Original Article

A Minimally Invasive Technique Using a Modified Stoppa Approach for Periacetabular Osteotomy: A Preliminary Cadaveric Study

Turgut Akgul, Osman Coskun[1], Murat Korkmaz[2], Ilke Ali Gurses[1], Cengiz Sen, Ozcan Gayretli[1]

Departments of Orthopedics and Traumatology and [1]Anatomy, Istanbul Faculty of Medicine, Istanbul University, [2]Sisli Hamidiye Etfal Training and Research Hospital, Istanbul, Turkey

Abstract

Background: Developmental hip dysplasia is diagnosed when the femoral head is not sufficiently covered by the acetabulum. Anterior and lateral cover deficiency is seen, as a result a dysplastic hip joint. Various incision modifications have been developed because of the muscle dissection and wide wound scar in Smith-Peterson incision, which was originally used in Bernese osteotomy. This study evaluates applicability of the modified Stoppa approach in the performance of Bernese periacetabular osteotomy (PAO). **Materials and Methods:** Ten hemipelvises of five donor cadavers were used. The transverse Stoppa incision was made 2 cm over the symphysis pubis for quadrilateral surface exposure and pubic and ischial bone osteotomies. The second skin incision, a few centimeters lateral to the original incision, was made along the tensor fascia lata. Iliac bone osteotomy was performed starting just above the rectus femoris insertion. The displacement of the osteotomy was measured clinically and radiographically. **Results:** The mean anterior coverage calculated with center-edge angle was improved from 22.8° ±2.8 (range 20° min–28° max) preoperatively to 44.1° ± 3.7 (range 36° min–48° max). The displacement of the osteotomy at the iliopectineal line calculated on the iliac inlet view radiographs was 22.1 ± 3.4 mm (range 15 mm min–26 mm max). The clinical amount of the anterior displacement on the cadavers was 17.8 ± 3.35 mm (range 11 mm–21 mm) and lateral displacement was 20.3 ± 3.23 mm (range 15 mm–24 mm). The amount of the posterior intact bone enlargement at the quadrilateral surface was 5.3 ± 0.48 mm. **Conclusion:** This less traumatic two-incision exposure is an adequate technique for Bernese PAO, allowing the bone to be cut under direct visual observation and reducing the need to use fluoroscopy.

Keywords: *Bernese periacetabular osteotomy, cadaver, developmental hip dysplasia, Ganz, modified Stoppa*

MeSH terms: *Cadaver, osteotomy, developmental bone disease, developmental disabilities*

Introduction

Developmental hip dysplasia is diagnosed when the femoral head is not sufficiently covered by the acetabulum. Anterior and lateral cover deficiency is seen, as a result a dysplastic hip joint. Bernese periacetabular osteotomy, described by Ganz, is the most popular reorientation osteotomy performed in adolescence, whereas different osteotomies are described for children. This osteotomy leaves the posterior column intact, providing relative stability.[1] The main disadvantages of Bernese periacetabular osteotomy (PAO) are the 2.7% joint penetration rate due to the fact that the quadrilateral surface cannot be seen directly and the residual scarring due to the wide exposure.[2]

Various incision modifications have been developed because of the muscle dissection and wide wound scar in Smith-Peterson incision, which was originally used in Bernese osteotomy.[3-5] Bernstein *et al*. used a double incision technique with a second incision in addition to the standard incision although he failed to report a significant difference compared to the single standard incision.[5] Pajarinen and Hirvensalo report that osteotomy can be performed in a less invasive manner using two incision. First incision was approximately 10 cm of length laterally on the anterior superior spine, the anterior part of the iliac wing, and second low midline incision was made from the symphysis cranially in their clinical study. In their studies, it was also reported that a significant reduction can be achieved using fluoroscopy.[3] It is emphasized in an anatomical study by Bilgili *et al*.[6] that blind ischial and pubic cuts are dangerously close to neurovascular structures and should be performed medially when possible. It was

How to cite this article: Akgul T, Coskun O, Korkmaz M, Gurses IA, Sen C, Gayretli O. A minimally invasive technique using a modified stoppa approach for periacetabular osteotomy: A preliminary cadaveric study. Indian J Orthop 2017;51:687-91.

Address for correspondence:
Dr. Turgut Akgul, Department of Orthopedics and Traumatology, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey.
E-mail: mrtmkz@gmail.com

Access this article online

Website: www.ijoonline.com

DOI: 10.4103/ortho.IJOrtho_204_16

Quick Response Code:

reported that visualizing quadrilateral surface directly is important for the safety of the osteotomy and enables it to be minimally invasive.[4,7] Minimally invasive approach for Bernese PAO has high risk and increased fluoroscopy usage.

In this study, we evaluated the applicability of minimally invasive Bernese PAO and performed with a short spina iliaca anterior superior (SIAS) incision along with a Stoppa incision on the cadaver, with regard to complications and fluoroscopy usage.

Materials and Methods

Ten hemipelvises of five donor cadavers (one female and four males) preserved with a formaldehyde-ethanol-glycerin-phenol solution. Ages of the cadavers ranged between 67 and 83 years. The cadavers were provided by the Body Donation Program of the Department of Anatomy with informed consent from all donors under the procurement, preservation, transfer, and transplantation of human tissues and organs act (number 2238) before their death. Institutional Review Board approval was not needed for cadaveric studies at the institution where the study was performed. The cadavers did not have hip dysplasia and previous hip or abdomen surgery. All procedures were performed on a radiolucent table in a supine position. The first transverse incision was made 2 cm over the pubic symphysis [Figure 1]. Deep dissection was made through fat and superficial fascia to expose both anterior rectus sheaths. The aponeurosis was sharply dissected longitudinally, and the rectus muscle was released partially at the insertion on the pubis. Blunt dissection was performed to reach the quadrilateral surface just over the peritoneum after the rectus muscles were laterally retracted. The anatomical structure of the external iliac artery, vein and obturator neurovascular bundle was examined [Figure 2]. The origin of the obturator internus muscle was dissected from the quadrilateral surface to expose the lower edge of the ischium. The corona mortis was dissected and ligated if it interfered with the approach [Figure 2]. Hohmann retractors were placed in the greater and lesser sciatic notches. Ischium osteotomy was performed with a 30°-angled chisel just parallel to the infracotyloid region observed under fluoroscopy positioned at 30° outlet and 15° iliac views [Figure 3]. The osteotomy was extended through to the sciatic spine.

The second osteotomy was performed leaving at least 5 mm of intact bone in the posterior column from the sciatic spine to the iliopectineal line just 10 mm anterior from the apex of the sciatic notch [Figure 4]. A chisel was used at a 20° oblique angle to prevent joint penetration. A second 3 cm incision was then made between the SIAS and anterior inferior iliac spine avulsion (AIIS). The second skin incision in this modified surgical exposure, a few centimeters lateral to the original surgical exposure, is made along the tensor fascia lata. The membrane of the tensor fascia lata is incised along its fibers, and part of the muscle is retracted laterally. Then, the lateral femoral cutaneous nerve (LFCN), with its surrounding tissues, is

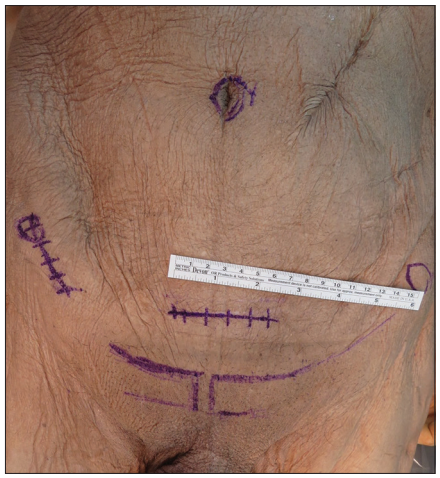

Figure 1: Clinical photograph showing modified Stoppa incision just 2 cm above symphysis pubis

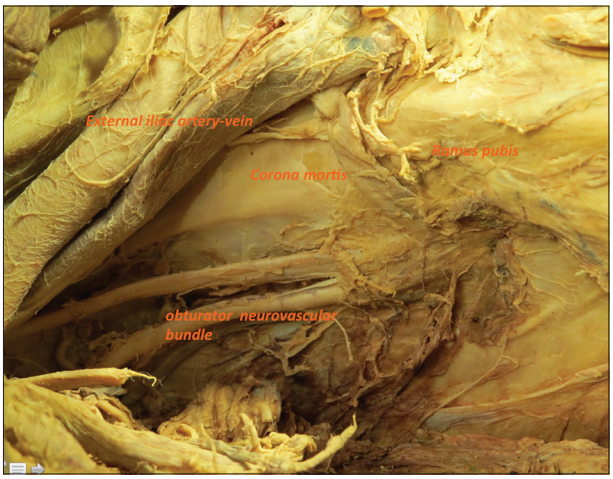

Figure 2: The medial view of the quadrilateral surface and neurovascular bundle and corona mortis

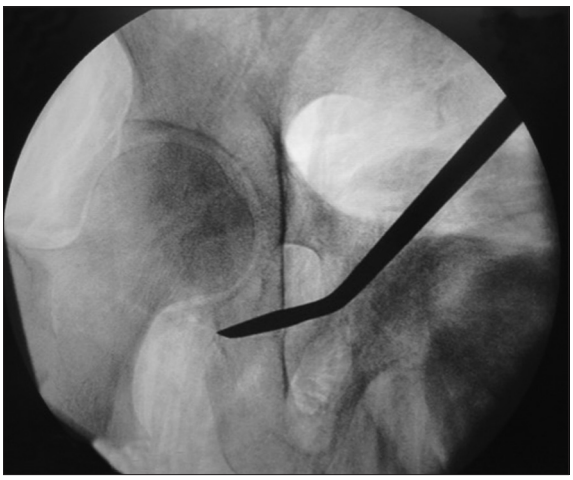

Figure 3: Fluoroscopic view showing the ischial osteotomy at the infracotyloid area controlled by fluoroscopy

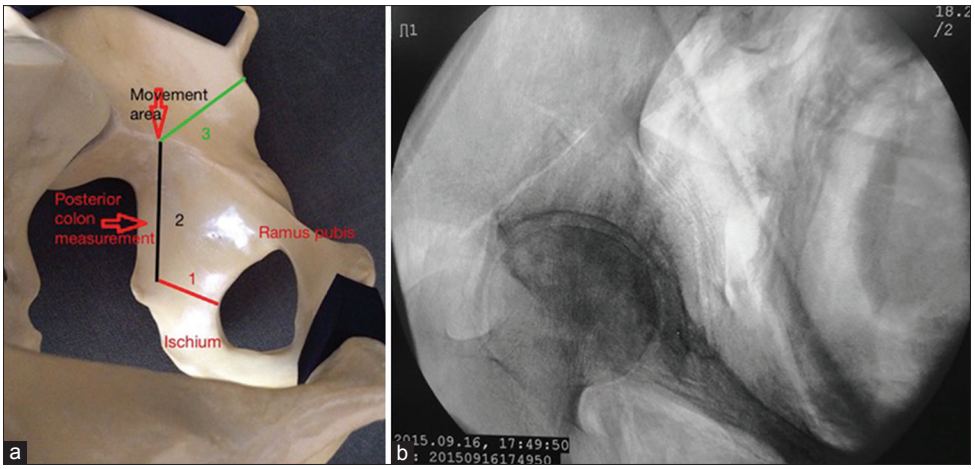

Figure 4: The quadrilateral osteotomy (a) osteotomy line (b) fluoroscopic view

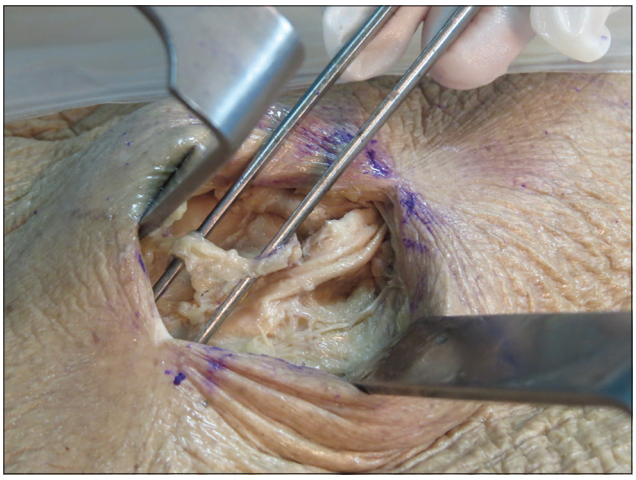

Figure 5: The second incision just over the iliac anterior superior spine for iliac bone osteotomy and lateral femoral circumflex artery dissection

retracted medially [Figure 5]. A small Hohmann retractor was placed under the sartorius and iliacus muscles through to the sciatic notch. Osteotomy was performed just above the rectus femoris insertion. The orientation of osteotomy and merger with the posterior osteotomy was observed under fluoroscopy positioned at 30° inlet, 30° iliac, and 10° rotation views [Figures 6 and 7]. The acetabulum was reorientated using a Schanz screw placed anterosuperior of the acetabulum and a wide chisel placed in the ischial osteotomy line. The chisel was used to distract osteotomy side while using the Schanz pin to place acetabulum laterally and anteriorly. The osteotomy was stabilized with two temporary K-wires; then a minimum of two 4.5 mm cortical screws for stability. The two screws were placed from iliac wing just posterior the SIAS to posteromedial part of the osteotomized acetabulum. One additional screw was placed from just above AIIS to iliac wings [Figure 8]. Changes in the lateral and anterior coverage with the osteotomies were measured on the X-ray. The anterior and lateral movement of the acetabular fragment was measured clinically.

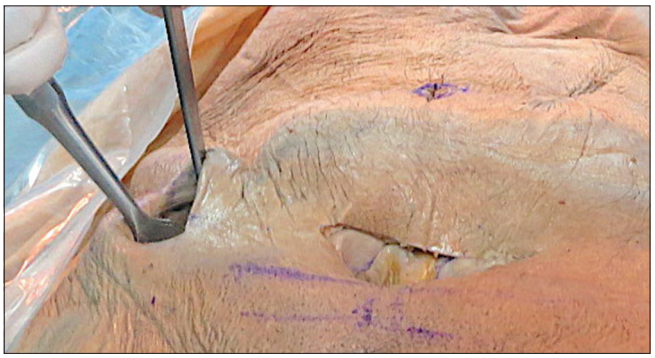

Figure 6: Iliac bone osteotomy clinical view

Results

The mean anterior coverage, calculated by center edge angle, was increased from 22.8° ± 2.8 (20° min–28° max) preoperatively to 44.1° ± 3.7 (36° min–48° max). The displacement of the osteotomy at the iliopectineal line calculated on iliac inlet view radiographs was 22.1 ± 3.4 mm (15 mm min–26 mm max). The clinical amount of the anterior displacement on the cadavers was 17.8 ± 3.35 mm (11 mm–21 mm) and lateral displacement was 20.3 ± 3.23 mm (15 mm–24 mm). The amount of the posterior intact bone enlargement at the quadrilateral surface was 5.3 ± 0.48 mm.

The lateral displacement of the osteotomy measured clinically has a high correlation with lateral coverage of the acetabulum ($R = 0.66462$, $P = 0.036$). There is no correlation with lateral coverage and radiological measurement of displacement ($R = -0.117652$, $P = 0.74617$).

The corona mortis artery was ligated in four out of ten hemipelvises before starting the osteotomy. After osteotomy, hip joint visualization showed that there was no fracture or implant penetration and neurovascular structures were anatomically intact. The tension on obturator and LFCNs was increased with acetabular displacement. The osteotomy line performed on the

quadrilateral surface was done crossing obliquely with the obturator nerve.

Discussion

Periacetabular reorientation osteotomy is a widely used treatment option in young patients with hip dysplasia.[1,8,9] The most commonly performed PAO is Bernese osteotomy, which is stable due to the preservation of the posterior column of the quadrilateral surface without pelvic discontinuity and reshaping. In this procedure, an intraarticular chisel penetration may occur accidentally because the position of the hip cannot be confirmed by direct observation, even if the osteotomy site is checked with an image intensifier. Although the risk of penetration was 2.7% according to reports by experienced senior authors, the rate of complication could be higher in the hands of inexperienced orthopedists.[1,2] Performing Bernese PAO with direct observation of the quadrilateral surface can reduce joint penetration and total amount of radiation.

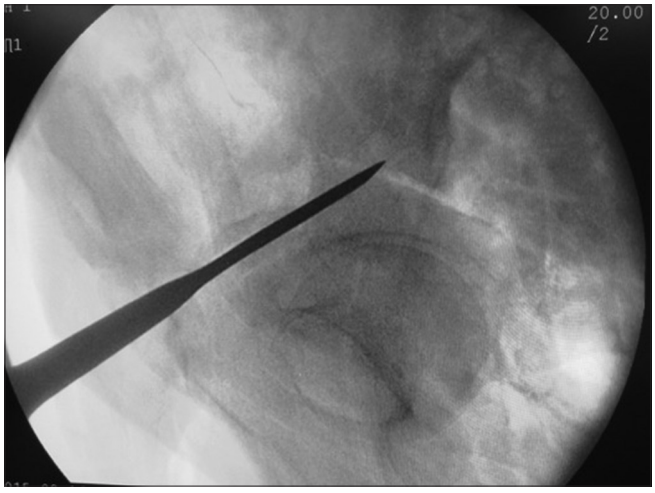

Figure 7: Iliac bone osteotomy fluoroscopic view

Shiramizu *et al*. reported that the safe zone between the acetabulum posterior wall and posterior aspect of the quadrilateral space was 15.4 ± 3.9 mm.[2] According to this measurement, we performed quadrilateral osteotomy starting at the spina ischiadica toward the iliopectineal area leaving 10 mm of intact bone in the posterior aspect of the posterior column. A 20° angled osteotomy was performed in the axial plane of the hip joint. Shiramizu, at this point, suggested the chisel insertion angle should be 25° to the quadrilateral surface in their curve-shaped osteotomy.[10] Stoppa approach allows for direct visualization of the quadrilateral surface and osteotomy can be performed without the use of fluoroscopy. Stoppa approach is used routinely with high success rates for acetabular fracture for it provides clear acetabular access and direct visualization of the quadrilateral space.[11]

The pubic osteotomy carries some potential risks for neurovascular injury as reported before with the standard approach. Furthermore, Kinoshita *et al*. reported that pubic osteotomy is located very close to the obturator artery, the distance measured as 1.8–3.3 mm vertically. Authors suggested angled osteotomy or caudocranial osteotomy to prevent vascular injury.[12] In our study, it was seen that the obturator artery was placed just inferior to the pubic osteotomy side as reported before. We used a chisel angled 20° medially on the axial plane and caudocranially; otherwise, there is a potential risk of injury to the obturator artery. The other anatomical structure potentially at risk is the corona mortis, which is seen in 30% of the general population. In our study, this variation was found in four

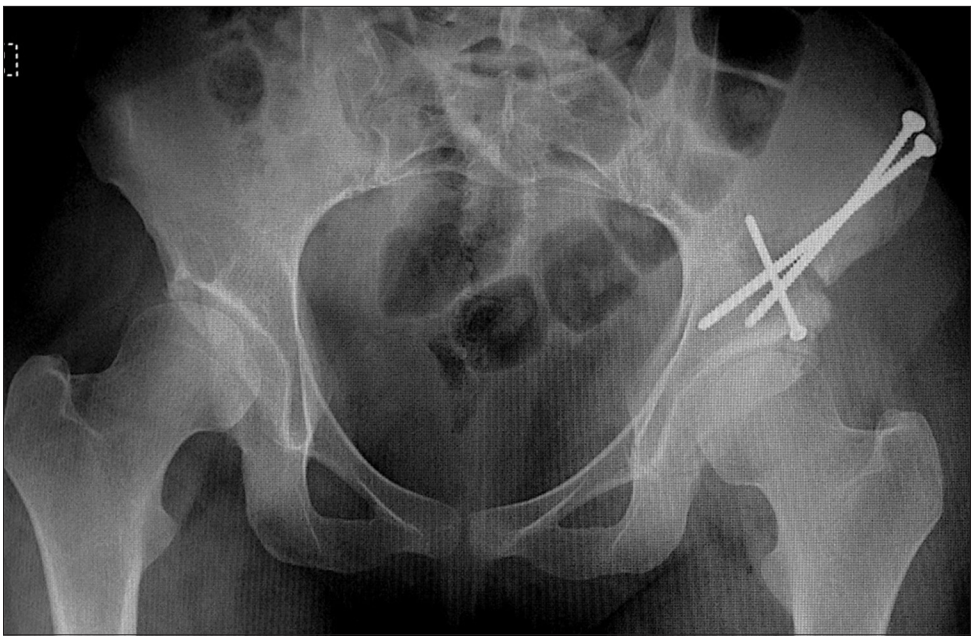

Figure 8: The radiograph of pelvis with both hip joints anteroposterior view showing the screw position after osteotomy

out of ten hemipelvises located near the osteotomy side and all were ligated.

Although there is a potential risk of injury to the obturator artery with ischial osteotomy, Kamada *et al*. presented that the mean distance between the obturator artery and the ischial osteotomy site was 35.6 ± 7.5 mm and always exceeded 20 mm.[13] Furthermore, we realized that the obturator artery was under risk at the proximal of quadrilateral posterior osteotomy more so than in ischial osteotomy. In our study, we used an image intensifier to locate the ischial osteotomy. The best positions for the fluoroscope are 30° outlet and 15° iliac views. The disadvantage of Stoppa approach is that it requires retraction of the obturator artery. Obturator neurovascular bundle is very close to the second osteotomy line just inferior the iliopectineal line. Surgeon should be aware of these structures when performing quadrilateral osteotomy.

The other main problem with the Smith-Peterson incision is postoperative scarring and excessive soft tissue dissection.[3,5] It is well documented that soft tissue healing is better after Stoppa approach compared to other longitudinal incision. The other main problem with the Smith-Peterson incision is the risk for LFCN neuropraxia. In our study, we performed iliac osteotomy after the LFCN was retracted and protected it without detachment of the muscle. In the standard Smith-Peterson approach, excessive traction or direct compression to the nerve by retractors is thought to be the main factors contributing to blood flow reduction, which is related to LFCN dysfunction.[14] Although the LFCN was kept anatomically intact, avoided direct trauma and excessive traction, we have found postoperatively that function of the LFCN was undisturbed.

There are no data in the literature about the usage time of fluoroscopy. It is well known that Bernese osteotomy requires routine fluoroscopic inspection, especially during ischial and quadrilateral surface osteotomies. The usage time of fluoroscopy could be longer in minimally invasive surgery or if performed by an inexperienced surgeon. In our study, fluoroscopic usage was limited to ischial osteotomy, calculation of acetabular coverage, and screw placement.

The limitation of the study is that the osteotomy was performed on a small group of cadavers fixed in formaldehyde. This study comprises a preliminary report presenting that this modified surgical approach is promising, but clinical studies are required before adapting this technique routinely.

The surgical approach we performed has been used for comminuted acetabular and pelvic fractures but has not been used routinely for PAO so far. This less traumatic two-incision exposure is adequate, allowing the bone to be cut under direct visual observation and reducing the use of fluoroscopy.

Conclusion

The surgical approach we performed has been used for comminuted acetabular and pelvic fractures but has not been used routinely for PAO so far. This less traumatic two-incision exposure is adequate, allowing the bone to be cut under direct visual observation and reducing the use of fluoroscopy.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Ganz R, Klaue K, Vinh TS, Mast JW. A new periacetabular osteotomy for the treatment of hip dysplasias. Technique and preliminary results. Clin Orthop Relat Res 1988;232:6-36.
2. Shiramizu K, Naito M, Asayama I, Yatsunami M. A quantitative anatomic characterization of the quadrilateral surface for periacetabular osteotomy. Clin Orthop Relat Res 2004;418:157-61.
3. Pajarinen J, Hirvensalo E. Two-incision technique for rotational acetabular osteotomy: Good outcome in 35 hips. Acta Orthop Scand 2003;74:133-9.
4. Wall EJ, Kolata R, Roy DR, Mehlman CT, Crawford AH. Endoscopic pelvic osteotomy for the treatment of hip dysplasia. J Am Acad Orthop Surg 2001;9:150-6.
5. Bernstein P, Thielemann F, Günther KP. A modification of periacetabular osteotomy using a two-incision approach. Open Orthop J 2007;1:13-8.
6. Bilgili F, Gürses IA, Ökaya U, Gayretli Ö, Parmaksizoglu AS, Cetiner Kale A. Ischial and pubic osteotomies performed by medial approach during periacetabular osteotomies: An anatomical study. Acta Orthop Traumatol Turc 2013;47:43-7.
7. Inan M, Gokce A, Ustunkan F. Endoscopy-assisted periacetabular osteotomy: A preliminary cadaveric study. Clin Orthop Relat Res 2008;466:862-70.
8. Clohisy JC, Barrett SE, Gordon JE, Delgado ED, Schoenecker PL. Periacetabular osteotomy in the treatment of severe acetabular dysplasia. Surgical technique. J Bone Joint Surg Am 2006;88 Suppl 1 Pt 1:65-83.
9. Davey JP, Santore RF. Complications of periacetabular osteotomy. Clin Orthop Relat Res 1999;363:3-7.
10. Shiramizu K. Curved periacetabular osteotomy for the dysplastic hip: Cadaveric and radiological analyses of safe procedures. J Orthop Traumatol 2003;4:55-60.
11. Isaacson MJ, Taylor BC, French BG, Poka A. Treatment of acetabulum fractures through the modified Stoppa approach: Strategies and outcomes. Clin Orthop Relat Res 2014;472:3345-52.
12. Kinoshita K, Naito M, Shiramizu K, Shiramizu K, Kamada S. Prevention of obturator artery injury during pubic osteotomy in periacetabular osteotomy. Curr Orthop Pract 2011;22:171-5.
13. Kamada S, Naito M, Shiramizu K, Nakamura Y, Kinoshita K. Is the obturator artery safe when performing ischial osteotomy during periacetabular osteotomy? Int Orthop 2011;35:503-6.
14. Kiyama T, Naito M, Shiramizu K, Shinoda T, Maeyama A. Ischemia of the lateral femoral cutaneous nerve during periacetabular osteotomy using Smith-Petersen approach. J Orthop Traumatol 2009;10:123-6.