year 2020 witnessed a staggering 8.3% surge in knee replacement procedures performed, underscoring a significant increase from the previous year [1]. This substantial rise raises a consequential concern – the parallel escalation of periprosthetic fractures encircling the knee, an intricately linked complication associated with both primary and revision total knee arthroplasty (TKA). Addressing these fractures poses a multifaceted challenge, necessitating a judicious allocation of time and resources. Recent advancements, including locking plate fixation, nailing

techniques, and the integration of endoprosthesis, represent pivotal strides in improving outcomes for these intricate injuries. This article endeavors to delve into the nuanced landscape surrounding periprosthetic knee fractures. Through an in-depth exploration of incidence and prevalence, it seeks to illuminate the trajectory of these fractures in the context of knee arthroplasty procedures.

This article aims to provide a comprehensive understanding of the varied manifestations and complexities inherent in periprosthetic knee fractures. However, given the paramount significance of femoral fractures, which notably stand as the most prevalent and consequential among these complications, the review strategically centers its focus on this subset. Femoral

fractures not only present formidable technical challenges but also entail substantial morbidity and mortality, amplifying the urgency for a meticulous examination of management strategies.

In essence, this article serves as a compass for navigating the intricate terrain of periprosthetic fractures around the knee. As the field continues to witness innovation and refinement in treatment modalities, this comprehensive analysis endeavors to offer a timely synthesis of the latest trends and advancements in the realm of periprosthetic knee fractures.

Classification

Periprosthetic fractures around the knee exhibit a broad classification dichotomy, encompassing intraoperative fractures and post-operative fractures. Further granularity is achieved by anatomical categorization, delineating fractures into femoral, tibial, or patellar subtypes.

Intraoperative fractures

Within the intraoperative realm, tibial fractures commonly manifest during

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revision surgery. Conversely, femoral fractures in this context, whether metaphyseal or diaphyseal, typically elude detection until the post-operative phase. Notably, their occurrence is heightened in posteriorly stabilized knee procedures.

Post-operative fractures

A significant proportion of post-operative fractures manifest in the supracondylar femoral region. Among the various proposed classification systems, the Lewis and Rorabeck classification, considering fracture displacement and femoral component fixation, stands prominently [2, 3]. Type 1 fractures are undisplaced, type 2 involves displacement or angulation exceeding 5 mm or 5°, yet the prosthesis remains stable, while type 3 fractures signify a loose component regardless of displacement. Alternatively, Kim et al. [4] introduced a classification hinging on distal fragment bone amount, component position, and fracture reducibility. Type 1 fractures with well-aligned components may be undisplaced (1A) or irreducible (1B), whereas type 2 fractures, with good bone stock, involve a loose or maligned component benefiting from revision arthroplasty. Type 3 fractures, marked by severe comminution and poor distal bone stock, necessitate distal femoral replacement.

Tibial periprosthetic fractures, categorized into four types based on anatomical location and component fixation, include type 1 involving the tibial plateau (often associated with loosening), type 2 around the prosthetic stem (traumatic with osteolysis influence), type 3 distal to the component, and type 4 involving the tibial tuberosity – with further distinctions based on intraoperative considerations [5].

Patellar periprosthetic fractures undergo classification considering component stability, bone stock quality, and extensor mechanism integrity. Types 1 and 2 entail

a well-fixed prosthesis, while types 3 and 4 involve a loose prosthesis, with type 2 fractures disrupting the extensor mechanism and type 4 fractures being associated with poor bone stock [6].

Treatment

Intraoperative fractures

Intraoperative fractures, once identified, generally pose a manageable scenario. Typically undisplaced with preserved implant stability and minimal soft tissue damage, metaphyseal femoral fractures find resolution through single transcondylar screw fixation, while diaphyseal perforations often respond well to stemmed components, circumventing the perforation by at least two cortical dimensions [7]. Tibial intraoperative fractures, more prevalent in revision surgeries, commonly undergo effective treatment with screw fixation, stemmed implants, or a combination without significant alterations to the post-operative rehabilitation protocol. Transverse patellar fractures, typically undisplaced, often undergo conservative management, although occasional cases may necessitate tension band wiring to mitigate the risk of post-operative extensor mechanism disruption [8].

Post-operative fractures

For periprosthetic fractures of the distal femur with a well-fixed total knee arthroplasty (TKA), the treatment options span non-operative and operative interventions. Given the often elderly and comorbid population, non-operative approaches, mainly suitable for non-displaced fractures and non-ambulatory patients, are considered, balancing the risk of mortality against the benefits [9]. Conservative measures entail prolonged immobility with a union period ranging from 2 to 4 months, although potential complications may outweigh the benefits, especially considering the risk of post-operative stiffness. Comparative studies indicate superior functional outcomes with stable

fixation, facilitating early motion, and averting stiffness. Operative interventions, guided by factors such as implant stability, fracture pattern, infection status, and bone quality, include implant retention, retrograde intramedullary nailing, open reduction and internal fixation (ORIF) with non-locked or locked plates, and external fixation techniques [10].

Intramedullary Nailing

Retrograde intramedullary nailing, offering a load-sharing construct and early weight bearing upon achieving satisfactory fixation, is a preferred option, particularly if closed reduction suffices. Careful considerations, including femoral component features and the presence of other implants, influence the choice of this technique [11].

Lari et al. [12] in their study on arthroscopic retrograde intramedullary nailing of periprosthetic fractures after TKA concluded that the technique is safe and offers a less invasive approach to fixation of periprosthetic femoral fractures after TKA.

Plating

The utilization of plates for open reduction and internal fixation in periprosthetic distal femoral fractures are categorized into non-locking (standard or conventional) plating and locking plates. Certain locking plate designs incorporate polyaxial screw orientation, enabling surgeons to optimize stability without compromising the existing implant or interface [13, 14]. While initial reports suggested satisfactory outcomes with non-locking plates, these have proven less effective in cases of periprosthetic distal femoral fractures characterized by comminution and osteoporosis [15].

Cohort studies highlight the efficacy of locked plate fixation, achieving high rates of union (96%), although requiring up to 6 months for complete consolidation and

up to 3 months of restricted weight bearing. Expedited recovery was observed in cases of distal femoral replacements, particularly when the in situ implants were unstable. The use of a less invasive stabilization system (LISS) plate demonstrated a mean time to union of 3.7 months, with incomplete follow-up but comparable Oxford Knee Score and Short-Form 12 scores to primary knee replacements [16].

Recent evidence suggests that augmenting locked plate fixation with cerclage wires may reduce complication rates, expedite the time to union, and lower revision rates (0% vs. 20%) [17]. However, caution is advised to prevent excessive soft tissue stripping in the metaphyseal region, which could lead to devascularization and an increased risk of non-union.

Studies by Hoffmann et al. [18] revealed non-union in 8 cases and hardware failure in 3 cases among 36 periprosthetic distal femoral fractures fixed with locking plates. Non-union rates were lower with less invasive surgical approaches, though post-operative stiffness was a common occurrence. Ehlinger et al. [19] advocated for minimally invasive surgery combined with locked plating to mitigate further soft tissue damage, achieving high rates of consolidation (94%).

Comparisons between retrograde intramedullary nailing and non-locking plates demonstrated the former's superiority in operative time and intraoperative blood loss [20]. Retrograde intramedullary nails also exhibited a significant risk reduction for non-union (87%) and revision surgery (70%) compared to non-locked plates [21]. In vitro assessments favored retrograde intramedullary nails for superior stability in specimens with no fracture gap or a 10 mm fracture gap [22]. Notably, the study suggested that locked lateral plating might not be suitable in cases of significant medial comminution or a fracture gap. Studies by Large et al.

[23] and Kiliçoğlu et al. [24] showed higher rates of malunion, non-union, and complication rates with non-locked plates or retrograde intramedullary nails compared to locked plates.

A recent systematic review underscored the advantages of retrograde intramedullary nailing and locked plate fixation over non-operative treatment and standard plating [25]. When comparing retrograde intramedullary nailing to locked plating, no significant difference was found in the rates of non-union or revision surgery, although a higher malunion rate was noted with nailing. However, it is crucial to acknowledge the limited evidence available (predominantly level IV) and the need for more robust level I or II evidence to guide treatment decisions effectively.

External fixation

External fixation techniques, while showing promise in alignment correction and stability with post-operative knee motion, are confined to limited case reports, warranting careful consideration and expertise [26].

Revision arthroplasty

Revision total knee arthroplasty (TKA) emerges as the preferred option, especially in cases of loose or malaligned components. Feasibility rests on factors such as bone stock adequacy, fracture pattern simplicity, and the absence of ligamentous deficiency. However, deficient bone stock may necessitate distal femoral megaprosthesis or allograft prosthesis composites, with recent studies suggesting comparable functional outcomes among these options [27]. Srinivasan et al. [28] in their study highlighted the role of long-stem prosthesis in periprosthetic and some complex distal femoral fractures in offering stability and early mobilization. Chalmers et al. [29] concluded that patients with periprosthetic fractures

around prior primary TKA treated with distal femoral replacement with cemented femoral fixation had a 97% 5-year survivorship free from any re-revision.

Endoprostheses

Distal femoral replacements, well-established in tumor surgery, are increasingly applied in treating supracondylar periprosthetic fractures with component loosening and poor bone stock. Offering early mobilization and weight bearing, they prove valuable in managing non-unions or implant failures following periprosthetic fracture fixation. Selective use, with surgeon expertise, is crucial to mitigate complications associated with their application [30].

Canon et al. [31] in their study concluded that the use of a tumor-type endoprosthesis in situations of comminuted periprosthetic fractures associated with a loose prosthesis shows favorable results with low complication rates and rapid mobilization. Similarly, Windhager et al. [32] concluded that megaprotheses represent a valuable option in distal femoral periprosthetic fractures type 3, as well as proximal tibia periprosthetic fractures type 1B with loose tibial components.

Conclusion

In summary, managing periprosthetic fractures around the knee presents formidable challenges, with profound implications for patients and intricate technical demands for surgeons. These fractures predominantly affect frail, elderly individuals with significant medical complexities, necessitating a collaborative approach that combines expertise in fixation techniques and revision arthroplasty. While a considerable portion of cases responds well to intramedullary devices or locked plating systems, careful consideration and patient selection are pivotal.

Revision surgery, and in certain instances, the application of a distal femoral endoprosthesis, emerges as a viable strategy, especially for patients with compromised bone stock. The overarching treatment objective remains the attainment of a well-aligned, mobile knee joint, ensuring the patient's ambulation and a successfully united fracture, all while prioritizing patient safety.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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