Modified Trap Door Procedure with Arthrodiastasis for Avascular Necrosis of Femoral Head

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ABSTRACT

Objective: To investigate the functional outcomes of modified trap door procedure with arthrodiastasis for avascular necrosis of femoral head.
Methods: This case series study was conducted at Orthopaedic Surgery Department of Ghurki Trust Teaching Hospital, Lahore from January 2015 to December 2018. We analyzed all cases of osteonecrosis, diagnosed from clinical evaluation, radiographs, magnetic resonance imaging (MRI) and staged them using "Association Research Circulation Osseous classification (ARCO)" classification. Merle score was calculated pre-operatively and on follow-up assessments.
Results: During the study period, 11 hips of 10 patients underwent the studied procedure. Out of these 10patients, 8(80.0%) were males and 2(20.0%) females. The mean age was 24.70±5.60 years ranging between 18-36 years. Mean duration of symptoms was 9.40±3.44 months. According to ARCO classification eight hips were classified as type-III and three hips as type-IV avascular necrosis of femoral head. Six (60.0%) patients had unilateral AVN and four (40.0%) had bilateral AVN. The mean duration of follow-up for patients was 42.8±6.4 months. After a period of three years following the procedure, a single patient had to undergo total hip replacement. No major complication occurred after surgery except infection in one patient, which settled down on removal of screws. Baseline Merle score was 6.20±1.40 while the mean post-surgery Merle score was 11.80±2.74 ($p<0.0001$) whereas the mean change in Merle score was 5.60±2.72 ranging between 0 to 10.
Conclusion: Modified trapdoor procedure with hip distraction arthroplasty in advanced AVN reduces the pain and limitation of daily activities at average follow up of 43 months. This is a reasonable time buying procedure especially in patients not willing for replacement surgeries.

Keywords: Arthroplasty, arthrodiastasis, avascular necrosis, femoral head, MRI.

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INTRODUCTION

Osteonecrosis of head of femur can be surgically treated by either femoral head replacement procedures like hemi-arthroplasty or total hip replacement, and arthrodesis.[1] Femoral head preservation procedures done to relieve pain and decrease the progression of disease are core decompression, non-vascularized bone grafting through the core decompression tract (phemister technique) or by making a window in the head of femur (trap door procedure) or in femoral neck (light bulb technique), vascularized bone grafting, insertion of porous tantalum rods or stem cells through core decompression tract, angular intertrochanteric osteotomies and rotational trans-trochanteric osteotomies.[2-4] The clear consensus for treatment of osteonecrosis of head of the femur in adults has not reached yet.

Phemister technique is the earliest head preservation procedure and has good short-term

clinical outcomes but long term results were not satisfactory (36% hips converted to hip replacement in follow up) so its use has been reduced significantly.[5,6] This lead to introduction of trap door procedure which showed excellent clinical outcome (83% hips had good or excellent results in Ficat-Arlet stage-III).[7,8] But in trap door approach, consistency of joint cartilage is disturbed which is thought to contribute to failure to heal postoperatively. Light bulb technique does not cause joint cartilage damage.[6,9]

At our institute, we performed the trap door procedure with arthrodiastasis using articulated hinged, distraction external fixator, as researchers in the past have shown that arthrodiastasis relieves pressure on articular cartilage, improves cartilage nourishment, promotes repair and allows joint motion.[10,11] In Pakistan, not much work is seen evaluating the functional outcomes of modified trap door procedure with arthrodiastasis for avascular necrosis of head of femur so this study was planned. The objective of this research study was to analyse the functional outcomes of modified trap door procedure with arthrodiastasis for avascular necrosis of the head of femur.

METHODOLOGY

This case series study was conducted at the Orthopedic Surgery Department of Ghurki Trust Teaching Hospital, Lahore from January 2015 to December2018. We analyzed all cases of osteonecrosis, diagnosed from clinical evaluation, radiographs, magnetic resonance imaging (MRI) and staged them using "Association Research Circulation Osseous (ARCO)" classification, who underwent modified trap door procedure with arthrodiastasis. Patients were not excluded based on etiology. Any patients unwilling to be part of this research or lost to follow up until the conclusion of study, were excluded from the analysis.

Surgical Technique

The patient was positioned with the affected side facing up on a radiolucent table in a lateral decubitus position. In order to protect the head of femur's blood supply, surgical hip dislocation was performed. Using Kocher Langenbeck approach, skin incision was given. Tensor fascia lata & Gluteus maximus were cut in line. Greater trochanteric bursa was dissected out and 15mm thick trigastric greater trochanter osteotomy was done. Z shaped capsulotomy was made. Hip dislocation was done by traction and figure of 4 position. Ligamentum teres was resected out. Cartilaginous flap was elevated from 3 sides. Dead bone was removed till bleeding appeared. After removal of dead bone the space was packed with cortico-cancellous autograft. Cartilage flap was stitched back with vicryl 2/0. Hip joint was reduced and capsule was closed with vicry l. Greater trochanter was fixed with 2 to 3 cortical screws. Vicryl 1 was used to close the gluteus maximus & tensor fascia lata while prolene 2/0 was used to close the skin. Across hip Orthofix was applied by passing 2 shanz in supraacetabular region and 3 shanz in the femoral shaft. (fig. 1) About 1 to 2 cm distraction was applied across the hip joint with the help of Orthofix and hinge joint of Orthofix was unlocked to start range of motion exercises. Up to 60 degrees flexion was allowed at the hip joint.

On the first post-operative day, walker assisted walking was allowed without bearing weight. At 3 months, Orthofix was removed and partial-weight-bearing was initiated. Complete weight bearing was allowed at around six months. X-rays were taken the day following surgery, at six weeks, three months, and then every three months after that. Functional results were assessed by the Merle grading. Three crucial components make up the Merle grading: painlessness, mobility, and walking capacity. These components are rated on a scale of 0 to 6, with 6 denoting normal or almost normal, both before and after surgery (table-1).[12] The difference between the pre- and post-operative figures was used to calculate the benefit of the procedure. The first and third numbers, pain and walking, were given double values, with mobility being assumed less significant.

Data analysis was performed using SPSS version 26. Frequency and percentages were used to portray the categorical data. Numeric data were shown as mean and standard deviation (SD). Comparison of Merle scorings between pre-surgery and post-surgery period were compared utilizing paired sample t-test considering significance at $p<0.05$.

Fig. 1: Orthofix applied across hip

Table I: Merle Grading

Score	Painless	Mobility	Walking Ability
0	Intense and permanent Pain	Ankylosis combined with bad hip posture	none
1	Severe night time pain	No movement with pain or slight deformity	Only with crutches
2	Severe walking pain that limits movement	Flexion less than 40	Only with canes
3	Unbearable pain with little activity	Flexion between 40 to 60 degrees	Less than an hour with just one cane
4	Mild walking pain that goes away on taking rest	Flexion between 60 to 80 degrees	A long time with cane
5	Very mild, sporadic pain that allows for regular activities	Flexion between 80 to 90 degrees	limping but without a cane
6	No pain	More than 90 degrees of flexion	Normal

RESULTS

During the study duration, 11 hips of 10 patients underwent the studied procedure at our institute. Of these ten patients, two (20.0%) were female and eight (80.0%) were male. The mean age was 24.70±5.60 year ranging between 18-36 years. Mean duration of symptoms was 9.40±3.44 months. Eight hips were classified as type III by ARCO classification, and three as type IV. Six (60.0%) patients had unilateral AVN and four (40.0%) had bilateral AVN. Only one patient out of four bilateral hips operated on both sides at different occasion. Table 2 displays the patient characteristics.

The patients were followed-up for an average of 42.8±6.4 months. After the treatment, one patient had a total hip replacement three years later. No major complication occurred after surgery except infection in one patient, which settled down on removal of screws. Baseline Merle score was 6.20±1.40, the mean post-surgery Merle score was 11.80±2.74 ($p<0.0001$) whereas the mean change in Merle score was 5.60±2.72 ranging between 0 to 10.

Table 3 provides information regarding how the operation affected the pain and mobility.

Table 2: Clinical and Sociodemographic Features of Patients (n = 10)

Characteristics		Number (%)
Gender	Male	8 (8.0%)
	Female	2 (20.0%)
Age (in years)	15-25	6 (60.0%)
	>25	4 (40.0%)
Socio-economic status	Low	7 (70.0%)
	Medium	1 (10.0%)
	High	2 (20.0%)
Risk factors	Cortisone intake	6 (60.0%)
	Trauma	4 (40.0%)
Duration of symptoms (months)	3-6	2 (20.0%)
	>6	8 (80.0%)
ARCO Staging	4	7 (70.0%0
	5	3 (30.0%)

Table-3: Operation's Effect on Pain and Mobility of affected hips (n=11)

	Pre-operative		Post-operative	
Pain	Painless	-	Still pain	0
	Painful	11 (100%)	Worse Unchanged Diminished Completely relieved.	- 1 (9.1%) 7 (63.6%) 3 (27.3%)
Mobility	Normal or greater mobility	-	Greatly reduced Reduced Preserved	- - -
	Limited mobility	11 (100%)	Reduced Unchanged Increased	1 (9.1%) - 10 (90.9%)

DISCUSSION

Literature mentions different treatment modalities for femoral head osteonecrosis, but there is lack of concrete evidence to conclude one possible definite treatment.[13] The average age in the current study was 24.70±5.60 years ranging between 18-36 years.[14] Patients with osteonecrosis usually present in age group of 20-40 years. A study done by Vardhan H et al revealed that 70.3% patients were aged between 20-40 years.[15] Due to increased wear and osteolysis in young active individuals, joint replacement surgery performed at a younger age increases the likelihood of revision surgery in the future. Results from joint preserving surgeries have been favourable at the short- and mid-term follow-up.[16]

The findings of this research help to assess clinical and functional outcomes of trapdoor procedure combined with arthrodiastasis in patients with AVN. We found no literature with combined trapdoor and arthrodiastasis for the treatment of AVN, though other adjuvant therapies are mentioned in the literature. In the present study, significant improvement in post-surgery Merle score was noted ($p<0.0001$) whereas the mean change in Merle score was 5.60±2.72 ranging between 0 to 10. It was Judet et al. who introduced the trapdoor approach for the first time.[17] Favorable outcome following trapdoor procedure mainly depends upon cartilage healing. Separating the articular surfaces and enhancing cartilage repair is made possible by the adjunct external fixator positioned between the pelvis and the proximal femur, at the same time maintains ligament tension, increase joint space and allows range of motion at hip.[18,19]

In our study, treatment was based on symptoms of patient, x-ray appearance and ARCO classification of osteonecrosis, however, hip distraction was used as a salvage operation because the majority of our patients exhibited severe femoral head collapse. Important outcome factors include patient compliance, adequate distraction, and supervised rehabilitation program. Fixator was placed for average 3 months. It was clearly explained to the patient that this procedure is time buying procedure and may require joint replacement surgery in the future; this procedure can help in achieving improvement in range of motion and relief of pain.

We evaluated the procedure's effectiveness using the Merle score both before and after surgery. All patients had pain and limited range of motion hindering daily life activities preoperatively. On follow-up, though Merle score showed improvement but range of motion was still limited to allow all daily life activities but all patients showed satisfaction with the chosen procedure except one. Pain was diminished in 64% and completely removed in 9%. We found 90.9% increase in post-surgical mobility resulting at an average follow up of 42.8±6.4 months while only one patient underwent total hip replacement. It was found that the patient's hip range of motion and pain had significantly improved clinically. There are different treatments modalities with their respective outcomes in the literature.[20-22]

We found no literature for treatment of advanced AVN with hip preservation surgery for comparison. Interestingly, our study group can be compared with group having femoral rotational osteotomies. Following intertrochanteric flexion osteotomy for stages III and IV hips, Drescher et al. observed conversion rates of 12% at five years and 24% at ten years of follow-up in their study of 65 hips.[20]

Though the outcome of trapdoor procedure with adjuvant arthrodiastasis was favorable, keeping the progressive nature of disease, we assume that some patients may require replacement surgery in future. Our patients showed delay of symptoms for average follow up of 43 months that indicates the applied technique halted the progressive nature of disease for at least 43 months.

Limitations of our study were limited number of patients because of decreased incidence of the disease and consent to undergo this procedure. We had a relatively short follow up of 43 months that is less keeping the progressive nature of the disease. Our study did not compare the different available femoral head preservation procedures. This introduced a procedure in hip preservation surgery list. Although, further studies are needed to be conducted to compare the studied approach with other contemporary hip preservation surgery procedures.

CONCLUSIONS

Modified trapdoor procedure with hip distraction arthroplasty in advanced femoral head AVN reduced the degree of pain and restrictions on day-to-day activities at an average follow-up of 43 months. This is a reasonable time buying procedure especially in patients not willing for replacement surgeries.

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