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Definition of post-traumatic outcomes of operated and unoperated knee fractures

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Summary

Knee fractures include fractures of the tibial plateau, distal femur, and patella. The most frequent complication of these fractures is post-traumatic osteoarthritis, defined as secondary osteoarthritis that develops as a result of direct damage or trauma to a specific joint.
According to the available data, 23-36% of people who have suffered an intra-articular knee fracture will develop secondary osteoarthritis. The average age at which it develops is 9-14 years before the average age at which primary osteoarthritis develops in the general population.
Analysis of the literature shows that treatment of knee fractures must be chosen according to various parameters such as age, state of health, and degree of activity of the patient as well as the extent of damage to the joint surface. In young patients, there is an indication for open reduction and internal fixation treatments, corrective osteotomies, or osteoarticular reconstruction, while in elderly patients with low functional demands the use of total knee prostheses should be considered. It must be taken into account, however, that poor functional results of prostheses are reported when used in cases of high complexity of joint deformity, especially if they involve both the femur and tibia and in case of compromised soft tissues that require reconstruction.

Key words: knee fractures, unoperated knee fractures, post-traumatic outcomes

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Introduction

Knee fractures include fractures of the tibial plateau, distal femur, and patella. In evaluating the post-traumatic outcomes of knee fractures, we decided to consider the joint fractures of the distal femur and tibial plateau. The most frequent complication of these fractures is post-traumatic osteoarthritis, which is defined as secondary osteoarthritis that develops as a result of direct damage or trauma at the level of a specific articulation [1].
Joint trauma, whether treated surgically or conservatively, may result in residual joint incongruity and instability due to injury to the surrounding soft tissues, leading to progressive wear and tear of articular cartilage, with bone remodeling and soft tissue changes that are typical of osteoarthritis.
The risk of developing post-traumatic osteoarthritis increases with the age at which the trauma occurs. In patients who had osteoarthritis before the trauma, both conditions compromise the ability to heal fractures [2].
According to the available data, 23-36% of people who have suffered an intra-articular knee fracture develop secondary osteoarthritis and the average age at which

it develops is less than 45-50 years, which is 9-14 years earlier than the average age at which primary osteoarthritis develops in the general population [2].
The knee, compared to other joints, better tolerates joint irregularities thanks to its extended joint surface and the presence of menisci, but is less tolerant of instability and misalignment on the coronal plane: the distal femur accepts -6° ±5°of valgus, the proximal tibia accepts -3° ± 5° of varus and -9° ± 5° of posterior slope [2].
The classification most used for post-traumatic osteoarthritis is that of Kellgren & Lawrence which includes the existence of four degrees of osteoarthritis through the evaluation of x-rays based on: the thickness of the joint rhyme and the presence of osteophytes, subchondral sclerosis, and bone deformities [3].

Methods

Our aim was to review the literature to compare treatment of traumatic outcomes of knee fractures in operated and non-operated patients.

Search strategy

A literature search was conducted on PubMed, Cochrane Library, and EuropePMC searching for the following keywords: post-traumatic arthritis, intra-articular fracture, degenerative arthritis, tibial plateau fractures, distal femur fractures, operated versus unoperated knee fracture, surgical versus non-surgical treatment in knee fractures.
No limit was set for the date of publication

Inclusion criteria

We included studies that dealt with the results of knee fracture treatments with statistically significant data.

Discussion

Distal femur fractures

Distal femur fractures have a bimodal distribution, and are often the result of high-energy trauma in young adults with male prevalence or the result of low-energy trauma in the elderly with female prevalence.
These fractures are classified by the AO/OTA classification into extraarticular fractures (type A), partial articular fractures (type B), and complete articular fractures (type C). Type B and C fractures are further sub-classified according to femoral condyle involvement and joint/metaphysis involvement, respectively (Figs. 1A-B) [4].
The treatment of these fractures according to AO guidelines provides a conservative treatment only for undisplaced, stable, and extraarticular (type A) fractures in patients who are not walking or not surgical candidates. Conservative treatment consists of a long leg plaster or cast with flexion of 30° for at least 6 weeks with non-weight bearing on the affected limb [4].
Surgical treatment is indicated in most cases: displaced fractures, intraarticular fractures, and distal femur malalignments. In case of surgical treatment, anatomical condyles reconstruction and restoration of the articular surface and rotation axes is obligatory. To achieve this, we can use several osteosynthesis devices, such as plates with compression or angular stability screws, retrograde nail, or free condyle screws [4].

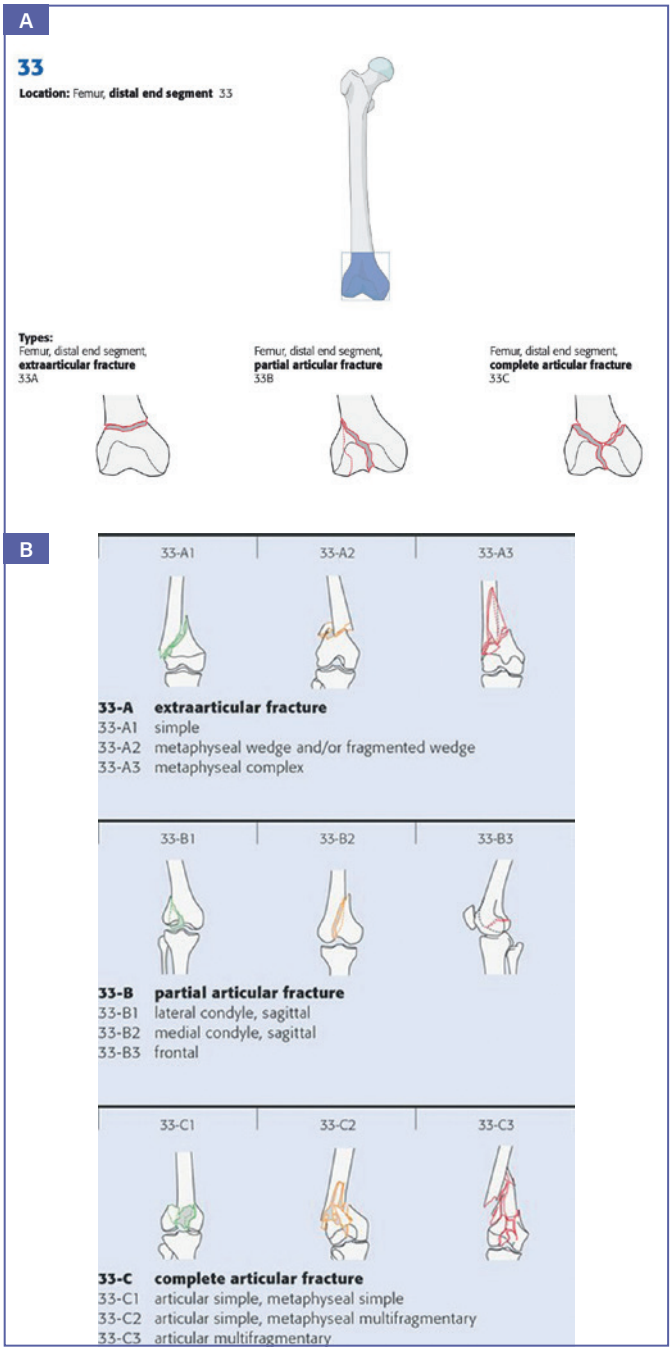

Figure 1A-B. Distal Femur AO/OTA classification.

According to the literature, good/excellent results are achievable with surgical treatment in 53% of cases, which is obtainable through conservative treatment in only 31% of cases [5,6]. Conservative treatment implies more complications, mainly due to the longer time of immobilization and non-weight bearing of the affected limb (DVT, bedsores, urinary tract infections and respiratory tract infections) [6].

When considering surgical treatment, it seems to be better synthesis with retrograde intramedullary nail than open reduction and internal fixation (ORIF), if the type of fracture allows it: patients treated with ORIF more often undergo associated procedures, such as bone grafting, and their malunion rates are significantly higher [7].

The radiographic evidence of post-traumatic osteoarthritis after surgical treated distal femur fractures develops in 36-50% of patients after a long period of observation [7,8]. To the detriment of this radiographic data and in favor of clinical evaluation, it must be emphasized that only a minimal percentage of patients need to undergo a TKA implant [5]. Some studies have found no correlation between development of secondary osteoarthritis with the patient's age at the time of trauma or with post-reduction axial alignment, but these data appear to be in complete disagreement with the most recent synthesis guidelines for this type of fracture [9,4].

For elderly patients with poor bone quality, pre-existing osteoarthritis, and high comorbidity, some authors consider as an option the implant of primary knee arthroplasty following a complex fracture of the distal femur. The advantage consists in the regain of pre-operative autonomy and recovery of the knee range of motion (ROM), as well as disadvantages such as surgical complications in the perioperative period, which appear to be proportionately contained [9,10].

Proximal tibia fractures

Fractures of the tibial plateau are classified using the Shatzker classification, rather than the more recent AO/OTA classification because it can provide more accurate therapeutic and prognostic indications (Figs. 2A-B) [11].

When considering tibial plateau fractures, the theory of the three columns should be mentioned, according to which they are divided into a lateral, medial, and posterior column: the portion concerned suggests the best surgical access and specific type of treatment [12].

According to the AO guidelines, the treatment of tibial plate fractures is mandatory in the following circumstances: exposed fractures; fractures with associated vascular lesion or compartment syndrome; fractures-dislocations; intra-articular fractures; joint depression with knee instability associated; malalignment; polytrauma [4].

Surgical treatment must aim to obtain restoration of the joint surface, also with the aid of an arthroscope to ensure direct view of the cartilage. Bone substitutes or autologous bone grafts are used to fill the bone gaps, and synthesis is performed

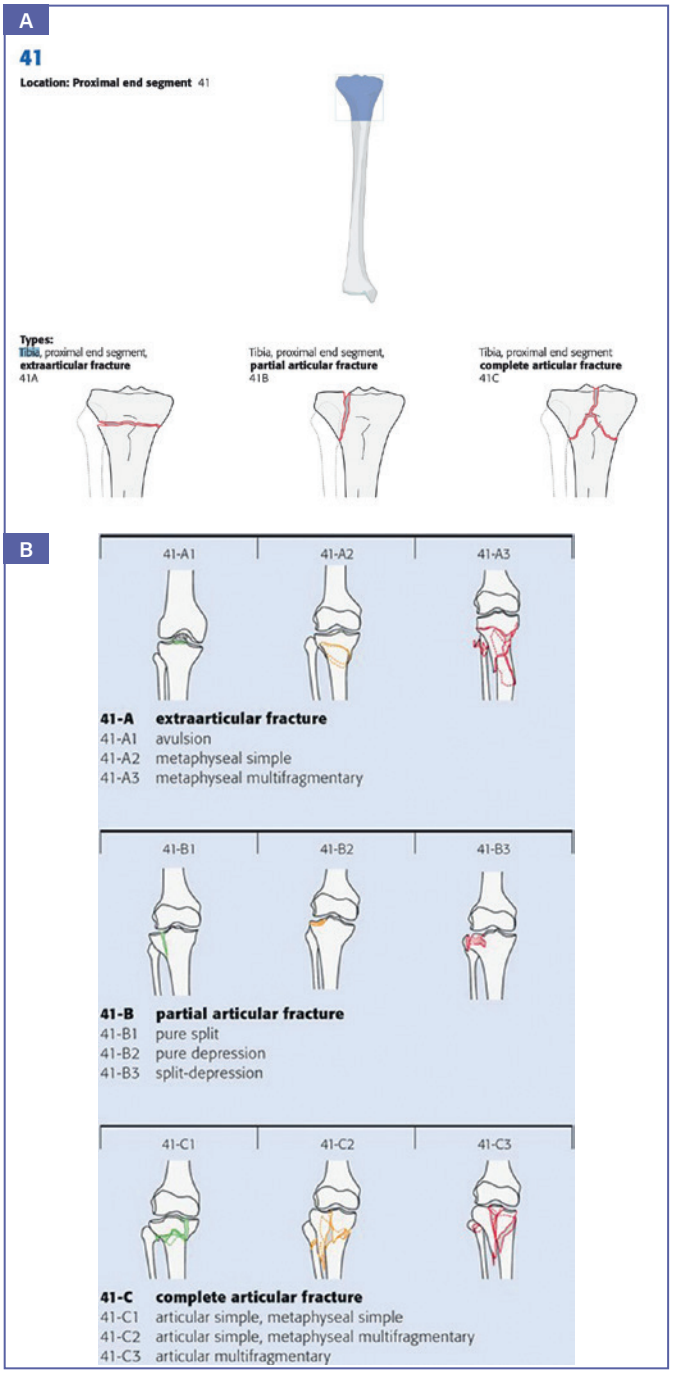

Figure 2A-B. Proximal tibial AO/OTA classification.

with screws with or without the support of a plate depending on the fracture type [4].

The indications for conservative treatment are non-displaced fractures without ligament damage with a stable knee at the varus-valgus stress and in extension. In this case, the treatment consists of immobilization in a long leg plaster or cast for 6 weeks with non-weight-bearing on the limb [4].

When the fracture falls within the criteria that require surgical treatment, poor bone quality does not justify conservative treatment. It has been observed that the fracture pattern is related to bone density, but the fracture pattern and use of bone graft during the synthesis do not correlate with the final clinical outcome [13].
The most important factor to predict the outcome of the fracture is the adequacy of reduction; a joint incongruence of > 5 mm is associated with an unsatisfactory result, while the method used for reduction and the duration of immobilization are not so crucial [14]. The development of x-ray signs of post-traumatic osteoarthritis is correlated with the complexity of fracture, and reaches peaks of 58% of cases in Shatzker V and VI type [15]. The incidence of post-traumatic osteoarthritis also increases with age of patients, development of post-operative infections, residual ligamentous instability, and when meniscectomy is performed. The removal of the menisci is predictive for the successive development of osteoarthritis in in > 80% of cases, and seems more crucial than residual irregularity of the joint surface [16].
Only about 4-7% of patients are symptomatic and underwent TKA, which is a slightly higher percentage than in those with distal femur fractures. The necessity of TKA increases with patient age, complexity of the fracture, and severity of soft tissue lesions, including the meniscus and ligaments [15,17].
As seen for distal femur fractures, in this case you can also consider treating orthogeriatric patients affected by tibial plateau fractures, especially those with pre-existing symptomatic osteoarthritis, severe osteoporosis, and in case of intraarticular fractures that cannot be reconstructed, with primary TKA because it permits earlier mobilization, and reduces post-operative complications (deep venous thrombosis, pulmonary embolism, pneumonia, and decrease in muscle mass), mortality, and morbidity. This option has shown good functional results, but also a high percentage, about 20%, of prosthetic revisions for complications [18,19].
It is necessary to remember that the optimal treatment strategy for these fractures, as well as increasing the chances of return to usual activities and adequate quality of life, allows to treat patients with less complicated morbid conditions once post-osteoarthritis has developed.
Traumatic outcomes frequently involve ligament deformities and laxities that require the use of revision prostheses to restore the joint axis, stability, and function (Figs. 3-6).

Conclusions

Treatment of knee fractures should be based on the patient's age, degree of activity, and extent of damage to the joint surface: young patients find the indication for ORIF, intramedullary nailing, corrective osteotomies, or osteoarticular reconstruction with allograft; for elderly patients, TKA should be considered.
When treating young patients, the main thing to keep in mind is the anatomical reconstruction of the joint surface and respect for soft tissues, which if damaged must be reconstructed in the best possible way.

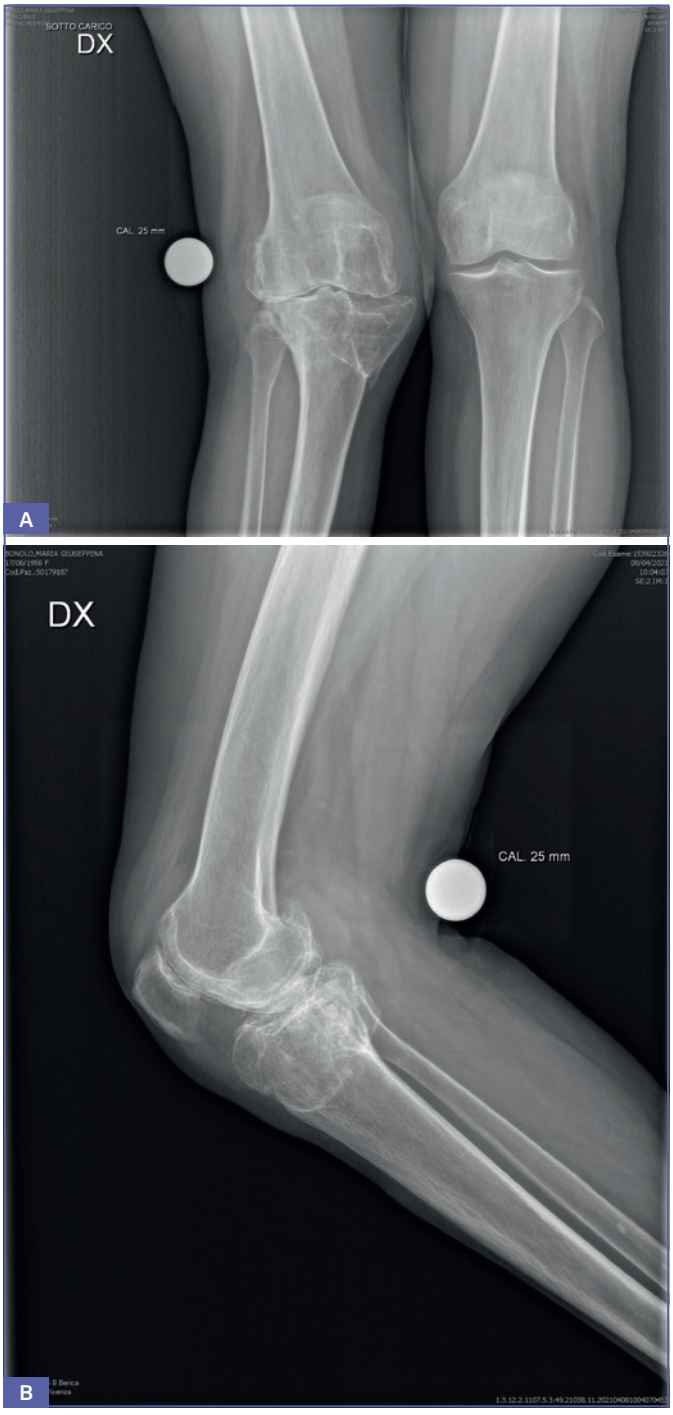

Figure 3. A) pre-operative x-ray Ap view; B) pre-operative x-ray lateral view.

Treating orthogeriatric patients with TKA offers important improvement in functional scores, improvement in ROM, and better pain management; however, it should be kept in mind that, compared to implants carried out for primary arthritis, they are bur-

Figure 4. Intra-operative knee exposure.

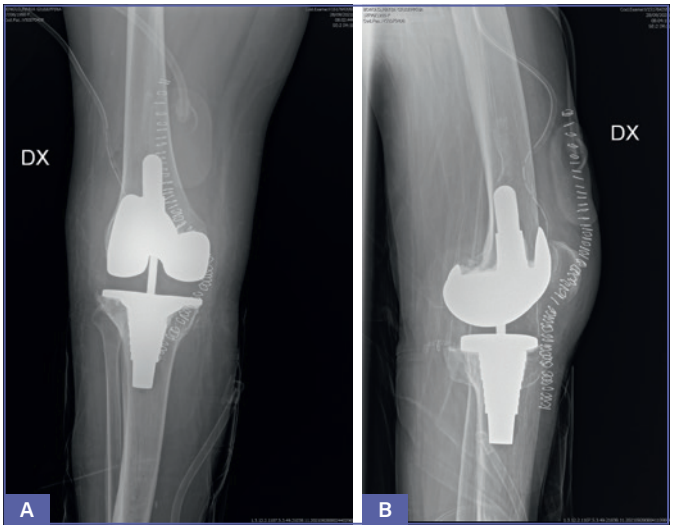

Figure 5. A) Post-operative x-ray AP view; B) post-operative x-ray lateral view.

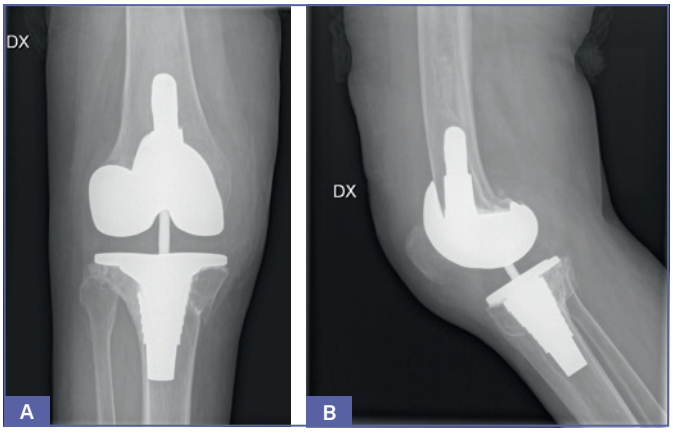

Figure 6. A) 3 months follow-up x-ray AP view; B) 3 months follow-up x-ray lateral view.

dened by a greater rate of revisions due to wear of polyethylene, probably because they are implanted in younger patients; greater rigidity; wound complications; and infections. Poor functional outcomes of prostheses may occur in cases of high complexity of joint deformity, especially if they involve both femur and tibia and in case of impairment of soft tissues that need reconstruction.

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Conflict of interest statement
The Authors declare no conflict of interest.

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Authors' contributions
All the Authors contributed equally to this work; CZ, AM and SG designed the research; MR analysed the data; CZ and JA wrote the paper; SG contributed to manuscript revision; all Authors approved the final version of the manuscript.

Ethical consideration
For this type of study, retrospective, the inclusion of any declaration relating to the studies carried out on humans and animals, is not required.

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