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Modified periacetabular osteotomy technique in the management of acetabular dysplasia

Abdullah A. Nada, MRCS, MSc.
Department Of Orthopedics, Tanta School of Medicine, Tanta University
*Corresponding author email: Doctor.Abdullah@live.com & Abdallah.nada@med.tanta.edu.eg

Mohamed H. El-Sayed, MD.
Department Of Orthopedics, Tanta School of Medicine, Tanta University

Mohamed H. Nagy, MD.
Department Of Orthopedics, Tanta School of Medicine, Tanta University

Ahmed M. El-Elaimy, MD
Department Of Orthopedics, Tanta School of Medicine, Tanta University

Abstract---Purpose: Evaluating the results of modified PAO in the management of acetabular dysplasia. Patients and Methods: This prospective study included 13 cases. All cases were diagnosed with acetabular dysplasia then treated by PAO using our modified technique. In all included patients, the retro-acetabular cut was performed before the ischial cut during PAO surgery. Eight cases were stage IV and five were stage III according to Severin classification. The mean preoperative HHS was 83 points. The mean preoperative acetabular angle of Sharp value was 49 degrees. The mean preoperative LCEA value was 12 degrees. Results: The mean postoperative HHS at the final follow up was 87 points. The mean postoperative acetabular angle of Sharp value was 37 degrees. The mean postoperative LCEA value was 32 degrees. According to HHS score, six cases had excellent results, six had good results, and one case had fair outcome. Lateral femoral cutaneous nerve neuropathy occurred in two patients, and superficial wound infection was encountered in one patient.Conclusion: Performing the retro-acetabular cut before the ischial cut prevented posterior column fracture Interruption in all cases, making PAO safer and easier to perform, and reducing its risk.

Keywords---periacetabular osteotomy, acetabular dysplasia, posterior column interruption.

Introduction

Hip dysplasia is a dynamic mechanical disorder , characterized by a shallow acetabulum that does not sufficiently cover the femoral head, thus causing variable degrees of hip instability (1). Improvement of the femoral head coverage and acetabular orientation is crucial to optimize the mechanical forces across the joint. By enhancing these mechanical conditions, hip dysplasia-related dynamic and static instability patterns, can be appropriately managed (2–4). Ganz, or Bernese, periacetabular osteotomy (PAO) (3) is one of the pelvic osteotomies used for correcting acetabular dysplasia. Numerous other pelvic osteotomies were described for the management of acetabular dysplasia (5–8). Nevertheless, PAO is considered the golden standard for reorientation of dysplastic acetabula after triradiate cartilage closure (3,9)**.** One major advantage of PAO is preserving the posterior column intact (4). Preservation of the posterior column maintains the stability of the involved hemipelvis, thus allowing early mobilization and weight bearing , in addition to maintenance of hip abductor musculature, the preservation of the acetabular blood supply, and sciatic nerve protection. The osteotomy planes of PAO are close to the joint center of rotation, allowing optimal deformity correction without any undesirable translation . (10,11).

Inadvertent extension of the osteotomy to the posterior column is a significant complication that can occur during PAO surgery. Posterior column discontinuity can lead to failure of surgery if not addressed properly. Non-union, acetabular migration, and consequent delayed weight bearing, are possible sequalae. In some cases, another surgery to fix the posterior column discontinuity or a revision surgery may be necessary (12–14). In this study, we proposed a new modification to avoid posterior column interruption during PAO. The retro-acetabular cut was performed before the ischial cut, so that the distal end of this cut will function as a stopper, preventing the inadvertent posterior extension of ischial cut.

Patients and Methods

This prospective study included 13 cases, seven males (54%) and six females (46%). The mean age was about 18 years. Symptomatic patients who had radiographic evidence of acetabular dysplasia, who had an adequate hip range of motion (ROM) (at least 80% of the normal side range of motion (ROM)), and had a closed triradiate cartilage, were included. The presence of a neo-acetabulum, or evident hip dislocation in the x-ray, worsening of hip congruency on abduction, and patients with limited hip ROM, were excluded from this study. The left side was dysplastic in seven cases (54%) , and the right side in six cases (46%), all had unilateral affection. The mean body mass index (BMI) of the included cases was 26. Five patients (38%) were considered overweight (BMI ranges between 85th percentile and 95th percentile for age), and two cases (15%) were obese (BMI is equal or more than 95th percentile for age) (15). According to Severin classification (16), five patients were grade IV (38%), and eight patients (62%) were grade III.

A detailed history, was taken from all cases, including the age, chief complaint, activity level, sports, past medical, and history of previous surgeries. Physical examination was performed for all patients, including general and local

examination of both hip joints. The Radiographic pre-operative evaluation included antero-posterior and false profile plain x-ray views of the hip, CT with 3D reconstruction of the hip and pelvis, with distal femoral cut to measure proximal femoral version angle, and MRI to exclude labral pathology. Pre-operatively, planning of the osteotomy was done based on the pre-operative measurements of the lateral and anterior center-edge angle (LCEA), the acetabular index of Sharp ,and the bony acetabulum configuration as seen in CT with 3D reconstruction cuts. Under general anesthesia, patients lie supine on a radiolucent operating table. The entire buttock and the proximal half of the thigh were sterilized and draped.

Modified SmithPetersen anterior approach, as described by Ganz et al (13) was performed in all cases (Fig 1). The incision, 15-20 centimeters in length, started at the iliac crest, towards the anterosuperior iliac spine (ASIS) and then continued longitudinally along the lateral aspect of the proximal thigh. Superficial dissection was carried out, care to avoid injury of the main branch of the lateral cutaneous nerve of the thigh, as it lies within the sheath of the sartorius muscle. Then, the fascia of the tensor muscle was split. The tensor muscle belly of the was pulled laterally while the sartorius muscle was dissected and retracted medially. Osteotomy of ASIS was performed when more exposure was needed The periacetabular osteotomy surgery was divided into five main steps.

- Firstly, a complete osteotomy of the superior pubic ramus, just medial to the ilio-pubic eminence, using a chisel at a 45 degrees angle medially, was performed.
- Secondly, supra-acetabular and retro-acetabular osteotomy planes were marked by two k-wires, the marking started on the lower border of the ASIS and continued in a posterior direction stopping short of the posterior column edge by about 1.5-2 cm (Fig 2), osteotomy was performed from the anterior edge of the iliac wing to a point nearly two cm proximal to the pelvic brim.
- Thirdly, under fluoroscopy, a straight chisel was continued form the inside of the pelvis, at an angle of about 120 degrees, from the end of the previous cut, distally in the direction of the ischial spine. This retro-acetabular cut run at a distance of at least one cm away from the edge of the greater sciatic notch (Fig 3).
- After that, incomplete osteotomy of the ischial tuberosity was performed. A large periosteal elevator was used to assist in the introduction of a Ganz chisel (with a fish tail tip to minimize the risk of surrounding soft tissue injury). Under fluoroscopy, the axilla of the ischium was palpated with a chisel. A notch was made using the chisel, while pointing the handle in posteriorly and slightly inferiorly , then advancing it slowly to perform an incomplete osteotomy of the ischium. The ischial cut spontaneously stopped when it met the retro-acetabular one, avoiding posterior column interruption (Fig 4).
- Lastly, manipulation of the acetabular fragment into the desired position was performed using a Schanz pin and pointed reduction clamps (Fig 5).

The radiographic features of an proper correction include:

- The teardrop sign is elevated or in a more superior position compared to the pre-operative position.
- The acetabular roof or sourcil is horizontal.
- The anterior rim was medial to the posterior one (the socket was not retroverted)
- The hip center was medialized Prominent parts of the iliac part of the mobilized fragment were excised and were inserted deeply as a graft to provisionally maintain the new desired acetabular fragment position, and to accelerate the bony union.

Then, fixation of the acetabular fragment in the new position was done by using three or four 3.5 long cortical screws (Fig 6). Capsulotomy was done after correction and fixation of the PAO, to allow inspection of the labrum acetabuli, and to exclude potential impingement with the proximal femur against the acetabular rim. No significant labral injury was found in any case necessitating surgical repair or debridement. Postoperatively, analgesics and broad-spectrum antibiotics were given for 48-72 hours Early passive ROM started within few days after surgery. Passive rotation in extension ROM was encouraged immediately after surgery. Partial weight bearing (toe touch with crutches) as tolerated for the first 4-6 weeks. Active abduction exercises were allowed after four weeks, and active flexion exercises after six weeks. Full weight bearing and full active ROM were started when radiographic evidence of healing appeared (usually after 8 -12 weeks). Progressive weight bearing was continued depending on the bony union as evaluated by the radiographs. Follow up x-rays were taken at six weeks, every three months in the first two years, then yearly, to measure and document the CEA and acetabular angle of Sharp. Clinical evaluation of the patient, especially hip ROM, was done routinely every follow-up visit. HHS questionnaire (17) was obtained and recorded after one year. (Fig 7,8)

Results

All cases were followed up, both clinically and radiographically for at least one year. The average follow-up period was about 17 months. After one year, the clinical results were evaluated according to the HHS criteria. The overall final clinical results were excellent in six hips (46%), good in six (46%), fair in one hip (8%) with no poor results. Therefore, satisfactory results were obtained in 12 hips (92%) and unsatisfactory in one case (8%). The mean pre-operative HHS was 83, while the mean post-operative HHS was 87. The preoperative acetabular angles of Sharp mean of 49 degrees. Postoperatively, the mean was about 37 degrees. The preoperative LCEA mean of 12 degrees. Postoperatively, the LCEA mean value of about 32 degrees. The average operating time was 128 minutes (range 100–170 minutes).

Complications were encountered in three cases (23%), all of which were considered minor ones according to Davey and Santore (18). Dysesthesia of the lateral femoral cutaneous nerve was encountered in two patients (15%) early after surgery. It was diagnosed clinically by the presence of numbness and paresthesia along the lateral femoral cutaneous nerve distribution at the lateral aspect of the proximal thigh. The condition improved during the follow-up course, both cases within two months after surgery. One patient (8%) suffered from superficial

wound infection, manifested by redness and hotness of the wound edges, but with no discharge, four days after surgery. This was managed by daily dressings and giving broad spectrum antibiotics. The infection resolved without any sequels within one week. No posterior column interruption was encountered in any case in the current study.

Discussion

Several Technical modifications for the original PAO were described in the literature, in the sake of easier and safer surgery (19–24). These modifications included the incision, the exposure steps, osteotomy techniques, sequence, and fixation methods. In the original description, Ganz et al (12) performed PAO cuts by following four main consecutive steps; the ischial cut, then the pubic cut, the roof-shaped supracetabular cut, and lastly the retro-acetabular cut. In this study, the retro-acetabular cut was carried out before the ischial one, so that the ischial cut spontaneously stopped when it met the retro-acetabular one, avoiding posterior column interruption. In all cases included in this study (13 cases), no posterior column interruption occurred. According to Davey and Santore posterior column discontinuity was considered as a major complication if surgical intervention is required (18), if not , then it is classified as moderate complication. According to Clavien-Dindo classification, posterior column discontinuity it is considered as grade III complication, as it can cause residual disability and needs further surgical management (25).

Several authors reported posterior column interruption complication during PAO surgery (12,14,26,27). In his original paper, Ganz et al (12) reported one case of posterior column discontinuity which resulted in a symptomatic nonunion that necessitated internal fixation using a plate, through a posterior approach. Biedermann et al (14) reported four cases out of total 60 (7%) of posterior column discontinuity that required surgical stabilization, and thus were considered major complications. Sen et al (28) reported one case (4%) of posterior column interruption (out of total 25 cases included) , it did not need further stabilization and thus was considered as moderate complication. Crockarell et al (26) had 3 cases (14%) of complete ischial fractures due to posterior column interruption, which did not need any further stabilization. Zaltz et al (27) reported posterior column interruption requiring operative fixation in only one hip (out of 205). In a review of the Swiss experience of PAO, Büchler and Beck (29) reported osteotomy extension or interruption of the posterior column in 1.2 % of cases, which was considered as a major complication. There was one case (8%) who had fair result in this study, thus considered as unsatisfactory outcome. According to HHS score, the preoperative functional status in this patient was fair (75 points), which improved postoperatively (79 point), however, remained unsatisfactory. A small number of patients were included in this study, thus, the direct correlation between the index modification and the risk of posterior column interruption could not be confirmed. In addition, there was no comparison between patients operated with and without the index modification by the same surgeon.

Conclusion

Posterior column interruption during PAO can be avoided by performing the retro-acetabular osteotomy cut before the ischial one. This simple modification is relatively safe and easy to reproduce.

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Conflict of Interest: none

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Informed consent was obtained from all involved patients regarding the use of data and x-ray images. This study was approved by the institutional Ethical committee.

Authors' contribution

Abdullah Ahmed Nada: Conceptualization, Resources, Methodology, Investigation, Validation, writing original draft, review and editing, Data curation, project administration.
Mohamed Hosney El-Sayed: Conceptualization, writing original draft, review and editing, Methodology, supervision.
Mohamed Hosam Eldin Nagy: Conceptualization, review and editing, Data curation, Methodology, Investigation, and validation.
Ahmed Mohsen El-Elaimy: Conceptualization, Methodology, Validation, writing original draft, review and editing, and supervision.
all authors approve the final version of the paper provided.

Level of evidence: Level IV case series study

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List of figures

Figure 1

Figure 2

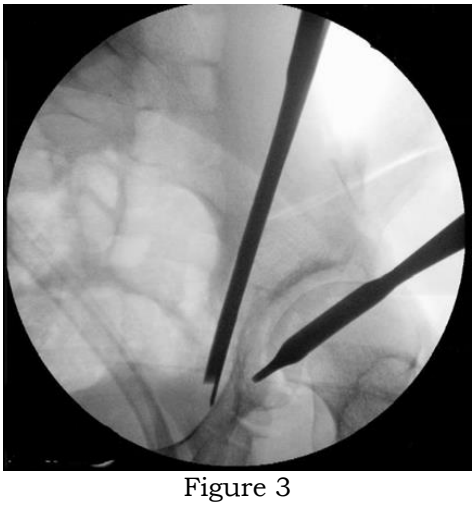


Figure 3

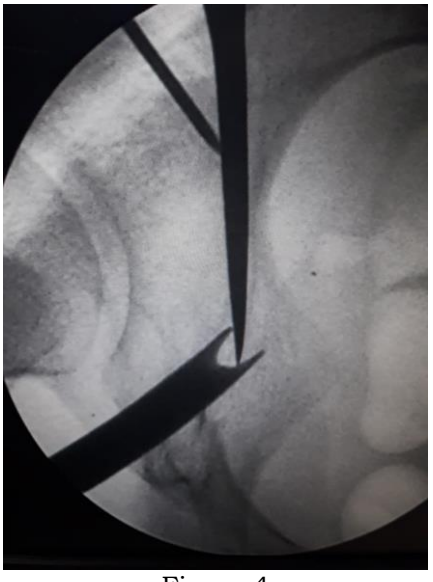
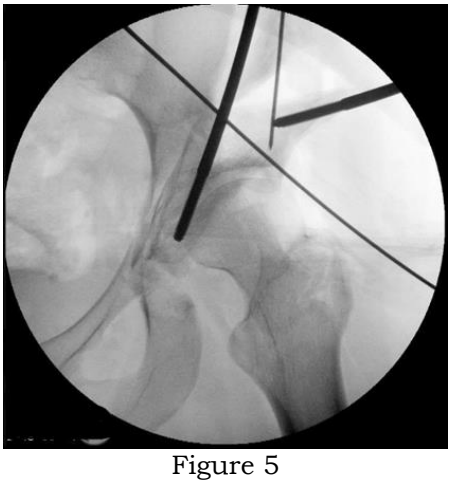


Figure 4



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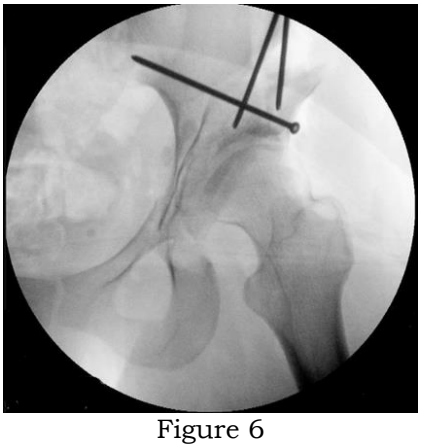

Figure 6

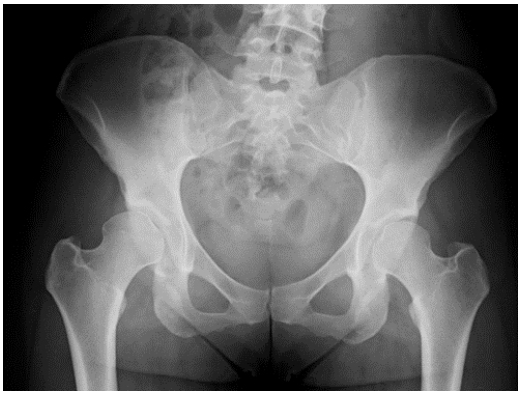

Figure 7 A

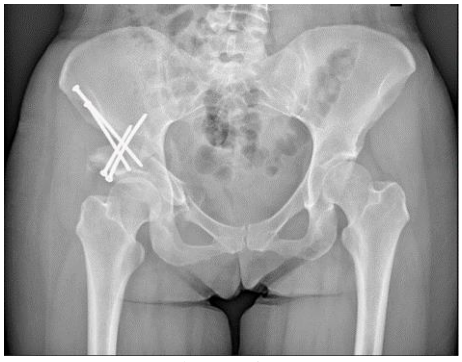

Figure 7 B