

Early Clinical Results of Surgical Treatment of Patients with Femoroacetabular Impingement

Desimir Mladenović^{1,2}, Zoran Andjelković³, Zoran Vukašinović^{4,5}, Milorad Mitković^{1,2}, Saša Milenković^{1,2}, Ivan Micić^{1,2}, Marko Mladenović¹

¹Orthopedics and Traumatology Clinic, Clinical Center, Niš, Serbia;

²Faculty of Medicine, University of Niš, Niš, Serbia;

³Department of Orthopedics and Traumatology, General Hospital, Leskovac, Serbia;

⁴Institute for Orthopedic Surgery "Banjica", Belgrade, Serbia;

⁵School of Medicine, University of Belgrade, Belgrade, Serbia

SUMMARY

Introduction Surgical treatment is the treatment of choice in patients with symptoms and radiological signs of femoroacetabular impingement.

Objective Our experience and early results of surgical treatment of patients with signs of femoroacetabular impingement and early hip osteoarthritis are reported.

Methods The results of treatment of 21 patients aged 23-54 years with different types of femoroacetabular impingement are presented. Safe open surgical dislocation of the hip was performed in all patients. Before and after surgery, the WOMAC score was performed, clinical and radiographic data of the operated hips were evaluated and t-tests were used for statistical analyzes of data.

Results The WOMAC score improved from 70.5 points (range 56.3 to 89.8 points) to 90.3 points (range 70.3 to 100 points) at one year of follow-up ($p < 0.0001$), anterior impingement test was negative in all operated cases, average hip internal rotation improved significantly, no complications were found, except trochanteric nonunion at the site of osteotomy, which was reattached.

Conclusion Postoperative results have shown that the surgical approach to treating patients with femoroacetabular impingement is the method of choice. Three operated patients, with advanced osteoarthritis of the hip, had to be converted to total hip replacement.

Keywords: femoroacetabular impingement; open surgery; early results

INTRODUCTION

Femoroacetabular impingement (FAI) is a pathophysiological entity developed as a result of abnormal bone morphology of the acetabulum and femoral head, which causes groin pain in young adults and leads to early hip osteoarthritis [1-7].

Minimal and abnormal bone changes of the proximal femur and /or acetabulum are the primary pathologic substrate of FAI. None-spherical femoral head-neck junction, abnormal bone changes that produce cam-type FAI, are described as a pistol grip [8] or tilt deformity [1]. The non-spherical, anterosuperior femoral head-neck junction underlines the acetabular labrum, pressuring and squeezing the cartilage adjacent to the acetabular labrum, leaving the acetabular labrum itself initially intact and causing the separation of the articular cartilage from the labrum and subchondral bone, which, in advanced cases, represents early degenerative changes of the hip [4, 9, 10]. Extensive significant articular cartilage damage occurs first, while the labrum lesions are secondary, which is why pain occurs later. Therefore, the cam-type FAI is considered as a malignant form of impingement.

Excessive localized or generalized femoral head over coverage in acetabular retroversion

[11], in coxa profunda protrusio acetabuli [12] and less frequently a malrotated acetabular bone fragment in periacetabular osteotomy [9, 13], are acetabular abnormal bone changes which produce the pincer-type FAI. The former femoral head over coverage in the pincer-type FAI acts as a barrier to internal rotation and flexion of the hip impinging the anterosuperior aspect of the femoral neck to the anterior margin of the acetabular edge damaging the acetabular labrum along with a narrow strip of the adjacent acetabular cartilage and creating a hinge mechanism in which the femoral head is being lifted from the acetabulum, and impacts the posteroinferior acetabular cartilage, creating, the so called counter-coup acetabular cartilage damage [14]. Acetabular cartilage damage is circular, located close to its edge, in the form of narrow bands adjacent to the damaged acetabular labrum. These changes are in the form of degeneration, thinning, rupture or even the lack of labrum in the zone of maximum impact. Often, the labrum is ossified, thus further deepening the already deep acetabulum, further reducing the distance between the acetabular edge and femoral neck and thereby exacerbating the impingement mechanism. In the pincer-type FAI, acetabular labrum lesion is dominant, which produces earlier pain in patients with this form of FAI.

Correspondence to:

Desimir MLADENOVIĆ
Bulevar dr Zorana Đinđića 73/29
18000 Niš
Serbia
mladenovicmarko@gmail.com

OBJECTIVE

The aim of this study was to present our experience in surgical treatment of patients with femoroacetabular impingement and early clinical and radiological results of surgical treatment in this group of patients.

METHODS

Open surgical dislocation of the hip, as the method of choice, were conducted by senior authors in 21 patients with FAI between 2008 and 2011 at our hospital. There were 16 females (77%) and 5 males (23%) with an average age of 38.7 years (range 23 to 54). Eight patients (38%) had the cam-type FAI, one patient (4.7%) had the pincer-type FAI and twelve patients (57.3%) had a mixed form of FAI. The right side was involved in 11 (53%) and the left side in 10 patients (47%).

Clinical method

The dominant symptom of all operated FAI patients were anterior groin pain during flexion activities such as sitting and squatting and positive impingement test in all patients [4]. Clinical results were graded with the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [6], which was measured preoperatively and one year postoperatively.

Radiographic method

The radiographic assessment was based on the pre- and postoperative measurements of the following parameters on the antero-posterior and lateral radiograms of the hips: Tönnis angle [15], center-edge angle of Wiberg [16], the presence of acetabular retroversion (cross-over sign [17] and the posterior wall sign [11]), femoral neck-shaft angle [18], anterior femoral head-neck offset [19] and the ala-angle by Nötzli [12]. Hip arthritis degree was graded according to the Tönnis criteria [19].

Operative method

The indications for the surgical treatment of FAI were as follows: more than one year duration of symptoms, 2-3 months without response to conservative treatments, positive impingement test and radiographic signs of FAI during the examination. Lateral incision and greater trochanteric flip osteotomy were used to dislocate and debride the hip [20, 21]. In 21 hips, anterior "Z" capsulotomy, surgical dislocation of the hip, and debridement of the hip pathology were done.

The integrity of the acetabular labrum lesion was assessed and classified as a labral tear, degeneration, detachment, calcification or labral absence. The size, character,

and location of the acetabular cartilage damage were graded according to the Outerbridge grading system of hondral lesions [22]. Labral and acetabular cartilage lesions were described using the clock classification system [7, 23]. Damages of the acetabular labrum were located in the anterosuperior acetabular quadrant (12 to 18 o'clock). Labral lesions were resected or reattached (Figures 1 and 2) depending on labral integrity [24, 25]. In 20 of 21 hips, femoral head-neck junction osteochondroplasty was performed to improve femoral head-neck offset. A total amount of bone resection did not exceed 30% of femoral neck thickness (Figure 3) to minimize the risk of femoral neck fracture, so if the diameter of a femoral head-neck junction was 50 mm intraoperatively, a 15 mm deep osteochondroplasty (30% resection) in the anterolateral quadrant was the very highest limit of resection [24-27]. A relative femoral neck lengthening was performed by moving the greater trochanter more distally at the time of reattachment and then debriding the residual bone from the medial aspect of the remaining greater trochanter and from the base of the femoral neck. The greater trochanter was reattached with two cortical screws.

Estimated blood loss was on the average 370 ml (range 120 to 1200 ml). The patients were hospitalized for an average of four days. Anticoagulation included the administration of low molecular heparin during hospital stay and then salicylates for six weeks after hospital discharge. A



Figure 1. Resected acetabular labrum

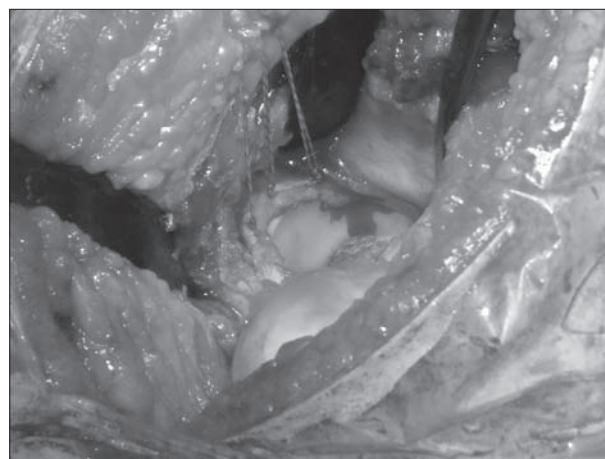


Figure 2. Acetabular labrum reattached by three anchor sutures



Figure 3. Performed femoral head-neck junction osteochondroplasty

partial weight-bearing with two crutches was encouraged for six weeks, and then full weight-bearing was allowed with one crutch or a cane.

Statistical method

Strength of statistical tests was set at 80% with a possible beta error of 0.20, and the level of significance of the test with a margin of error in the conclusion of less than 5% so that the null hypothesis was rejected if $p < 0.05$. Normality of distribution of the parametric data was checked using the Kolmogorov-Smirnov test. A paired two-way t-test was used to test the significance in difference of arithmetic means. All obtained data were analyzed using a computer program for statistical data analysis (SPSS 8 for Windows).

RESULTS

The anterior impingement test was negative in all remaining operated cases at the last follow-up. The average hip internal rotation improved from the preoperative value of 13.5° (range 0° to 25°) to 31.5° (range 20° to 45°) at one year of follow-up ($p < 0.0001$).

WOMAC score average improved from the preoperative value mean 70.5 points (range 56.3 to 89.8 points) to 90.3 points (range 70.3 to 100 points) at one year of follow-up ($p < 0.0001$). Three (14%) of twenty-one hips, all in female patients, were considered far because of pain/ or progressive hip arthritis. These hips were converted to a total hip arthroplasty three years after open hip dislocation surgery. At the time of the arthrotomy, all three hips were found to have severe delamination of the acetabular articular cartilage (Outerbridge grade IV).

Preoperative radiographic results showed a mean of 8.2° (range 6° to 17°) of Tönnis angle (normal value $< 15^\circ$), which was higher than 15° in two cases. The mean center-edge angle of Wiberg (normal value $> 20^\circ$), a helpful measure of femoral head over coverage, was 36.2° (range 26° to 50°). The cross-over and posterior wall signs were observed in five cases. The mean femur neck-shaft an-

gle (normal range 120° to 140°) was 132.1° (range 118° to 142°), in one case it was less than 120° , and in another one it was over 140° . The anterior head neck offset (normal range 8.2 mm), was 10.2 mm (range 6.5-18.1 mm) on the average and less than 8 mm in three cases. The mean of alpha angle of Nötzli was 64.8° (range 54° to 92°) on the anteroposterior view, and 54.6° (range 50° to 64°) on the lateral view (normal value $< 55^\circ$ on the anteroposterior and 45° on the lateral view).

Preoperatively, 19 acetabular margins were retroverted. Os acetabuli [28, 29] was seen on the radiographs of two hips. Postoperatively, the anterior head-neck offset was 12.4 mm (range 8.2 to 18.1 mm). The mean of alpha angle of Nötzli on the anteroposterior radiograms was 45.2° (range 40° to 51°) and on Dunn 90 views it was 35.7° (range 34° to 44°).

Tönnis osteoarthritis grade index was 0 in six hips, grade 1 in ten hips, grade 2 in two hips, and grade 3 in three hips. The osteoarthritis grade did not progress in thirteen of the twenty-one hips. There was one Tönnis grade of progression in eight hips.

Intraoperatively, of 21 hips 18 (86%) had an abnormal labrum: 9 labrums were detached, 3 were torn, one degenerated and 5 labrums were calcified. Twelve of these labrum damages were reattached with anchor suture, and six labrums were partially resected with an antero-superior acetabular margin resection osteoplasty. In five cases of anterior femoral head over coverage, anterior acetabulum edge osteotomy was done after acetabular labrum mobilization and then the labrum was reattached with one to three anchor sutures.

Specific treatment of damaged acetabular articular cartilage varied over the course of the study period. From seven hips with Outerbridge grade III or IV cartilage delamination, six underwent resection of the delaminated articular cartilage and either micro fracture of the acetabular subchondral bone (one hip) or without specific osseous treatment (other hips). Acetabular labrum or underlying articular cartilage damage was located in the anterosuperior acetabular quadrant in the area of the femoral head-neck junction abutment against the acetabulum, on the articular side.

There were no complications, such as femoral head vascular necrosis or early and late infection developed at the last follow-up. However, there were two cases of trochanteric site osteotomy nonunion, which were reattached.

DISCUSSION

Femoroacetabular impingement has been proposed as the major etiological factor in the development of hip osteoarthritis [1-8, 29, 30]. Treatment of FAI is focused on the relief of femoroacetabular abutment and repair or debridement of damaged chondro-labral tissue.

The femoral head-neck junction abnormality has been noted to be the predictor of the cam and mixed type FAI [14]. The non-spherical femoral head, as seen on the antero-posterior and lateral hips radiograms, has been

described as a pistol-grip deformity and correlated, over the years, with idiopathic osteoarthritis [10, 28, 31]. The subclinical slipped capital femoral epiphysis has been suggested as a possible cause of this deformity and thus of secondary osteoarthritis [1, 31, 32].

The surgical treatment of cam-type FAI is directed at restoring femoral head-neck offset by debriding osteochondral prominence at the femoral head-neck junction and debriding or attempting to repair an acetabular labrum damage and acetabular articular cartilage delamination. The acetabular or pincer-type of impingement with an anterior acetabular edge pathology is treated by labrum resection and/or refixation simultaneously with femoral head-neck junction trimming.

The technique of safe surgical dislocation developed by Ganz et al. [20] preserves femoral head blood supply and allows a direct visualization of 360° circumference of acetabular pathology. Our results confirm that surgical dislocation of the femoral head is a safe technique that does not appear to jeopardize the vascularity of the femoral head, as postoperatively we did not observe any cases of femoral head avascular necrosis. The optimum treatment of severe acetabular chondral injury (Outerbridge grade III or IV) is unknown. We performed excision of delaminated articular cartilage with an underlying bone, followed by labral advancement to the newly created anterior aspect of the acetabular rim. The improvement of clinical signs and function after open FAI treatment has been documented by other authors; Beck et al. [11] reported that 14 men and five women with a mean age of 36 years (range 21-52 years) were treated with a surgical dislocation and offset creation of the hip. The follow-up averaged 4.7 years (range 4-5.2 years). Using the Merle d'Aubigne hip score, 13 hips were rated excellent to good, with the pain score improving from 2.9 points to 5.1 points at the latest follow-up. There was no avascular necrosis of the femoral head. Five of the 19 patients, two with grade 2 osteoarthritis, two with grade 1 osteoarthritis but with severe acetabular cartilage damage, and one with untreated ossified labrum underwent a subsequent total hip arthroplasty (THA). Peters et al. [29] pointed out that the average Harris hip score improved from a preoperative value of 70 points (range 20-81 points) to 88 points (range 49-100 points) at one year ($p < 0.0001$). Four (13%) of 30 hips,

all in female patients, were considered failures because of pain and/or progressive arthrosis. Three of these hips were converted to a total hip arthroplasty because of clinical failure. At the time of arthrotomy, all three were found to have severe delamination of the acetabular articular cartilage (Outerbridge grade IV). The fourth hip with a failure had radiographic signs of progressive arthrosis. Espinosa et al. [24] concluded that at one year postoperatively, there was a significant improvement in clinical scores mainly pain, in the group of labral resection and labral refixation 80% of the hips had an excellent result, 14% had a good result, and 6% had a moderate result. But there were no published reports of using the WOMAC score in evaluating pre- and postoperative clinical results in the operated FAI group of patients. In our report, of 21 patients treated with surgical dislocation of the hip, we noted improvement in the WOMAC score from 70.5 to 90.3 points ($p < 0.0001$), and internal rotation from 13.5° to 41.5° ($p < 0.0001$) at one year follow-up.

Peters et al. [29] reported their results; four of the 30 hips (13%) required a total hip arthroplasty. Our results confirmed their results; three of 21 hips (11.5%) were converted to a total hip arthroplasty three years after open hip surgery. In our group trochanteric site osteotomy nonunion occurred as a complication in two cases (9%).

CONCLUSION

In summary, open surgical treatment, as a method of choice, for all type of FAI in young adult hips without substantial femoral head neck osteochondral prominence and acetabular labrum and hyaline cartilage damage, experienced reduced pain and improved function of the hips with a low complication rate. In the cases of advanced osteoarthritis, open treatment of femoroacetabular impingement was certainly not warranted.

ACKNOWLEDGEMENT

This paper was supported by the grants III 41017 and III 41004, Ministry of Education, Science and Technological Development of the Republic of Serbia.

REFERENCES

- Murray RO. The etiology of primary osteoarthritis of the hip. *Br J Radiol.* 1965; 38:810-24.
- Solomon L. Patterns of osteoarthritis of the hip. *J Bone Joint Surg.* 1976; 58:176-83.
- Tönnis D, Heinecke A. Acetabular and femoral anteversion: relationship with osteoarthritis of the hip. *J Bone Joint Surg Am.* 1999; 81:1747-70.
- Ganz R, Parvizi J, Beck M, Leuning M, Notzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. *Clin Orthop Relat Res.* 2003; 413:112-20.
- Wagner S, Hofstetter W, Chiquet M. Early osteoarthritic changes of human femoral head cartilage subsequent to femoro-acetabular impingement. *Osteoarthritis Cartilage.* 2003; 11:508-18.
- Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt JW. Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. *J Orthop Rheumatol.* 1988; 1:95-108.
- Beck M, Kalhor M, Leuning M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoro-acetabular impingement as a cause of early osteoarthritis of the hip. *J Bone Joint Surg.* 2005; 87:1012-8.
- Harris WH. Etiology of osteoarthritis of the hip. *Clin Orthop Relat Res.* 1986; 213:20-33.
- Myers SR, Eijer H, Ganz R. Anterior femoro-acetabular impingement after periacetabular osteotomy. *Clin Orthop Relat Res.* 1999; 363:93-9.
- Ito K, Minka MAII, Leuning M, Werlen S, Ganz R. Femoro-acetabular impingement and the cam-effect: A MRI-based quantitative anatomical study of the femoral head neck offset. *J Bone Joint Surg.* 2001; 83:171-6.

11. Beck M, Leuning M, Parvizi J, Boutier V, Wyss D, Ganz R. Anterior femoro-acetabular impingement: Part II. Midterm results of surgical treatment. *Clin Orthop Relat Res.* 2004; 418:67-73.
12. Nötzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg.* 2002; 84:556-60.
13. Siebenrock KA, Schoeniger R, Ganz R. Anterior femoro-acetabular impingement due to acetabular retroversion: treatment with periacetabular osteotomy. *J Bone Joint Surg Am.* 2003; 85:278-86.
14. Parvizi J, Leuning M, Ganz R. Femoroacetabular impingement. *J Am Acad Orthop Surg.* 2007; 15(9):561-70.
15. Tönnis D. Normal values of the hip joint for the evaluation of x-rays in children and adults. *Clin Orthop.* 1976; 119:39-47.
16. Wiberg G. Studies on dysplastic acetabular and congenital subluxation of the hip joint. *Acta Orthop Scand.* 1939; 83(Suppl 58):7-38.
17. Reynolds D, Lucas J, Klauw K. Retroversion of the acetabulum. A cause of hip pain. *J Bone Joint Surg.* 1999; 81:281-8.
18. Paley D. Normal lower limb alignment and joint orientation. In: *Principles of Deformity Correction.* New York: Springer-Verlag; 2003. p.1-19.
19. Tönnis D, Heinecke A, Nienhaus R, Thiele J. Predetermination of arthrosis, pain and limitation of movement in congenital hip dysplasia (author's transl.). *Z Orthop Ihre Grenzgeb.* 1979; 117:808-15.
20. Ganz R, Gill TJ, Gautier E, Ganz K, Krugel K, Berlemann U. Surgical dislocation of the adult hip. A technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg.* 2001; 83:1119-24.
21. Gautier E, Ganz K, Krugel N, Gill T, Ganz R. Anatomy of the medial femoral circumflex artery and its surgical implications. *J Bone Joint Surg.* 2000; 82:679-83.
22. Outerbridge RE. The etiology of chondromalacia patellae. *Clin Orthop Relat Res.* 2001; 389:5-8.
23. Leuning M, Werlwn S, Ungersbock A, Ito K, Ganz R. Evaluation of the acetabular labrum by MR arthrography. *J Bone Joint Surg.* 1997; 79:230-4.
24. Espinosa N, Rothenfluh DA, Beck M, Ganz R, Launig M. Treatment of femoro-acetabular impingement: preliminary results of labral refixation. *J Bone Joint Surg Am.* 2006; 88:925-35.
25. Peters CL, Erickson JA. Treatment of femoro-acetabular impingement with surgical dislocation and debridement in young adults. *J Bone Joint Surg Am.* 2006; 88:1735-41.
26. Mardones MR, Gonzales C, Chen Q, Zobitz M, Kaufman KR. Surgical treatment of femoroacetabular impingement: evaluation of the effect of the size of the resection. *J Bone Joint Surg Am.* 2005; 87:273-8.
27. Lavigne M, Parvizi J, Beck M, Leuning M, Siebenrock KA, Ganz R, et al. Anterior femoro-acetabular impingement. I. Techniques of joint preserving surgery. *Clin Orthop Relat Res.* 2004; 418:61-6.
28. Eijer H, Leuning M, Mahomed MN, Ganz R. Cross-table lateral radiographs for screening of anterior femoral head-neck offset in patients with femoro-acetabular impingement. *Hip International.* 2001; 11:37-41.
29. Peters CL, Erickson JA. The etiology and treatment of hip pain in the young adult. *J Bone Joint Surg Am.* 2006; 88:20-6.
30. Maheshavari VA, Malik A, Dorr DL. Impingement of the native hip joint. *J Bone Joint Surg Am.* 2007; 89:2508-18.
31. Stulberg SD, Cordell LD, Harris WH. Unrecognized childhood hip disease: a major cause of idiopathic osteoarthritis of the hip. In: *Hip: Proceedings of the Third Open Scientific Meeting of the Hip Society.* St. Louis: C.V.Mosby; 1975. p.2112-228.
32. Solomon L. Patterns of osteoarthritis of the hip. *J Bone Joint Surg.* 1976; 52:176-83.

Рани клинички резултати хируршког лечења болесника са фемороацетабуларним сударом

Десимир Младеновић^{1,2}, Зоран Анђелковић³, Зоран Вукашиновић^{4,5}, Милорад Митковић^{1,2}, Саша Миленковић^{1,2}, Иван Мицић^{1,2}, Марко Младеновић¹

¹Ортопедско-трауматолошка клиника, Клинички центар, Ниш, Србија;

²Медицински факултет, Универзитет у Нишу, Ниш, Србија;

³Одељење за ортопедију и трауматологију, Општа болница, Лесковац, Србија;

⁴Институт за ортопедску хирургију и трауматологију „Бањица“, Београд, Србија;

⁵Медицински факултет, Универзитет у Београду, Београд, Србија

КРАТАК САДРЖАЈ

Увод Хируршко лечење је метода избора у лечењу особа с клиничком сликом и радиографским знацима фемороацетабуларног судара (ФАС).

Циљ рада Циљ рада био је да се прикажу наше искуство и рани резултати хируршког лечења болесника са знацима ФАС и раном артрозом кука.

Методе рада Хируршки је лечен 21 болесник узраста од 23 до 54 године с различитим типовима ФАС. Сви болесници су оперисани отвореном методом са сигурном хируршком дислокацијом кука. Пре и после операције рађен је WOMAC тест, процењени су клинички и радиографски параметри оперисаних кукова, а за статистичку обраду података коришћен је Студентов *t*-тест.

Резултати Резултати на WOMAC тесту су се побољшали

са 70,5 бодова (опсег: 56,3–89,8 бодова) пре операције на 90,3 бода (опсег: 70,3–100 бодова) годину дана касније ($p < 0,0001$). Тест предњег удара је био негативан код свих оперисаних болесника. Побољшан је и просек унутрашње ротације кука код свих оперисаних испитаника. Компликација није било, изузев незарастања места остеотомије великог трохантера који је био поново фиксиран.

Закључак Резултати лечења испитаника са ФАС и артрозом кука показали су да је хируршки приступ код ових болесника метода избора. Код три оперисана болесника лечење је морало да се заврши уградњом тоталне протезе кука, јер су у питању били болесници са унапредовалим обликом артрозе кука.

Кључне речи: фемороацетабуларни судар; хируршко лечење; рани резултати