Intracapsular Femoral Neck Fractures

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Femoral neck fractures are common and constitute one of the largest healthcare burdens of the modern age. Fractures within the joint capsule (intracapsular) represent a specific surgical challenge due to the difficulty in predicting the rates of bony union and whether the blood supply to the femoral head has been disrupted in a way that would lead to avascular necrosis. Most femoral neck fractures are treated surgically, aiming to maintain mobility, whilst reducing pain and complications associated with prolonged bedrest.

algorithm arthroplasty femoral neck fractures hip fractures fixation screws surgical management

1. Introduction

Femoral neck fractures are one of the biggest diseases of modern times, with lifetime incidences of approximately 1 in 4 for women and 1 in 10 for men [1]. Their prevalence and severity result in vast health and financial burdens; they are the most expensive fractures to treat [2]. Complications remain common given the spectrum of different fracture patterns and the baseline functions of the population affected, and if reoperations are required, mortality rates and financial costs rise considerably [3].

Most hip fractures occur within the capsule of the joint. These fractures pose specific difficulties because of the risk of disruption to the vascularity of the femoral head which can lead to avascular necrosis (AVN). Outcomes, compared to extracapsular fractures, are thus potentially more dependent on the choice and quality of the operation performed. Focusing on intracapsular fracture types, we aimed to create an evidence-based algorithm for the management of an intracapsular hip fracture.

2. Intracapsular Femoral Neck Fractures

Fractures within the region of the femoral neck (AO/OTA 31–B1-3) present surgical challenges due to the uncommon vascular supply to that region. The majority of the blood supply to the femoral head enters in a retrograde fashion, predominantly via the lateral epiphyseal artery, a branch of the medial femoral circumflex artery. Healing of intracapsular fractures occurs through primary osteonal reconstruction due to the inability to bone in this region to form external callus. These anatomical factors combine to heighten the risk of nonunion and AVN with these fractures, further worsened by any disruption to the arterial blood supply due to the energy from the initial trauma, and/or ongoing hypoperfusion through malreduction and reduced arterial flow. However, even in the presence of initial arterial damage, fragment stabilization can be sufficient to reduce the risk of AVN, as reduction and stability enable revascularization across the fracture, before AVN and subsequent collapse can occur [4][5]. Concerns about AVN occurring (including the difficulty in predicting which fractures are more susceptible), fractures not uniting, and the risks from any further operations often justify a more pre-emptive approach in patients with a reduced physiological capacity to deal with such events. This is contrasted with a more accepting stance towards future surgery in young patients [6], where preservation of the native joint predominates due to both the finite lifespan from articular replacements and the increased demands that an active patient would be expected to have.

2.1. Presence of Pathological Fracture

Pathological fractures require additional management considerations, in part, due to the lack of healing potential that is required for successful osteosynthesis, alongside presenting other technical complexities such as having reduced quantity and unknown quality of residual bone stock. Therefore, arthroplastic solutions—total hip arthroplasty (THA) or hemiarthroplasty (HA)—are required to restore the patients to their baseline function and to enable mobilization; these operative options have been shown to last longer than fixation treatments [7]. Furthermore, intramedullary procedures may risk generating metastases through embolization of malignant tissue. As further bone destruction can occur after fracture treatment due to the ongoing neoplastic condition, replacement surgery reduces the risk of future reoperation, as may be the case with fixation options. The exception to this is when additional neoplastic lesions within the shaft of the femur would result in stress raisers to an implanted stem. In this instance, cephalomedullary nailing or arthroplasty with concurrent stress-reducing plating are surgical options but require planning on a case-by-case basis. Thorough imaging of adjacent joints is required to assess for other lesions and to ensure that stress raisers are neither encountered nor created intra- or post-operatively.

2.2. Non-Pathological Fractures—Fracture Displacement

In the absence of prior symptomatic osteoarthritis (OA), fracture displacement needs to be assessed to determine the operative intervention. Completely undisplaced fractures occur rarely [8]. Though being an imperfect surrogate marker [9], displacement is thought to correlate with suspected femoral head blood supply disruption, which in turn predicts the rates of AVN; reportedly between 7 and 78%, with younger groups having higher rates, probably reflecting the higher energy that caused their fracture [8][10][11]. Displacement needs to be assessed orthogonally. Commonly the Garden classification [12] (I—valgus impacted, II—undisplaced, III—partially displaced, IV—fully displaced) is used for assessing coronal displacement, though the key distinction needed is whether there is true displacement or not, regardless of whether partial or full. Firstly, as there has not been shown to be a difference in healing rates between Garden III and IV [13] and secondly, as partially and fully displaced fractures are managed in the same way. Additionally, as the Garden classification is based only on coronal radiographs, lateral images must also be viewed to ensure displacement is not underestimated or missed entirely. Sagittal displacement, typically measured on a lateral radiograph, ≥20° posterior tilt, or ≥10° anterior tilt, has been shown to worsen outcomes when fixed [14][15].

3. Fixation Methods for Undisplaced Fractures

The aim of fixation is to allow compression at the fracture site without shortening, whilst maintaining alignment. Fixation options have typically been either multiple cancellous cannulated screws or a sliding hip screw (SHS). The former offers benefits of a smaller biological footprint both from the surgical exposure and implanted metalwork, whilst the later provides greater angular stability [16]. There is limited clinical evidence of an advantage of one fixation method over another [17]. A previous review found no superiority between cannulated screws osteosynthesis and SHS, though an increase in AVN with cannulated screws [18]. However, a more recent prospective trial randomizing 1079 unblinded patients to receive either SHS or cancellous screws contradicts the increase in AVN, though agrees that overall, there is no superiority between either method [19]; it showed a higher rate of AVN and more conversions to THA after SHS fixation, though no difference in patient reported outcomes. SHS led to better outcomes in current smokers, more displaced fractures, and fractures with a more vertical line (Pauwels III), explained by the angular stability created by this construct.

4. Displaced Fractures

4.1. Young Patients

Patients under 60 years of age account for between 4 and 13% of the intracapsular hip fractures [20][21]. However, this group represents the greatest operative challenge as preservation of the native hip joint should be prioritized—due to the demands that may be placed on the implants and as the patient's life expectancy is greater than that of the implants. The strategy should be to reduce the fracture, converting the configuration into the equivalent of an undisplaced variant and then managed as per this fracture type. Albeit observing low energy fractures, a clinical study on 1059 patients observed that 58% of cases (614 patients) needed some reduction; 5% (48 patients) received open and 53% (564 patients) required closed reduction [19]. For closed reduction, traction in extension with internal rotation of the leg from an abducted position can adequately reduce the fracture [22]. Open reduction may be needed if there is more displacement, as seen after high energy trauma. For open reduction, either an anterolateral or modified anterior approach, or combination can be used, where reduction is performed anteriorly and fixation laterally. No comparisons between the different reduction techniques have been performed; the key being that reduction is achieved rather than the method leading to it.

4.2. Old Patients

The vast majority of old patients have replacement surgery if they have sustained a displaced intracapsular fracture —92% in the UK [23]. Compared to HA for displaced fractures, osteosynthesis has been shown to result in higher complication rates of between 10 and 45% [24][25][26], including nearly a threefold increase in revision surgery (4% after HA and 11% after fixation of displaced fractures [27]), though with newer fixation techniques these rates have been considerably reduced. Functional outcomes are also better after HA compared to osteosynthesis in the elderly population [28].

Replacement options are either HA or THA. The latter is suggested for patients who were able to walk independently out of doors with no more than the use of stick, are not cognitively impaired and are medically fit for the anesthesia and the procedure; in the UK, 7% of all femoral neck fracture patients received a THA in 2019 [23]. Additionally, THA is indicated in symptomatic pre-injury OA, as a failure to treat prior OA that was limiting the patient's mobility before the injury can be expected to impact their rehabilitation potential following hip fracture surgery. As the vast majority of hip fractures occur in the elderly, pre-existing OA of this joint is frequently encountered. However, the key information regarding management options is how symptomatic this is during their activities of daily living. Unfortunately, data are lacking and conflicting regarding the medium- and long-term comparisons of HA and THA. No difference in reoperation rate, function or mortality at 2 years has been seen in patients randomized between HA or THA [29], nor in functional outcomes at 12 years [30], however, a meta-analysis has shown improved patient reported outcomes with THA [31], with another review challenging this [32]. Outcomes following THA for displaced fractures have been shown to be worse than following elective THA [33] and are associated with higher mortality rates when performed after trauma rather than electively [34].

5. Conclusions

Intracapsular hip fractures are heterogeneous both in terms of fracture characteristics and patients they occur in. Using the described algorithm enables an evidence-based approach, addressing the numerous factors that need consideration for optimum management.

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