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Open Reduction *Versus* Closed Reduction: The Management of Femoral Bone Fractures in the Elderly – A Narrative Review of Current Guidelines

Omar Fayek Ismail[1], Zahra Zarrinhonar[2] and Hussain Ramzan[3*]

[1]University of Debrecen, Hungary

[2]St. George's University, Grenada

[3]Nishtar Medical University and Hospital, Multan, Pakistan

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[*]**Corresponding author:** Hussain Ramzan, Nishtar Medical University and Hospital, Multan, Pakistan

ABSTRACT

Femoral fractures in the elderly represent a major public health crisis, driven by demographic aging and associated with devastating mortality, functional decline, and immense economic costs. The surgical decision between Open Reduction (OR) and Closed Reduction (CR) is a cornerstone of management, influencing healing biology, complication profiles, and ultimate recovery. This narrative review synthesizes contemporary evidence and guideline recommendations to compare these reduction strategies across femoral fracture patterns in older adults. For displaced femoral neck fractures, current guidelines strongly advocate for arthroplasty over internal fixation, effectively minimizing the relevance of the OR *versus* CR debate for fixation in this subset. In subtrochanteric fractures, the quality of the achieved reduction is a more critical determinant of union than the method used to attain it. For femoral shaft fractures, meta-analyses confirm that CR with intramedullary nailing yields superior union rates and faster healing compared to OR. In distal femoral fractures, a hybrid approach-open reduction for articular reconstruction combined with closed, minimally invasive fixation for the metaphyseal segment-is emerging as a balanced strategy. Ultimately, the choice must be integrated into a patient-centred, multidisciplinary orthogeriatric pathway to optimize outcomes in this vulnerable population.

INTRODUCTION

Femoral fractures in the elderly population constitute a catastrophic health event, with a global incidence that continues to rise steeply due to the aging of populations worldwide [1]. These injuries are predominantly fragility fractures resulting from low-energy mechanisms, such as a fall from standing height, and they signal underlying osteoporosis and frailty [1]. The consequences are severe, with one-year mortality rates persistently ranging between 20% and 30%, representing a three- to four-fold increase in mortality risk compared to age-matched peers without fracture [2]. Survivors face a profound loss of independence, with a high likelihood of institutionalization and permanent functional decline [2]. The economic burden is staggering, encompassing acute hospitalization, surgical intervention, prolonged rehabilitation, and long-term care, with annual costs exceeding $30 billion in the United States alone [3]. Surgical management is the standard of care, with the

primary goals being early stabilization, pain relief, and facilitation of immediate mobilization to mitigate medical complications [4,5].

Within surgical strategy, the technique of fracture reduction-open *versus* closed-is a fundamental choice that carries significant implications for healing and recovery. Open reduction provides direct visualisation and anatomical restoration but sacrifices soft-tissue biology, while closed reduction prioritizes biological preservation at the potential cost of reduction accuracy [6,7]. Major clinical practice guidelines, such as those from the American Academy of Orthopaedic Surgeons (AAOS) and the UK's National Institute for Health and Care Excellence (NICE), provide evidence-based frameworks for the overall management of hip fractures, including surgical timing and implant selection [4,5]. However, specific guidance on selecting between OR and CR for different femoral regions is often implied rather than explicitly detailed [4,5]. Furthermore, the optimal surgical approach must be contextualized within a comprehensive orthogeriatric model of care, which emphasizes coordinated, multidisciplinary assessment and rehabilitation from admission onward [9,10]. This narrative review, therefore, aims to critically appraise and synthesize current evidence and guideline recommendations regarding open *versus* closed reduction for the management of femoral fractures in the elderly, from the femoral neck to the distal femur.

METHODOLOGY

This narrative review was conducted to synthesize current guidelines and evidence on open *versus* closed reduction for femoral fractures in the elderly. A systematic search strategy was employed using electronic databases (PubMed, Google Scholar, Cochrane Library) and guideline repositories (AAOS, NICE). Search terms included combinations of "femoral fracture," "hip fracture," "open reduction," "closed reduction," "elderly," "geriatric," "guidelines," "systematic review," and "meta-analysis." The focus was on literature published from 2020 to the present to ensure contemporary relevance, though seminal older studies were included where foundational. Clinical practice guidelines, systematic reviews, meta-analyses, and recent high-quality prospective or retrospective comparative studies were prioritized. The retrieved evidence was organized anatomically (femoral neck, intertrochanteric/subtrochanteric, shaft, distal femur) and thematically (principles, outcomes, complications, patient factors). Pertinent data and recommendations were extracted, compared, and integrated into a coherent narrative summary.

DISCUSSION

Overview of femoral fractures in the elderly: epidemiology and significance

The epidemiology of femoral fractures in older adults is characterized by a high and growing incidence, directly tied to global demographic shifts towards an older population [1]. These are overwhelmingly fragility fractures, with osteoporosis being the predominant predisposing condition, making even low-energy falls a potent mechanism of injury [1]. The personal toll is immense, as a hip fracture is often a life-altering event that abruptly ends independent living for many seniors. From a public health perspective, the burden is multifaceted, encompassing acute care, surgical costs, rehabilitation, and long-term institutional care, which collectively exert tremendous pressure on healthcare systems [3]. Mortality remains alarmingly high, with one-year rates between 17% and 25%, and this elevated risk persists for years after the initial injury [2]. Consequently, the management of these fractures extends far beyond simple bone healing; it is a geriatric syndrome requiring a holistic,

multidisciplinary approach [9]. The primary surgical objectives are to provide stable fixation that allows immediate weight-bearing, controls pain, and prevents the cascade of medical complications (e.g., pneumonia, delirium, thromboembolism) that lead to mortality [4,5]. Within this framework, the choice of reduction technique-open or closed-is a critical surgical decision point that influences the biological environment for healing, soft-tissue integrity, and ultimately, the patient's functional trajectory [6,7].

Principles of fracture reduction: open *versus* closed

The fundamental goal of any fracture reduction is to restore anatomical alignment to provide a mechanically stable environment conducive to bone healing. Open reduction involves a direct surgical approach to the fracture site, allowing visualisation and anatomical approximation of fragments [6]. This method is particularly valuable for intra-articular fractures, where precise restoration of joint congruity is paramount, and for complex, multifragmentary patterns where indirect methods may fail [6]. However, the significant disadvantage of OR is the inevitable soft-tissue dissection, which compromises the periosteal and extraosseous blood supply, potentially devitalising bone fragments and increasing the risk of infection and non-union [7]. In contrast, closed reduction is performed using external manipulation, traction, or percutaneous instruments under fluoroscopic guidance, without exposing the fracture haematoma [7]. The paramount advantage of CR is the preservation of the fracture biology, including the haematoma, which is rich in osteogenic factors, and the periosteal blood supply [7]. This biological advantage typically translates to shorter operative times, less blood loss, and lower rates of surgical site infection [7]. The principal challenge of CR is the difficulty in achieving and maintaining an anatomically perfect reduction without direct visualisation, which can lead to higher rates of malreduction, especially in unstable fracture patterns [6,7]. Therefore, the choice between OR and CR often represents a trade-off between mechanical precision and biological preservation [6,7].

Femoral neck fractures: guidelines and reduction strategies

Femoral neck fractures in the elderly are pragmatically classified as displaced or non-displaced, a distinction that critically guides management. For displaced femoral neck fractures, high-level evidence and major guidelines consistently recommend arthroplasty (total hip arthroplasty or hemiarthroplasty) over internal fixation for medically fit older adults [4,5]. This recommendation is driven by the significantly lower reoperation rates associated with arthroplasty, as internal fixation in osteoporotic bone carries a high risk of failure, including non-union, avascular necrosis, and screw cut-out [4,5]. Consequently, for displaced fractures, the debate between OR and CR for the purpose of internal fixation is largely obsolete, as reduction is an inherent step in the arthroplasty procedure itself. For non-displaced or valgus-impacted femoral neck fractures, internal fixation with multiple parallel cannulated screws or a sliding hip screw remains the standard [4]. In these scenarios, reduction is almost invariably achieved through closed or percutaneous means, as the fracture is inherently stable. Open reduction is rarely indicated but may be considered as a salvage procedure when a satisfactory closed reduction cannot be obtained, though this is uncommon. Thus, the paradigm shift towards arthroplasty for displaced fractures has dramatically narrowed the clinical situations where surgeons must actively choose between OR and CR for femoral neck fractures in the elderly [4,5].

Intertrochanteric and subtrochanteric fractures

Intertrochanteric fractures are typically managed with cephalomedullary nailing or a sliding hip screw, with reduction frequently achieved closed using traction on a fracture table. Open reduction is generally reserved for irreducible fractures or those with significant posteromedial comminution that requires direct reduction and

possible cerclage wiring to restore stability. The subtrochanteric region presents a unique challenge due to high mechanical stresses and powerful deforming muscle forces. A recent retrospective study of subtrochanteric fractures treated with nailing found that open reduction achieved an "acceptable reduction" (based on modified Baumgaertner criteria) significantly more often than closed reduction (94.9% *vs.* 68.0%) [6]. However, the critical finding was that clinical outcomes-specifically delayed union and non-union rates—did not differ significantly between the OR and CR groups [6]. Instead, the quality of the reduction itself emerged as the strongest predictor of healing; patients with an acceptable reduction healed faster and had far fewer complications regardless of how the reduction was achieved [6]. This evidence underscores a pivotal surgical principle: the surgeon's primary goal should be to obtain an acceptable reduction, whether by open or closed means [6]. An open approach may be necessary to achieve the required mechanical stability, but a successful closed reduction offers superior biological conditions for healing [6,7].

Femoral shaft fractures: evidence from meta-analysis

Intramedullary nailing is the unequivocal gold standard for femoral shaft fractures in all age groups, including the elderly. A 2023 systematic review and meta-analysis directly compared OR and CR for nailing of femoral shaft fractures, providing high-level evidence to guide practice [7]. The analysis concluded that closed reduction was associated with a higher pooled union rate (93.93%), a statistically significant increased odds of union (OR=1.62), and a faster time to union compared to open reduction [7]. There were no significant differences in operative time or overall complication rates, but CR trended towards a lower risk of infection [7]. The biological rationale for these findings is clear: CR preserves the fracture haematoma and periosteal blood supply, creating a more favourable environment for bone healing [7]. Therefore, closed reduction should be the default and preferred approach for femoral shaft fractures [7]. Open reduction remains a vital alternative when closed methods fail to achieve adequate alignment, such as in fractures with severe shortening, segmental patterns, or interposed soft tissue [7]. The meta-analysis confirms that while OR yields acceptable union rates, CR provides superior healing outcomes when technically feasible [7].

Distal femoral fractures: balancing articular reduction and biology

Distal femoral fractures in the elderly are complex injuries, often involving osteoporotic bone and intra-articular extension, which complicates management [8]. Treatment options include Open Reduction and Internal Fixation (ORIF) with locking plates, intramedullary nailing, and in select cases, distal femoral replacement arthroplasty [8]. The reduction strategy is fundamentally dictated by the articular component; anatomical reduction of the knee joint surface is mandatory and almost always requires an open arthrotomy for direct visualisation and precise reconstruction [8]. However, for the metaphyseal-diaphyseal component, Minimally Invasive Plate Osteosynthesis (MIPO) techniques, utilizing closed or percutaneous reduction, are increasingly advocated to preserve the biological envelope [8]. A 2025 meta-analysis comparing Distal Femoral Replacement (DFR) to ORIF highlighted that while ORIF remains standard, DFR may offer lower mortality and reoperation rates in select frail patients, underscoring that the choice of implant and approach must be highly individualized [8]. Consequently, the evolving best practice is a hybrid approach: mandatory open reduction for the articular block to ensure joint congruity, combined with closed, indirect reduction and bridging fixation for the metaphyseal segment to minimize soft-tissue trauma and promote healing [8].

Perioperative considerations: impact of reduction choice

The selection of reduction technique has direct and measurable impacts on perioperative metrics and patient physiology. Open reduction typically entails longer surgical duration, greater estimated blood loss, and potentially increased fluoroscopy time, although challenging closed reductions can also prolong imaging. These factors collectively increase the physiological strain on elderly, often frail patient, elevating the risks of transfusion, wound healing complications, and infection [6,7]. Closed reduction, while biologically favourable, may extend anaesthesia time if reduction attempts are protracted and can lead to significantly higher radiation exposure for both the patient and the surgical team [7]. Therefore, a thorough preoperative assessment is essential to weigh these risks against the patient's physiological reserve. The integration of Enhanced Recovery After Surgery (ERAS) protocols within orthogeriatric care models strongly advocates for techniques that reduce surgical stress, inherently favouring minimally invasive closed approaches where they can achieve the treatment goals [9]. Adjuncts like tranexamic acid are especially important in open procedures to mitigate blood loss [4].

Radiographic and functional outcomes

The ultimate success of fracture management is judged by both radiographic healing and functional recovery. Key radiographic outcomes include union rate, time to union, and the absence of malalignment (e.g., excessive varus, shortening, or rotation). As evidenced in subtrochanteric and shaft fracture studies, achieving an acceptable reduction is a stronger predictor of union than the surgical approach (open or closed) used to achieve it [6,7]. Functional outcomes, measured by tools like the Harris Hip Score or Knee Society Score, are the ultimate patient-centred metrics. While accurate radiographic alignment correlates with better function, the surgical trauma of the approach itself can impair recovery; for example, a large open approach for a distal femur fracture may cause knee stiffness despite perfect X-ray alignment v. Therefore, the ideal surgical strategy seeks to balance the mechanical imperative for stability and alignment with the biological imperative for minimal soft-tissue disruption, thereby optimizing the conditions for both healing and rehabilitation [6-8].

Complications associated with reduction techniques

The complication profiles of OR and CR are distinct and must be factored into surgical decision-making. Open reduction is associated with higher risks of surgical site infection, wound dehiscence, haematoma formation, and iatrogenic neurovascular injury due to the necessary dissection [6,7]. It may also theoretically increase the risk of non-union due to devitalisation of bone fragments [7]. Closed reduction, while minimizing these direct surgical risks, is associated with a higher incidence of malunion and malreduction, which can lead to altered limb biomechanics, accelerated adjacent joint arthritis, and poor functional outcomes [6,7]. Other complications, such as implant failure, periprosthetic fracture, and venous thromboembolism, are more related to the fixation construct, bone quality, and patient comorbidities than to the reduction method itself [4,5]. The surgeon must anticipate these potential complications and select the technique that offers the best risk-benefit balance for the individual patient, often accepting a more invasive open approach if a closed method is likely to result in unacceptable and problematic alignment [6].

Patient-specific factors influencing decision-making

The elderly population is profoundly heterogeneous, mandating an individualized approach to management. Key patient factors include chronological and physiological age, pre-fracture mobility and cognitive function, bone quality (osteoporosis severity), and the burden of medical comorbidities (e.g., diabetes, vascular disease, nutritional status). A frail, bedbound patient with severe dementia may not tolerate a lengthy open procedure; in

such cases, a minimally invasive closed reduction, even if it yields a less-than-perfect anatomical reduction, might be the most prudent option to facilitate rapid mobilization and palliation [9]. Conversely, an active, healthy older adult with a complex intra-articular distal femur fracture would likely benefit from the precise alignment afforded by open reduction to maximize the potential for functional recovery and return to activity (8). Shared decision-making, involving the patient and family, when possible, is therefore crucial. The orthogeriatric care model is designed to facilitate this process by ensuring comprehensive medical optimization and aligning treatment goals with the patient's values and expectations [9,10].

The Role of surgeon expertise and technical resources

The successful execution of closed reduction techniques frequently demands a higher degree of surgical skill and experience compared to open reduction. Proficiency in intraoperative fluoroscopy, indirect reduction maneuvers, and percutaneous fixation is essential [7]. In resource-limited settings where advanced imaging (e.g., high-quality C-arms) or specific fracture tables may not be available, open reduction may be a more reliable and technically simpler option [7]. Surgeon comfort, training, and procedural volume also play a significant role; a surgeon highly proficient in closed techniques may achieve excellent results where others might struggle.

Future directions and research gaps

Despite the existing body of evidence, a significant gap remains: there is a paucity of high-level, Randomized Controlled Trials (RCTs) directly comparing OR and CR for specific femoral fracture patterns in the elderly. Most current data derive from retrospective cohort studies or meta-analyses of heterogeneous populations [6-8]. Future RCTs should focus on patient-important outcomes, including functional recovery, quality of life, and cost-effectiveness, across different fracture types. Furthermore, research into advanced technologies holds great promise; computer-assisted navigation and robot-guided surgery could enhance the accuracy of closed reductions, potentially bridging the gap between the biological benefits of CR and the precision of OR. The development of improved implants that facilitate reduction and provide stable fixation in osteoporotic bone is also a critical need [8]. Ultimately, the goal is to move towards more personalised surgical planning, where patient-specific factors, fracture characteristics, and advanced imaging guide the choice of reduction strategy using validated decision aids.

CONCLUSION

The management of femoral fractures in the elderly necessitates a careful, patient-centred approach where the choice between open and closed reduction is a key strategic decision. Current evidence and guidelines demonstrate that the optimal technique is highly dependent on fracture location and pattern. For displaced femoral neck fractures, arthroplasty is the dominant treatment, effectively circumventing the OR *versus* CR debate for fixation. In subtrochanteric fractures, the quality of the achieved reduction is a more critical determinant of healing than the method used to attain it. For femoral shaft fractures, closed reduction with intramedullary nailing demonstrates superior healing outcomes and should be the standard of care. In distal femoral fractures, a hybrid strategy-combining open reduction for articular reconstruction with closed, minimally invasive fixation for the metaphysis—represents the state-of-the-art balance between mechanics and biology. Across all anatomical regions, the surgeon must continually balance the mechanical imperative for anatomical alignment against the biological advantages of minimally invasive techniques. This decision is not

made in isolation but must be integrated into a comprehensive orthogeriatric care pathway, which includes medical optimization, multidisciplinary rehabilitation, and shared decision-making, to mitigate risks and maximize the potential for functional recovery in this vulnerable population.

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