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Femoral Preparation Before Head Dislocation in Hip Hemiarthroplasty for Fractured Neck of Femur Saves Time and Keeps the Acetabulum Clean of loose bone fragments: A Retrospective Study and Technical Report

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ABSTRACT

Introduction: Femoral neck fractures are the most common traumatic injuries associated with increasing age and osteoporosis, occurring most in older females. The femoral neck is under constant strain from externally and internally generated forces, approximately 500 – 200 micro-strains from daily activities. Common causes are falls in the elderly and road traffic accidents in younger patients. There is a significant in-house mortality and one-year mortality rate associated with femoral fractures. Fractures can be classified using the Garden Classification or the 2018 AO/OTA classification. Management includes open reduction and internal fixation, cannulated or sliding screws and hemiarthroplasty or total hip arthroplasty. This study examines the benefits of femoral preparation before head dislocation in hip hemiarthroplasties by assessing differences between pre-operative and post-operative haemoglobin levels and surgical times.

Methods: We report the surgical techniques of hip hemiarthroplasty where the femur is prepared before the femoral head is removed and the hip is reduced in the flexion position. A retrospective review of electronic patient records of patients who underwent hemiarthroplasties from June 2022 to June 2023 was conducted.

Results: Surgical times for this surgical technique were 30 minutes faster than traditional methods while the differences in haemoglobin levels were minimal.

Conclusion: Longer surgical times are associated with adverse events such as infections and wound dehiscence while increasing risks via surgeon fatigue and longer anaesthesia durations. Innovations in surgical techniques should thus aim to minimise surgical time without compromising procedures. This technique saves 30 min on average while having similar levels of blood loss to traditional techniques, maintaining standards, and not compromising on patient safety. Femoral preparation before dislocating the femoral head reduces the steps taken in leg repositioning which saves time and effort by the assistant. The reduction technique also avoids any risk of intra-operative iatrogenic fracture that can happen, especially if the assistant is a junior surgeon who lacks experience with hip reduction.

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Introduction

Femoral neck fractures are the most common traumatic injuries associated with increasing age [1-3]. Among fracture patterns, the incidence of femoral neck fractures is approximately equal to the incidence of pertrochanteric fractures, together making up >90% of all proximal femur fractures with the remaining 5 – 10% being subtrochanteric [4]. Annually, in the UK, 1.6 femoral neck fractures per 1000 are registered for women aged 65 – 69 years old, and 32.8 per 1000 for those 90 – 94 years old, while 0.7 and 14.0 per 1000 are registered for men respectively [5]. Besides osteoporosis, another proposed risk factor is femoral-acetabular impingement (FAI) which predisposes patients to osteoarthritis and is hypothesized to be the cause of non-union after femoral neck fracture fixation [6]. The fulcrum presented in FAI predisposes patients to medial neck fractures via a class 1 lever while severe hip osteoarthritis predisposes patients to pertrochanteric neck fractures related to a higher rigidity via a class 2 lever [6].

Biomechanical forces include: 1) externally generated forces which involve ground reaction forces from vertical impact being translated from the ankle to the femoral neck, and typically stay below 1.3 times body weight during low-speed walking; and 2) internally generated forces from muscles acting on the bone to accomplish desired movements and maintain balance which are typically 2 – 3 times body weight during low-speed walking [7]. These externally and internally generated forces collectively produce bending and torsional moments that act on the femoral neck, reported to be 500 – 2000 micro-strains from day-to-day activities [7].

Aetiology & Classification

Femoral neck fractures are caused by low-energy trauma in the elderly, such as in falls, and high-energy trauma in younger patients, such as in road traffic accidents, with higher risks in females and the elderly [8]. Subsequently, patients who have fractured their femoral neck have a 6% in-house mortality rate and a 20 - 30% one-year mortality rate [8]. Fractures in younger patients can be managed using open reduction and internal fixation while in the elderly, non-displaced fractures can be treated with cannulated or sliding screws and displaced fractures can be managed with a hemiarthroplasty or total hip arthroplasty depending on the patient's activity levels [8].

Femoral neck fractures can be classified according to the Garden Classification by using AP radiographs to assess displacement, fracture completeness, and relationships between bony trabeculae to categorise a fracture into one of four types: Type I) incomplete or valgus impacted; Type II) complete and non-displaced; Type III) complete and partially displaced; and Type IV) complete and fully displaced [9]. The 2018 AO/OTA classification is an alternative classification system with higher interobserver reliability that divides femoral neck fractures into three types: Type 31B1) subcapital; Type 31B2) transcervical; and Type 31B3) basicervical [10,11].

Irish Hip Fracture Standards

The Irish Hip Fracture Standards (IHFS) are 7 best practice guidelines incorporated to expedite the initiation of care and improve the quality of management for patients with hip fractures [12]. In order, IHFS1 to IHFS7 are 1) admission to the acute orthopaedic ward or brought directly to theatre within 4h of presentation to the emergency department (ED); 2) surgery conducted within 48h of admission; 3) eliminate the development of pressure ulcers; 4) routine review by a geriatrician or advanced nurse practitioner during admission; 5) bone health assessment to determine the need for therapy to prevent osteoporotic fractures; 6) specialist falls assessment and intervention to prevent falls; and 7) mobilise on the day of or after surgery by a physiotherapist [12].

This study examines the benefits of femoral preparation before head dislocation in hip hemiarthroplasties. This was done by assessing differences between pre-operative and post-operative haemoglobin levels and surgical times.

Surgical Technique

Patient Preparation and Surgical Approach

After spinal or general anaesthesia, all patients were positioned laterally with the affected side up, followed by preparation and draping. The Hardinge approach, also known as the Hip Direct Lateral Approach, is the standard approach for all hip hemiarthroplasties in our hospital. All patients were implanted with Exeter hip hemiarthroplasties. After the elevation of the anterior part of the gluteus medius and minimus in one layer, a T-shaped capsulotomy and rectangular excision of part of the capsule was conducted to expose the femoral head and neck. The leg was brought to 70° of flexion with 30° of external rotation and then fixed in this position for the duration of the procedure. The femoral neck was cut 15mm above the lesser trochanter, followed by the opening of the femoral canal by a box chisel and a rigid reamer. The femoral canal was prepared using broaches until the appropriate size was determined. The real stem was then opened, the canal size was measured, and a canal plug was inserted.

Removal of the femoral head

This was followed by the removal of the femoral head with a corkscrew (Figure 1 and 2). The head size was measured, and the outer shell was opened. The scrub nurse also started mixing the bone cement during the removal of the femoral head. The femoral canal was filled with cement and pressurised for the stem to be inserted into its appropriate position and height, with the tip of the greater trochanter at the level of the centre of the tip of the stem. This was judged using a Morris retractor, where the handle was kept parallel to the femoral shaft and the blade indicated towards the tip of the stem. After the cement was set, the inner head was fit onto the stem and outer shell.

Figure 1: Dislocation and Removal of The Femoral Head with A Corkscrew

Figure 2: Post-Removal of The Femoral Head

Hip Reduction and Completion of Hemiarthroplasty

The hip was reduced in the flexion position (Figure 3 and 4) and hip stability was checked to be within the correct hip range of motion. The leg was then repositioned for the length to be checked. The procedure was completed with a wash, repair of the gluteal muscles followed by the iliotibial tract, and then subcutaneous and skin closure.

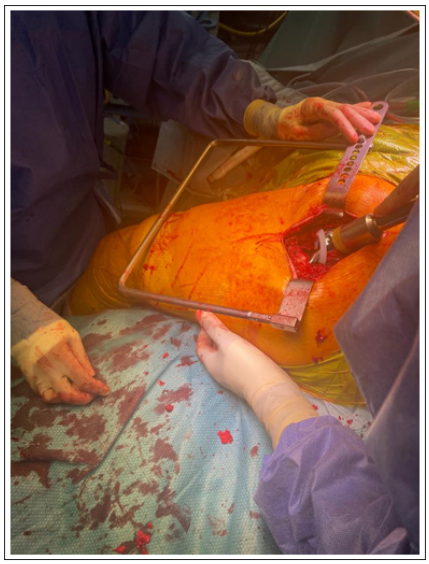

Figure 3: Reduction of The Hip While the Patient's Leg Is Kept in The Same Position

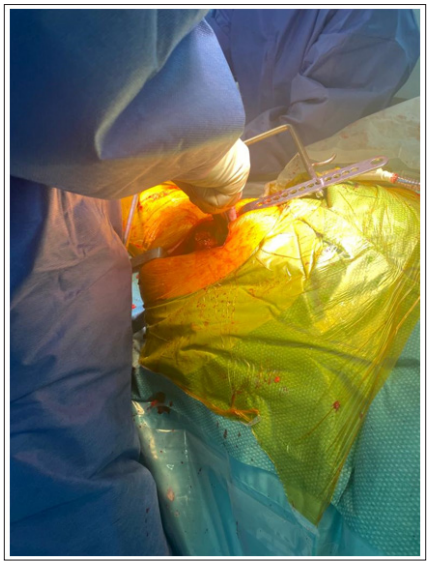

Figure 4: Post-Reduction of The Hip Joint in The Same Position

Discussion

A retrospective review of electronic patient records of all patients who underwent hip hemiarthroplasties from June 2022 to June 2023 at the Department of Trauma and Orthopaedic Surgery, St. James's Hospital, Dublin, Ireland yielded 85 results. Retrospective chart reviews at our hospital do not require consent from the Research Ethics Committee. Among these, two were combined with a second procedure and one involved the training of a junior surgeon, making surgical time difficult to ascertain. As such, a total of 82 patients were included, 53 were female and 29 were male. The average age was 79 years (range 51 – 98 years). The surgical technique discussed in this paper was used in 17 patients (group A). The average surgical time taken for Group A was 51.5 minutes (range 34 – 68 minutes) compared to 82.3 minutes (range 44 – 160 minutes) for procedures group B. The average change in haemoglobin levels was 1.53g/dL for procedures using the technique, and 1.32g/dL for procedures not using the technique.

	No. of Patients (M:F)	Average Age (Yrs)	Surgical Time (min)	Average Change in Hb (g/dL)	SD	P
Group A	17 (8:9)	79.24	51.5	1.53	8.7	<0.o5*
Group B	65 (20:45)	80.62	82.3	1.32	27.3	>0.05

Hip hemiarthroplasties have faster surgical times and lower volumes of blood loss compared to total hip arthroplasties [13]. Li and Luo (2021) concluded that compared to total hip arthroplasties, hemiarthroplasties had a lower risk of trauma, shorter operation times and less blood loss [13]. However, they also found that compared to total hip arthroplasties, hemiarthroplasties had significantly longer lengths of hospitalisation and a higher incidence of dislocation, pneumonia, and renal failure [13]. There were no significant differences in infection, pulmonary embolism, myocardial infection, mortality rates, or need for a reoperation between hemiarthroplasties and total hip arthroplasties [13]. Furthermore, hip hemiarthroplasties can be conducted from an anterior approach, a direct lateral approach or a posterior approach [14]. The surgical technique discussed in this paper utilises the direct lateral approach. Shuai at al., found that the posterior approach had a higher risk of dislocation and need for reoperation that the anterior and lateral approaches while the anterior approach had shorter lengths of hospitalisation and less post-operative pain [14]. Furthermore, Parker et al., concluded that rates of medical complications such as pneumonia, congestive cardiac failure and urinary tract infection, and mortality rates at six months, one year and two years, were higher in the posterior approach than the anterior approach while the anterior approach appeared to have a higher rate of pain at one month after surgery and impaired mobility [15]. Parker et al., also state that the one randomised controlled trial included in their review was of questionable methodological quality and that the increased mortality in the posterior approach group may have been due to patients being nursed flat in bed for two weeks after the surgery [15]. Hongisto et al., concluded that despite similar complication rates, the posterior approach had an eight-fold increased risk of dislocation compared to the lateral approach while the lateral approach had a give-fold increased risk of postoperative haematoma compared to the posterior approach [16]. Despite the extensive research comparing hip hemiarthroplasties and total hip arthroplasties, or research comparing the approaches to a hip hemiarthroplasty, there are no studies or technical reports that discuss the benefits of the surgical technique discussed in this paper.

The surgical technique discussed in this report has reduces surgical time by almost 30 minutes compared to traditional techniques. According to Bohl et al., longer operative times give bacteria in the operating room more opportunity to infiltrate the open surgical site while longer torniquet and retraction times increase local tissue ischemia, eventually leading to a higher risk of surgical site infection and wound dehiscence [17]. Longer surgical times also allowed for more bleeding, increasing the risk of anaemia, need for blood transfusion, transfers to intensive care and the risk of allergic reactions to transfusion products [17]. Associated hypovolemia and tissue hypoperfusion further increased the risk of renal insufficiency [17]. Prolonged anaesthesia can cause hypothermia that leads to immunodeficiency which further increases the risk of sepsis and urinary tract infections [17]. A systematic review and meta-analysis by Cheng et al., discussed the relationship between surgical times and complications such as infections, cardiac complications, and renal failure [18]. They also

attribute the increased risk of infections to prolonged exposure to bacteria, prolonged retraction, diminished efficacy of antimicrobial prophylaxis over time, and increased opportunities for the sterile technique to be violated 18. Longer surgical times have a higher risk of venous thromboembolism due to increased coagulation, blood stasis and endothelial damage [18]. Furthermore, longer surgical times lead to surgeon fatigue and longer patient exposure to anaesthesia [18]. They also highlighted that longer operative times usually indicate more complex or difficult surgeries where an intra-operative complication may have occurred, inevitably leading to higher rates of complications, therefore emphasizing that safety should never be sacrificed for surgical speed [18]. A study by Surace et al., found that among patients who had undergone total hip arthroplasties, longer surgical times was associated with increased readmission and reoperation rates, infections, wound dehiscence and renal complications while an operative time exceeding 80 minutes had a significant increase in aforementioned complications [19]. Given the association between longer surgical times and complications, innovations in surgical techniques should aim to minimise surgical time without compromising the procedure [17-19]. As such, the surgical technique discussed in this report which reduces the average surgical time by approximately 30 minutes without any postoperative haematoma may be effective in reducing the risk of intra-operative and post-operative complications.

A limitation of the chart review we carried out was that intra-operative blood loss was not accurately recorded for all surgeries. To overcome this limitation, we utilised changes in haemoglobin levels to determine blood loss. The difference between pre-operative and post-operative haemoglobin is a more accurate representation of intra-operative blood loss than directly calculating blood volume lost [20]. Jaramillo et al., explained this by describing how blood volume loss might not always be accurately reflected in the haematological parameters due to variable degrees of dilution and haemoglobin mass [20]. The decrease in haemoglobin levels in procedures using this surgical technique is still comparable to procedures that did not, despite having a much smaller sample size. This proves that this surgical technique has similar levels of blood loss to the conventional technique and does not compromise patient safety and haematological outcomes.

Conclusion

Preparing the femur before dislocating the femoral head reduces the steps taken in leg repositioning which saves time and effort by the assistant. The reduction technique also avoids any risk of intra-operative iatrogenic fracture that can happen, especially if the assistant is a junior surgeon who lacks experience with hip reduction.

Declaration

The authors declare that this research is original and there is no conflict of interest.

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