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HIP FRACTURES IN ADULTS

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Femoral Neck Fractures: Osteosynthesis

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Abstract

Femoral neck fractures in young adults below the age of 65 most often result from high-energy trauma, in contrast to the low-energy mechanisms more common in elderly patients. As a result, treatment goals in younger patients focus on preserving the femoral head's blood supply, achieving anatomic reduction, and maintaining stable fixation to support long-term function. This article reviews the anatomy and biomechanics of the femoral neck, emphasizing the vascular supply and structural support that influence both surgical strategies, as well as risk of complications. Classification systems including Pauwels, Garden, and OTA are outlined to better understand how they can help treatment decisions. Principles of reduction are discussed, covering both closed and open techniques, along with considerations in implant placement and approach. Postoperative management, including protected weight-bearing, early rehabilitation, and monitoring for complications is discussed. Challenges such as avascular necrosis, nonunion, fixation failure, and femoral neck shortening remain significant concerns; strategies for prevention, management, and consistent monitoring are reviewed. The purpose of this article is to provide a practical framework for understanding and managing femoral neck fractures in young adults. By combining anatomical principles, classification systems, surgical techniques, and postoperative protocols, the article aims to equip readers with the knowledge necessary to optimize outcomes in young patients.

KEYWORDS

Femoral Neck Fractures, Fracture Fixation, Internal, Young Adult, Femur Head Necrosis, Fracture Reduction, Postoperative Complications

Introduction

Femoral neck fractures in young adults below the age of 65 years typically result from high-energy trauma involving increased axial loading and abduction. These mechanisms differ significantly from those seen in older adults, who commonly sustain fractures due to lower-energy incidents like ground-level falls, often exacerbated by decreased bone density. Consequently, treatment approaches for young adults are notably different from those employed in elderly populations.

Surgical priorities in young patients emphasize preserving the femoral head's vascular supply to avoid complications such as avascular necrosis (AVN). Achieving precise anatomical alignment and robust mechanical stability is crucial due to younger patients' higher activity levels and functional demands. In contrast, management strategies in elderly patients typically prioritize pain relief, rapid mobilization, and minimizing perioperative risks and complications, considering age-related comorbidities. Understanding these distinct priorities is essential for optimizing fracture healing and functional recovery in younger patients, thus necessitating detailed understanding of femoral neck anatomy and biomechanics.

Anatomy & Biomechanics

The femoral neck connects to the femoral shaft at an approximate neck-shaft angle of 125-135 degrees, which significantly impacts load transmission and mechanical stability. Additionally, the neck is anteverted approximately 10 degrees relative to the femur's longitudinal, trans-epicondylar axis, which is important to be aware of when positioning surgical hardware during fixation. The medial aspect of the femoral neck is reinforced by a dense ridge known as the calcar femorale, which is critical for supporting compressive loads. Injury or loss of integrity here often leads to structural weakness and fixation failure.

Blood supply to the femoral head and neck primarily comes from a network formed by the medial and lateral femoral circumflex arteries (MFCA and LFCA), which have numerous intracapsular retinacular branches that allow for perfusion of the femoral head even in instances of complete displacement.[1] Recent anatomical studies have drawn attention to the inferior retinacular artery from the MFCA.[2] Additionally, the ascending branch of the LFCA also plays a significant role in perfusing nearly half of the anterior inferior femoral neck.[3] Understanding the vascular anatomy is integral to careful reduction tactics and implant placement that do not compromise the blood supply and predispose to AVN. Meticulous soft tissue handling during reduction and fixation is therefore essential.

Fracture Characteristics

Multiple classification systems exist to describe femoral neck fractures, each offering unique insights that can guide treatment decisions.

System	Type	Description	Clinical Relevance
Pauwels	I	< 30° fracture angle	Stable; compressive forces dominate
	II	30°–50° angle	Moderate stability; mixed forces
	III	> 50° angle	Unstable; shear forces dominate, high risk of fixation failure
Garden	I	Incomplete/valgus-impacted fracture	Often stable, difficult to detect
	II	Complete, nondisplaced	Anatomically aligned, stable
	III	Complete, partially displaced	Loss of alignment; unstable
	IV	Complete, fully displaced	No cortical contact; highest risk of avascular necrosis (AVN)
OTA (31-B)	B1	Subcapital, valgus-impacted	Typically stable, minimal displacement
	B2	Transcervical	Unstable; crosses mid-neck
	B3	Basicervical	Near intertrochanteric line; biomechanically extracapsular

Figure 1 Overview of femoral neck fracture classification systems (Pauwels, Garden, Orthopedic Trauma Association (OTA))

Pauwels' classification is particularly relevant in younger patients due to its biomechanical implications related to fracture stability and risk of fixation failure. Higher Pauwel angles indicate increased instability, requiring stronger fixation strategies.

The Garden classification categorizes fractures based on radiographic displacement and is predominantly applied in geriatric populations to assess fracture stability and AVN risk.

The OTA (31-B) classification provides a systematic coding system, distinguishing between subcapital, transcervical, and basicervical patterns. Figure 1 summarizes these classifications.

Increased degree of initial displacement of the femoral neck is highly correlated with poor outcomes due to the potential soft-tissue and vascular disruption (Figure 2).[4] Posterior comminution also heightens risk of poor outcomes, like nonunion and loss of reduction and fixation (Figure 3).[5] This is likely due to the concomitant disruption of the retinacular branches of the MFCA through posterior comminution.

Surgery

Reduction quality is the most strongly correlated predictor of healing.[4–6] However, this is highly surgeon dependent. Ideally, displacement should be limited to 2mm and angulation under 5 degrees in any plane; however, displacement under 5mm and angulation under 10 degrees may be clinically acceptable. A detailed pre-operative plan starts with attention to proper positioning and surgical preparation of the field to allow for either open or close reduction techniques.

Positioning

Prepare the injured leg on a radiolucent table or a traction table. Ensure sterile preparation includes the entire proximal femur, hip, and iliac crest, especially if anticipating open reduction, which may extend proximally toward the anterior superior iliac spine.

Radiolucent (free-leg) table vs fracture table: While a fracture table reduces the need for an assistant to maintain limb traction, the free-leg setup offers increased flexibility in multi-planar manipulations, particularly valuable

in complex or comminuted fractures. Place a bump under the injured hip in order to aid in lateral imaging.
Ensure adequate neuromuscular paralysis for effective manipulative reduction.
Position fluoroscopy on the contralateral side of the injured hip

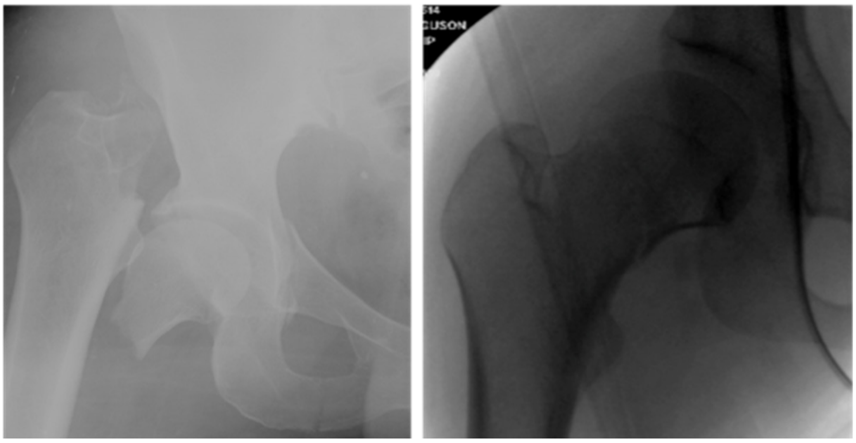

Figure 2 X-rays comparing displaced vs non-displaced femoral neck fractures

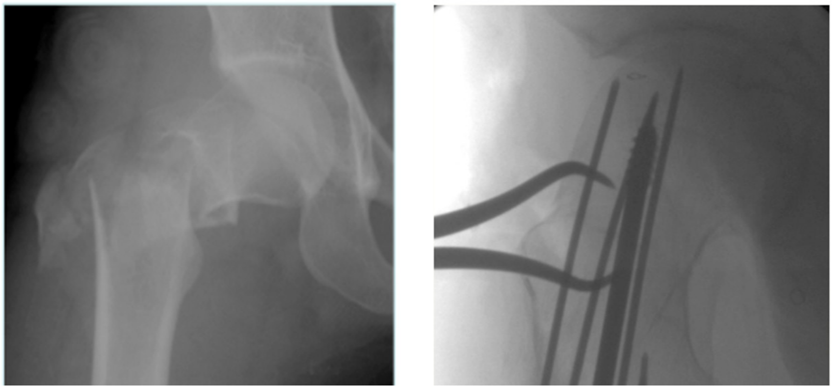

Figure 3 Posterior comminution in femoral neck fractures

Figure 4 Positioning for operative management of femoral neck fractures

Open vs. Closed Reduction

Open Reduction

Open reduction is indicated when closed maneuvers fail to achieve adequate alignment. Predominant approaches include Watson-Jones and modified Smith-Petersen.[7]

For the Watson-Jones approach, the incision is centered over the proximal tip of the greater trochanter and extends towards the anterior superior iliac spine. Superficial dissection involves separating the interval between the gluteus medius and tensor fascia lata muscles. Deeper dissection continues down to the femoral neck capsule, which is then incised to expose the fracture directly. For fractures that require greater exposure, the vastus lateralis can be partially elevated from its attachment along the intertrochanteric line. For the Smith-Peterson approach, the incision starts just distal to the anterior superior iliac spine, following the groove between the sartorius and tensor fascia lata muscles. Superficial layers are dissected carefully to protect the lateral femoral cutaneous nerve. The rectus femoris tendon is often transected for improved exposure and later repaired. Deep dissection involves careful removal or retraction of the iliocapsularis muscle and medial retraction of the iliopsoas tendon, clearly exposing the hip joint capsule. A T-shaped capsular incision is then performed to fully visualize the femoral neck fracture. A retrospective study comparing the Watson-Jones and Smith-Peterson approaches revealed no difference in the quality of reduction achieved.[8] Various surgical instruments significantly facilitate accurate fracture reduction and fixation. Schanz pins provide precise control of fracture fragments, particularly beneficial in reducing rotational and angular deformities. Reduction clamps can securely grasp bone fragments assisting reduction maneuvers and stabilization. In Figure 5, a segmental fracture of the inferior medial neck is visible. The modified Weber clamp was placed with one tine in the subcapital neck and the other tine in the anterior base of the neck to correct varus alignment and apex

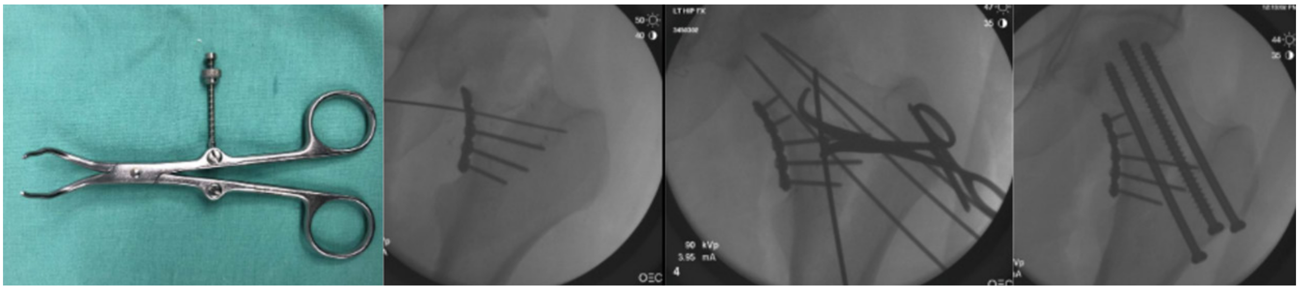

Figure 5 Use of modified Weber clamp

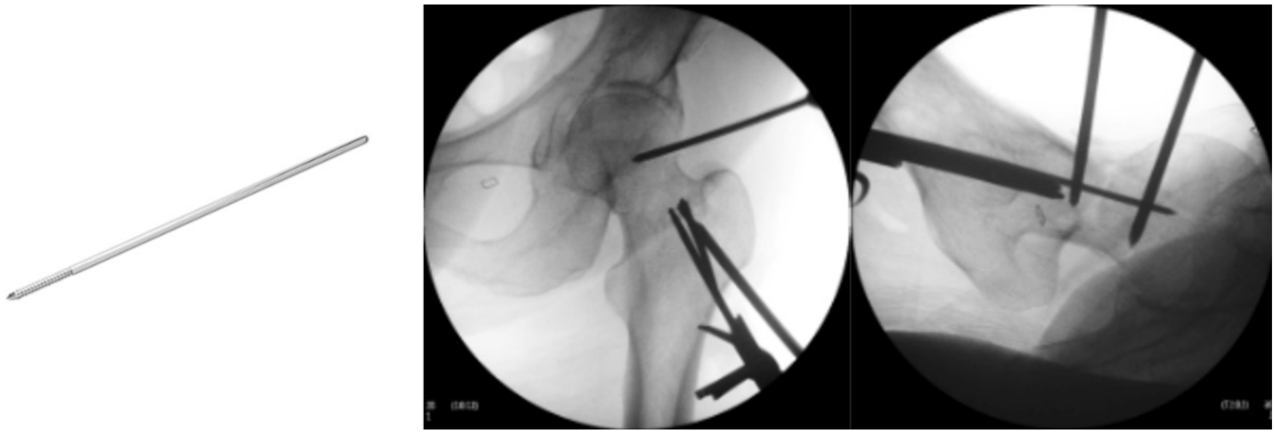

Figure 6 Use of Schanz pin

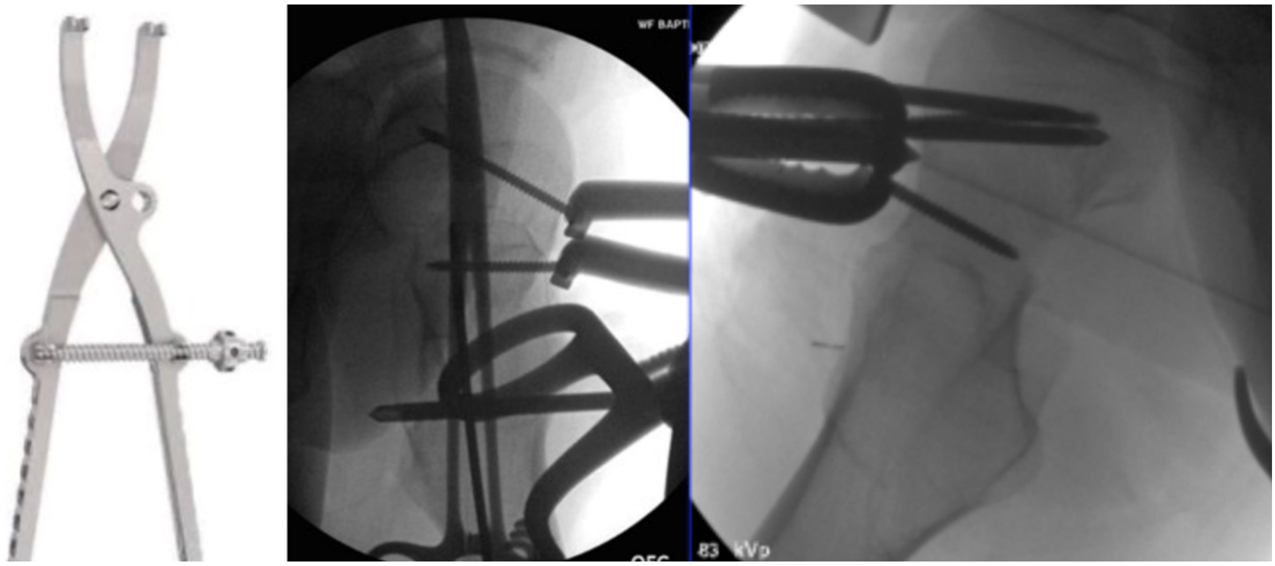

Figure 7 Use of Jungbluth and Farabeuf clamps

anterior angulation. Schanz pins are also useful in manipulating fragments, restoring length, and correcting sagittal plain deformity (Figure 6). Lastly, the Jungbluth and Farabeuf clamps can be applied over screws in the neck, often in conjunction with Schanz pins, to successfully reduce the fracture, and achieve adequate compression (Figure 7).

Closed Reduction

Closed reductions are primarily for minimally displaced fractures, those contraindicated for open surgery, or cases where satisfactory closed alignment is achievable.

4-Step Adaptation of the Leadbetter (Flynn) Maneuver for Closed Reductions (Figure 8):

1. Make a small direct lateral incision for implant application. Flex the hip in order to relax the iliofemoral ligaments and externally rotated to open and adjust any translation in the coronal or sagittal plane.
2. Internally rotate the leg in order to close the apex anterior deformity.
3. Extend the hip in an abducted position to place in valgus alignment as the pubofemoral and iliofemoral

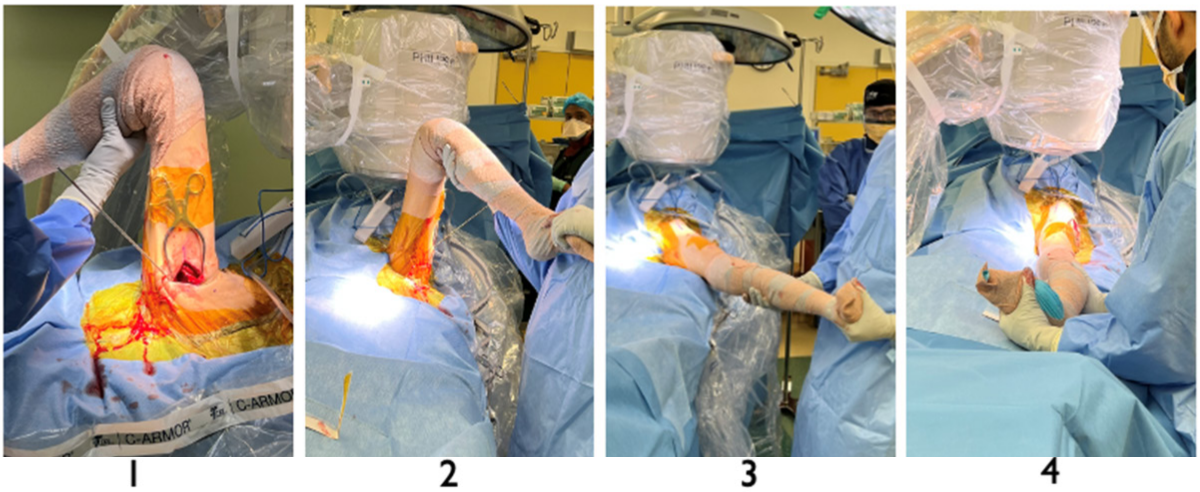

Figure 8 Four-step adaptation of Leadbetter (Flynn) Maneuver for closed reductions

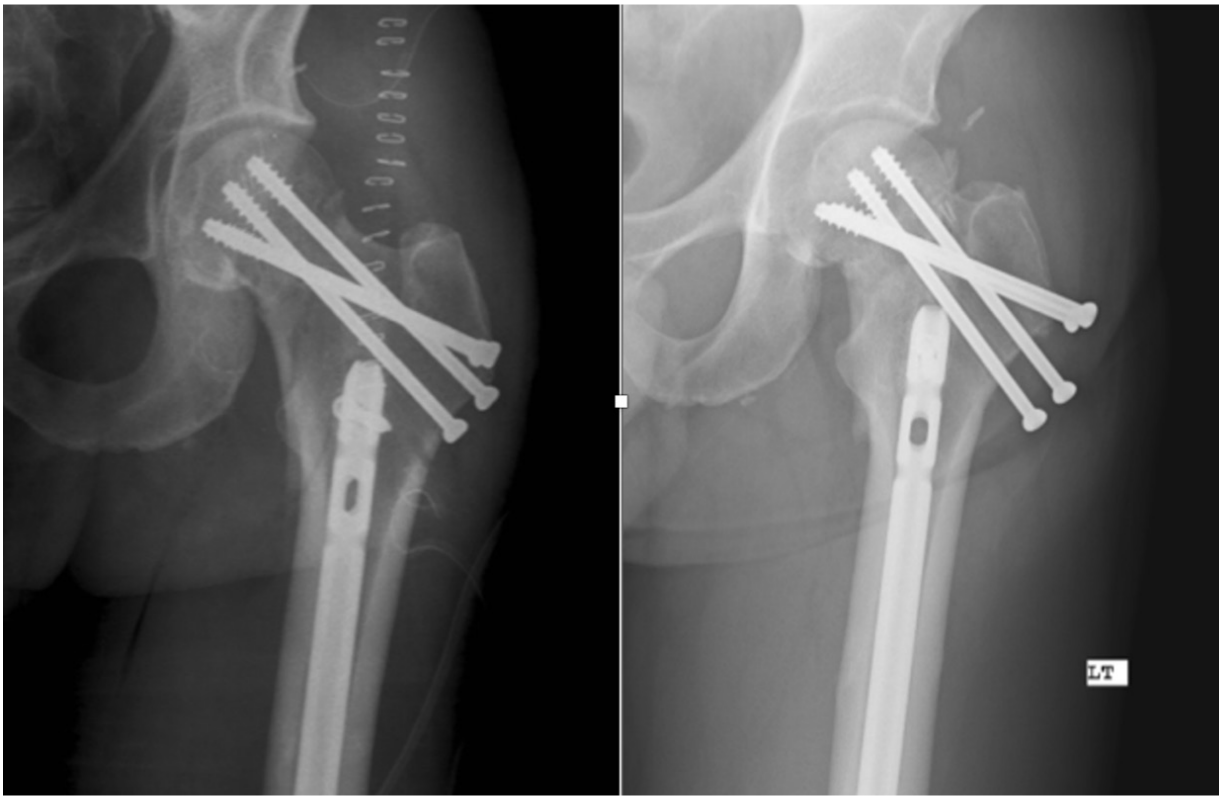

Figure 9 X-ray of femoral neck shortening post-operatively

ligaments tighten to lock in the reduction.
4. Slightly adduct to correct for any residual valgus alignment. The limb will be held in position here while provisional fixation is placed in the proximal head and neck fragment.
To minimize potential harm to the femoral head vascularity and avoid iatrogenic displacement, repeated

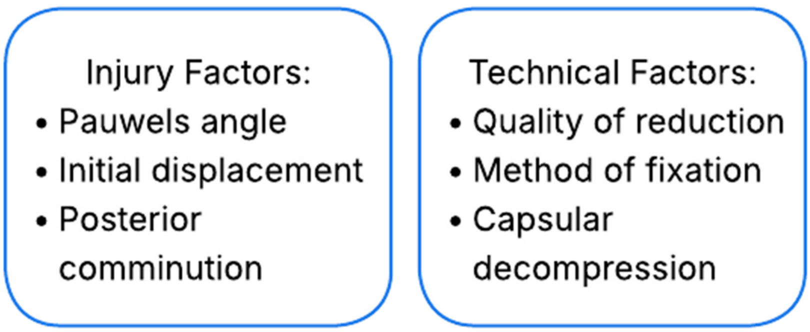

Figure 10 Key prognostic factors influencing femoral neck fracture outcomes

closed reduction attempts should be avoided. Inadequate closed reduction warrants open techniques. Schanz pins can also be used percutaneously in closed reductions to aid in manipulative reduction – although, they must be used carefully with attention to surrounding soft tissue anatomy.

Determining whether to do an open versus closed reduction is often an area of debate. Evidence from a systematic review suggests an increased incidence of deep wound infection in patients that underwent open reductions, yet rates of AVN and nonunion did not significantly differ between open and closed techniques.[9] A multicenter retrospective cohort study found that open reduction of displaced femoral neck fractures in nonelderly adults was associated with 2.4-fold greater hazard of reoperation without significantly improving reduction quality.[10] Although these results do not universally support closed reduction for all cases, it does highlight clinical scenarios where closed methods may be advantageous. For example, when the radiographic reduction looks close to the anatomic reduction in orthogonal planes, it may be reasonable to think that the fracture will not achieve a higher quality reduction when performed open, so further complications can be avoided by simply doing a closed reduction.

Ultimately, proficiency in open reduction remains critical. Understanding what a quality reduction looks like under fluoroscopy and correlating it with corresponding imaging post-operatively, will allow for clear translation of skills to properly performing closed reductions.

Post-surgery

Postoperative management focuses on controlled mobilization and weight-bearing to ensure healing without fixation failure. Generally, patients are advised to be protected weight-bearing with assistive devices for approximately 12 weeks. Early postoperative physical therapy initiates active-assisted joint motion, crucial for regaining functional mobility and preventing joint stiffness.

Potential complications of femoral neck fractures managed by internal fixation include both local and systemic issues. Locally, risks include surgical site infection, hardware loosening or breakage, nonunion, and femoral head osteonecrosis. Infection, though rare, requires prompt recognition and treatment. Fixation failures typically result from poor reduction or inappropriate implant placement, often necessitating revision surgery. Femoral neck shortening also predicts functional impairment due to decreased hip offset, altered biomechanics, and increased joint forces, potentially predisposing patients to early arthritis (Figure 8).[11,12] Systemically, venous thromboembolism poses a significant risk, necessitating prophylactic anticoagulation postoperatively. Monitoring AVN, nonunion, and reoperation necessity further informs prognosis. (Figure 10)

Successful management of femoral neck fractures in young adults requires comprehensive understanding of anatomy, careful fracture classification, precise reduction techniques, careful fixation selection, and vigilant postoperative care to ensure optimal outcomes.

Conflict of Interest

None

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