Elderly Femoral Neck Fracture: Hemiarthroplasty via Direct Anterior Approach  
Surgical Techniques and Literature Review

Abstract
Introduction: Nowadays, there is consensus regarding arthroplasty as the preferred treatment method for displaced femoral neck fracture among the elderly population. Although posterior and lateral surgical approaches are the most commonly used approaches for hip arthroplasty, direct anterior approach (DAA) has become popular in many centres. Considering the many advantages of DAA, this study aimed to study the results of hemiarthroplasty via DAA for femoral hip fracture in the elderly people in our centre.

Methods: All the femoral neck fractures that had received hemiarthroplasty via DAA between January 2010 and January 2013 in a teaching hospital were extracted from the database. The pre, intra, and post-operative information and clinical follow-up data were all collected and analysed. The Harris Hip Score and physical exam was used for functional assessment.

Results: 45 patients (16 males and 29 females) with a mean age of 73.4 years and a mean follow-up of 76 months entered the study. There was no complication such as dislocation, wound problem or deep infection. The final mean Harris Hip Score was 87 (76-95).

Conclusion: given that the patients with femoral neck fractures are often old, hemiarthroplasty treatment via direct anterior approach (DAA), has multiple advantages and is recommended for this population.

Keywords: Femoral Neck Fracture, Hemiarthroplasty, Direct Anterior Approach

Received: 5 months before printing; Accepted: 1 month before printing

Introduction

Nowadays, there is consensus regarding hip arthroplasty as the preferred treatment method for displaced femoral neck fracture among the elderly population^{1-4}. Rogmark and Johnwell conducted a meta-analysis on 14 clinical trials pertain to 2,289 patients, published between 1996 and 2004, and concluded that the patients with hip fractures that had undergone primary hip arthroplasty had fewer complications and less need to re-operation compared to those that had undergone internal fixation. There was no difference in mortality between the two groups. However, the patients in the hip arthroplasty group had better functional outcomes and less pain. Finally, they concluded that arthroplasty is preferred for treatment of displaced femoral neck fracture in the elderly patients^{2}. For many elderly patients, hemi-arthroplasty is better than total hip arthroplasty^{5,6}.

Posterior and lateral surgical approaches are the most commonly used approaches for hemiarthroplasty^{7}. Several studies have compared these two approaches^{8-11} and obtained either comparable results with these two approaches^{10,11}, or better results with the posterior approach^{8,9}. Due to the familiarity of most orthopedic surgeons with the posterior approach, some studies have also investigated the results of hemiarthroplasty via this approach. According to these studies, the most significant complication in this approach is higher dislocation incidence for hip prostheses^{12,13}. 

*SMJ Mortazavi, MD; S H Shafiee, MD

* Orthopeadic Surgeon, Tehran University of Medical Sciences
* Correspondence: SMJ Mortazavi, MD
Email Address: Smj_mort@yahoo.com
Recently, direct anterior approach has again attracted the attention of orthopedic surgeons around the world. In this approach, the interval between tensor fasciae latae (TFL) and sartorius muscles is applied\(^{7,14}\). This approach is based on the pathway between two muscles and two nerves and the supporters of this approach believe that it causes less muscle damage, less postoperative pain (and lower narcotic use), faster recovery and less use of walking aids\(^{15,16}\).

The use of this approach for hemiarthroplasty in the elderly patients for treatment of femoral neck fractures can lead to faster rehabilitation and regaining mobility, as well as lower rates of complications such as dislocation and wound complications. This study aimed to evaluate the results of hip hemiarthroplasty via direct anterior approach for elderly patients with femoral neck fracture.

**Method**

We retrospectively retrieved the data of our Joint Reconstruction Center and selected all the femoral neck fractures treated with bipolar hemiarthroplasty using direct anterior (DA) approach from among all the surgeries performed between January 2010 and January 2013 to treat femoral neck fractures. The exclusion criteria was having undergone surgical procedures other than bipolar hemiarthroplasty or approaches other than direct anterior approach.

One hundred patients were excluded (from among those patients who had undergone a surgery to treat femoral neck fractures) of whom, 45 patients had undergone approaches other than direct anterior approach and 10 patients had undergone direct anterior total hip arthroplasty and ultimately 45 patients entered the study. Necessary ethics approval was obtained from Ethics Committee of our center. All the patients had referred to emergency department of our center. All of them were examined based on patient history and they underwent surgery during the first 48 hours (after preparation). According to our department’s protocol, all patients received 15mg / kg Transamin prior to making the first surgical incision and all of them received spinal anesthesia. Direct anterior approach was used which will be described in detail below. After surgery, all the patients except high-risk ones received deep venous thrombosis (DVT) prophylaxis, aspirin 325 Mg, twice a day for 4 weeks. The study objective was explained to the patients in the last clinical follow up and all the patients who were willing to participate in the study had signed the consent form. Their data including their age during the surgery, sex, duration of the surgery, the amount of blood loss and the need for blood transfusion were extracted from the database. Clinical follow up data (obtained in the first week, the first month, the third month, the sixth month, the first year and once a year afterwards) extracted from the database included surgery wound, the strength of flexor and abductor muscles a month after the surgery, assessment of muscle strength, walking and radiography as well as Harris hip score (3 months after the surgery). The patients were examined by the researchers at the time of last follow up.

**The Surgical Technique**

The patient lies in a supine position and pillow is placed under the patient’s hip with anterior superior iliac spine in the middle. Then a cylindrical -shape pillow is placed under the patient’s shoulder such that his /her shoulders are at the same level (figure 1). After preparing the patient and spreading the shoulders, the landmark (anterior superior...
iliac spine (ASIS) and the skin incision route (from 3cm lateral and 1cm distal to ASIS toward head of the fibula) are marked with a marker of 6-10 cm length. Then, sterile drip is applied on the skin. Hypotensive anesthesia will be used for surgery to reduce intraoperative blood loss if the patient’s general condition allows it. Then the skin and subcutaneous tissues are incised along the given direction. The subcutaneous tissues are elevated off the fascia using a Cobb's elevator to facilitate subsequent repair. Two landmarks are used for making an incision on the fascia and creating a deep plane: The first one is fascia color: two white fasciae on both sides (lateral fascia on the abductor fascia and medial fascia on sartorius) and the red fascia in the middle (the fascia on the tensor fasciae latae muscle). The second landmark is a small vein entering the tensor fascia about 1cm medial to the abductor fascia and an incision is made in the fascia immediately at the anterior to this vein (Fig. 2). Then, the medial side of tensor fascia is separated from the tensor muscle using fingers and the plane between tensor fasciae latae muscle on the lateral side and sartorius on the medial side is incised using fingers. Then a Curved Hohmann Retractors- Blunt (used for minimally invasive approaches) is placed lateral to the neck. The second retractor (a sharp curved Hohmann retractor used for minimally invasive approaches) is placed lateral to trochanteric ridge (next to the first one). Then, the ascending branches of the artery and vein of the lateral femoral circumflex are cauterized and incised in four parts. After that, a retractor similar to the first one is placed over inferior border of femoral neck. Next, the plane between the rectus femoris muscle (its straight head) and the joint capsule is specified and a retractor similar to the second one is placed in this space (specified using a Cobb's elevator) to the anterior wall / pelvic brim (Orientated towards the opposite kidney) (Fig. 3). In this way, around the joint capsule is specified on the anterior side, then an arthroscopy is performed through inverted T incision and an anterior capsulotomy is performed (the lower half of the capsule is removed first and then the upper half is removed). At this time, the neck fracture site is specified. In the case of subcapital fracture that the remainder of femoral neck is too long and impede head to be extracted it should be osteotomized by power saw, one can use osteotome but it should be consider there is high risk of calcar fracture in this situation. Then the femoral head is removed using a corkscrew (Fig. 4). Next, retractors No1, No2 and No3 are removed and a double footed retractor (with long legs) is placed between the capsule and the gluteus minimus muscle at the lateral side. At this stage, the surgical table breaks down midway (where the BUMP is placed under the hip) and the limb is hyperextend at its operative side (Figure 5). At the same time, adduction and external rotation of the limb is done by the surgeon’s assistant. (Note: Considering that patients with hip fractures who are candidates for hemiarthroplasty are often osteoporotic, if adduction and external rotation of the limb (positioning) is done in an invasive manner and before superomedial capsule release, there will a risk of great trochanter avulsion or fracture). Then, superomedial capsule is released. After complete release (when the double footed retractor can easily be levered down and the great trochanter is levered up without any limitations), the retractor No. 4 is removed and instead, a double footed retractor with shorter legs is placed in medial neck and small trochanter. The surgeon’s assistant on the opposite side of the surgical table is responsible for both double footed retractors. At this stage, the medial facet of great trochanter is initially removed using a chisel box and the canal is opened using a canal finder with a blunt tip (or a tall, narrow curette). Then, the canal is reamed to the desired extent using a reamer existing in the canal surgery set (Fig. 6) and next, broaching is performed using a broach, in order of size. (Fig. 7). When the last broach is fitted, the joint is reset with the help of neck and head of femur trial. Joint stability is checked in various positions, especially full flexion, full extension, Flex, abduction and external rotation. The length of the limb is compared to that of the opposite limb, as well. If the situation is appropriate in all of the above, the joint will be extracted using a hook. Ultimately, the joint is reset, washed, closed in an anatomical layer and dressed up. The pre and post-operative graphs are shown in Figures 8 and 9.

Figure 3. Placing 4 retractors

Figure 4. Femoral head removal using a corkscrew
A total of 45 patients (16 males and 29 females) from among 100 patients with femoral neck fractures who had undergone arthroplasty were included in this study. The mean age was 73.4 years (62-92 years), their mean BMI was 28.3 kg/m² and all of the patients were followed up for at least 76 months (62-86 months). All of the patients were examined at the time of last follow-up and they filled out Harris Hip Score rating forms. The average surgery duration was 93 minutes. The average blood loss was 250 cc. None of the patients needed blood transfusions. All of the patients regained mobility on the first day after the surgery. The average length of hospital stay for these patients was 2.5 days (2-5 days). Complications such as dislocation, deep infection & wound problems occurred for none of the patients. The mortality rate was 10% after one year and the mean Harris Hip Score was 87.1(76-95).

Results

fractures in the elderly. With increasing demand for minimally invasive approaches, other approaches (except commonly used posterior and lateral approaches) were also introduced among which direct anterior approach has become the most popular approach. It is clear that any damage to muscle or joints will result in decreased muscle strength and disruption of proprioception. Minimally invasive approaches, provided for the purpose of minimal damage to soft tissues (especially muscle and joints), can be particularly effective in hemiarthroplasty for the elderly with advantages at least for a short term after the surgery. Traditionally, posterior and lateral approaches have been used for hip hemiarthroplasty. Kristensen et al. studied femoral neck fractures in people over 60 and reported 18,000 lateral and about 2,000 posterior approaches used for surgeries between 2014 and 2005 and observed less pain, patient satisfaction and better quality of life in the group that had undergone surgery via posterior approach. In another study, about 1,200 patients were included in the study 1-3 years after the primary hip arthroplasty. The questionnaires were sent to them and the scales such as Hip disability and osteoarthritis outcome score as well as Western Ontario and Macmaster Universities Osteoarthritis Index were used. During Interpretation of the results, it was found that 1-3 years after the primary hip arthroplasty, lateral approach has led to worse outcomes.

Discussion

Given the complications of internal fixation for the elderly femoral neck fracture (such as displacement, nonunion and avascular necrosis), today, most surgeons prefer hemiarthroplasty for treatment of displaced fractures in the elderly. With increasing demand for minimally invasive approaches, other approaches (except commonly used posterior and lateral approaches) were also introduced among which direct anterior approach has become the most popular approach. It is clear that any damage to muscle or joints will result in decreased muscle strength and disruption of proprioception. Minimally invasive approaches, provided for the purpose of minimal damage to soft tissues (especially muscle and joints), can be particularly effective in hemiarthroplasty for the elderly with advantages at least for a short term after the surgery. Traditionally, posterior and lateral approaches have been used for hip hemiarthroplasty. Kristensen et al. studied femoral neck fractures in people over 60 and reported 18,000 lateral and about 2,000 posterior approaches used for surgeries between 2014 and 2005 and observed less pain, patient satisfaction and better quality of life in the group that had undergone surgery via posterior approach. In another study, about 1,200 patients were included in the study 1-3 years after the primary hip arthroplasty. The questionnaires were sent to them and the scales such as Hip disability and osteoarthritis outcome score as well as Western Ontario and Macmaster Universities Osteoarthritis Index were used. During Interpretation of the results, it was found that 1-3 years after the primary hip arthroplasty, lateral approach has led to worse outcomes.

Given the complications of internal fixation for the elderly femoral neck fracture (such as displacement, nonunion and avascular necrosis), today, most surgeons prefer hemiarthroplasty for treatment of displaced fractures in the elderly. With increasing demand for minimally invasive approaches, other approaches (except commonly used posterior and lateral approaches) were also introduced among which direct anterior approach has become the most popular approach. It is clear that any damage to muscle or joints will result in decreased muscle strength and disruption of proprioception. Minimally invasive approaches, provided for the purpose of minimal damage to soft tissues (especially muscle and joints), can be particularly effective in hemiarthroplasty for the elderly with advantages at least for a short term after the surgery. Traditionally, posterior and lateral approaches have been used for hip hemiarthroplasty. Kristensen et al. studied femoral neck fractures in people over 60 and reported 18,000 lateral and about 2,000 posterior approaches used for surgeries between 2014 and 2005 and observed less pain, patient satisfaction and better quality of life in the group that had undergone surgery via posterior approach. In another study, about 1,200 patients were included in the study 1-3 years after the primary hip arthroplasty. The questionnaires were sent to them and the scales such as Hip disability and osteoarthritis outcome score as well as Western Ontario and Macmaster Universities Osteoarthritis Index were used. During Interpretation of the results, it was found that 1-3 years after the primary hip arthroplasty, lateral approach has led to worse outcomes. Another study on 583 patients who had undergone hip arthroplasty for femoral neck fractures showed that the risk of prosthetic joint dislocation was 8 times higher in the group that had undergone posterior approach surgery compared to that in the group that had undergone lateral approach surgery and
consequently, frequent dislocations and the need for reoperations were more likely to occur in this group. Hence, the author recommends not to apply this approach for femoral neck fracture arthroplasty in the elderly\textsuperscript{(13)}. Considering the available evidence, none of the existing approaches is the preferred method for hemiarthroplasty in the elderly.

On the other hand, direct anterior approach has many potential advantages since it is minimally invasive. Bergin et al. compared minimally invasive direct anterior approach to posterior approach. In their research, 29 patients had undergone a surgery via direct anterior approach and 28 patients had undergone a surgery via posterior approach. Serum Creatine kinase (CK), IL-6, IL-I Beta and TNF-Alfa levels were measured for assessing the degree of muscle damage. The levels of these inflammatory markers in the DAA group was reported to be slightly lower than that in the posterior approach group. CK level in the posterior approach group was 5.5 times that in the DAA group. It was concluded that DAA causes significantly less muscle damage\textsuperscript{(18)}. Moreover, direct anterior approach has fewer complications compared to other approaches or complication rates comparable with those of other approaches which makes it an appropriate choice, especially for hemiarthroplasty in the elderly (which potentially has more complications compared to that in younger people).

With respect to blood loss and the need for blood transfusion, Pogliacomi et al., compared the results of direct anterior approach applied recently by an experienced surgeon to the results of a standard lateral approach and concluded that a week after the surgery, blood loss and blood transfusions were significantly lower in the direct anterior group\textsuperscript{(19)}. YUE et al., however, found no significant difference in blood transfusions between DA and lateral approaches\textsuperscript{(20)}. ALECCI et al. also showed lower blood loss in the direct anterior group\textsuperscript{(21)}. With respect to postoperative recovery rate which is an effective factor in reducing complications, especially in the elderly, in a meta-analysis of comparison of DA and lateral approaches used for total hip arthroplasty, YUE et al. showed that DAA leads to early postoperative functional rehabilitation, however, there was no difference in surgical complications between these two approaches\textsuperscript{(20)}. In another study, NAKATA et al. compared DA approach to MINI posterior approach and showed that 3 weeks after the surgery, in the DA group, %29 showed positive trend on Langberg’s test, while in the posterior group, 67% showed positive trends. Three weeks after the surgery, it took 52 minutes for the DAA group to walk 50 meters but for the posterior group, it took 74 minutes. Moreover, the mean length of hospital stay for the DAA group was 2.2 days. They concluded that after the minimally invasive surgery, the DAA group had better functional outcomes hip of as well as better gait ability compared to the posterior group\textsuperscript{(22)}.

Martin et al. compared 41 patients having undergone DAA and 47 patients having undergone posterior approach with respect to length of stay and the average time it took to regaining mobility and showed that the mean length of stay was 2.9 days for the DAA group and 4 days for the posterior approach group. Additionally, the average time it took for the DAA group to regaining mobility was 2.4 days while for the posterior approach group, it took 3.2 days\textsuperscript{(23)}.  

![Figure 8. Preoperative graph](image1)

![Figure 9. Postoperative graph](image2)
Pogliacomi et al. also showed that the length of hospital stay was shorter in the DAA group as opposed to that in the posterior approach group\(^{(19)}\). Alecci et al. also showed the same results in their study (comparison of DA and lateral approaches\(^{(21)}\)). Additionally, Yue et al. found shorter length of stay in the DAA group compared to that in the posterior approach group\(^{(20)}\).

With respect to post-operative pain, Alecci et al. compared DA and lateral approaches for hip arthroplasty and showed that the patients in the DAA group had less postoperative pain and less nausea and vomiting, however, their surgery lasted longer. They concluded that increase in surgeon experience can lead to reduced duration of the surgery via DAA approach\(^{(21)}\). Moreover, Pogliacomi et al. showed that the patients in the direct anterior group had less postoperative pain\(^{(19)}\). Besides, Yue et al. found less postoperative pain in the direct anterior group (p. 20).

All the patients who had undergone hemiarthroplasty via DA approach were investigated in this study. The mean surgery duration was 93 minutes which was similar to the results of the study conducted by Higgins et al.\(^{(24)}\) (a systematic review and comparison of DA and posterior approaches). In this review, the mean surgery duration was 46-118 minutes in the posterior group while it was 78-129 minutes in different studies. With respect to surgery duration, the results of our study was consistent with the results of other DA studies and comparable with the results of posterior approach studies. The amount of blood loss in our study was 250 CC and no blood transfusion was observed. According to Higgins\(^{(24)}\), it varied from 50 + 285 cc to 426 + 704cc in the DA group and from 107+ 191 cc to 310 + 685 cc in the posterior group. In this regard also, the results of our study was consistent with the results of other DA studies and comparable with the results of posterior approach studies. With respect to the average time it took to regaining mobility, we obtained better results compared to the results obtained by Martine et al.\(^{(23)}\) (1.1 days versus 2.4 days). The mean length of hospital stay was 2.5 days in our study and 2.9 days in the study conducted by Martine et al.\(^{(23)}\). And according to Higgins et al.\(^{(24)}\), the mean length of hospital stay varied from 0.8 +2.7 days to 0.39+ 3.5 days. In this regard also, our results were comparable and even better. Dislocation was observed in none of the patients in our study, while Higgins\(^{(24)}\) found only one case of dislocation in two studies. Moreover, most of the studies on anterior approach reported no dislocation.

Limitations
The first limitation of the study was that it was a case series research study not a randomized clinical trial. The number of our cases was low, which is, of course, comparable with most of the similar studies. Two surgeons operated the patients that could result in a variety of outcomes, although no problem was observed in our results since no complication was observed and our results, in terms of other variables, were comparable to large studies in this area.

Conclusion
Finally, given that the candidates for arthroplasty for femoral neck fractures are often old, and taking the advantages of DA approach into consideration(including supine position and minimal muscle damage as it is an intramuscular approach) DA approach leads to less(or comparable) intraoperative blood loss, shorter surgery duration, less postoperative pain and faster recovery as compared to other approaches. Hence, this approach is recommended to be applied for hip hemiarthroplasty in patients with femoral neck fracture in centers that have enough experience with this approach.

Conflicts of Interest
we wish to confirm that that there are no known conflicts of interest associated with this publication.
References


