



Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en



Original article

The Stoppa approach versus the ilioinguinal approach for anterior acetabular fractures: A case control study assessing blood loss complications and function outcomes



M. Elmadağ^a, Y. Güzel^{b,*}, M.A. Acar^c, G. Uzer^a, M. Arazı^d

^a Department of orthopaedics and traumatology, School of medicine, Bezmialem Vakıf university, Adnan Menderes Boulevard (Vatan street), 34093 Fatih, İstanbul, Turkey

^b Department of orthopaedics and traumatology, School of medicine, Campus of Cumhuriyet, Ordu university, 52200 Center/Ordu, Turkey

^c Department of orthopaedics and traumatology, Selçuklu school of medicine, Campus of Alaeddin Keykubat, Selçuk university, 42075 Selçuklu/Konya, Turkey

^d Department of orthopaedics and traumatology, Special Farabi Hospital, Veysel Karani Street, 42075 Selçuklu/Konya, Turkey

ARTICLE INFO

Article history:

Accepted 23 May 2014

Keywords:

Modified Stoppa
 Ilioinguinal
 Acetabulum fractures
 Acetabulum

ABSTRACT

Background: The modified Stoppa approach was introduced to manage fracture of the anterior column instead of the ilioinguinal approach to reduce morbidity. However there is no clinical evidence to confirm its efficiency. Therefore this study was designed to ascertain: (1) if the Stoppa approach versus ilioinguinal allows less blood loss, (2) if functional and radiological results are superior to that of the ilioinguinal approach, (3) if the rate of complication was different.

Hypothesis: The modified Stoppa approach allows less blood loss than the ilioinguinal in management of fractures of the anterior column of the acetabulum.

Patients and methods: Nineteen patients who were treated with the ilioinguinal approach (Group A) at a mean follow-up of 33 months and 17 patients who were treated with the modified Stoppa approach (Group B) at a mean follow-up of 28.9 months were retrospectively reviewed. Patients were called to the final follow-up examination, mean follow-up durations were set and the functional evaluation of patients was made with measurement of range of motion, Harris Hip Scores (HHS), and Merle D'Aubigné score.

Results: Average blood loss was determined at a mean 1170 mL (range, 750–2150 mL) in Group A and at a mean 1110 mL (range, 450–2000 mL) in Group B ($P=0.168$). The mean HHS (group A = 89.4 [73–99] and group B = 88.4 [75–97]) and Merle D'Aubigné scores (group A = 16.8 [13–18] and group B = 16.5 [13–18]) showed no significant difference between the groups ($P=0.169$). At the final follow-up, the mean hip flexion was found to be 106.83 ± 12.47 and the hip extension was 10.33 ± 6.12 in Group A, while these values were 103.71 ± 14.32 and 10.69 ± 8.17 in Group B (NS between groups regarding flexion [$P=0.678$] and extension [$P=0.445$]). The complication rate was 31% in Group A (6 patients) and 23% in Group B (4 patients) ($P>0.05$).

Discussion: Both surgical approaches give successful results in the treatment of acetabular fractures. Contrary to expectations, there was no difference in the amount of bleeding at the wound site from the Stoppa technique, even though it is minimally invasive, compared to the ilioinguinal approach.

Level of evidence: Level III retrospective case control study.

© 2014 Elsevier Masson SAS. All rights reserved.

1. Introduction

Acetabular fractures are difficult to treat regarding the complexity of the anatomical surgery. There is a strong relationship between reduction and treatment success. So, to increase the success, the most fitted surgical approach should be preferred, which will be dominated by anatomical structures [1]. In the choice of an appropriate approach, it is necessary to first carefully examine the type

* Corresponding author. Department of orthopaedics and traumatology, School of medicine, Campus of Cumhuriyet, Ordu university, 52200, Center/Ordu, Turkey.
 Tel.: +90 50 56 99 63 68.

E-mail address: dryg@windowslive.com (Y. Güzel).

of fracture. The approach to be selected should provide a sufficient angle of visualization, allow anatomic reduction, and to permit control of the fracture area. In addition to these queries, the definitive approach is defined by the general health status of the patient and advantages and disadvantages of the approach to be applied [2].

Ilioinguinal and femoral approaches have been used successfully for many years (Fig. 1a and b). Nowadays, although minimal invasive surgery has been popularized with the optimization of anatomic reduction and stability, the aim of the approach to be selected is also to reduce morbidity [3]. To this end, changes have been made to the ilioinguinal approach and different combinations have been described. The modified Stoppa approach was described by Cole and Balhofner in 1994 as causing the least tissue damage. It is currently used successfully in anterior column fractures and increasingly in combinations (Fig. 1c and d) [4,5]. Most surgeons select the surgical approach according to their own experience, but even for these serious injuries minimal morbidity should be aimed and, in that point of view, there are few studies comparing the Stoppa and the ilioinguinal approaches regarding efficiency and security.

Therefore we performed a case control study to determine:

- if the Stoppa approach versus ilioinguinal allows less blood loss;
- if functional and radiological results are superior to that of the ilioinguinal approach;
- if the rate of complication was different.

Our hypothesis was that modified Stoppa approach allows less blood loss than the ilioinguinal in management of fractures of the anterior column of the acetabulum.

2. Patients and methods

2.1. Patients

A retrospective evaluation was made of patients from three different centers who had been treated for an acetabular fracture. The patients included in the study were those who had undergone surgery for an acetabular fracture and had completed at least 1-year follow-up, with a healthy hip joint pre-trauma and had no lower extremity deficit pre-trauma. Exclusion criteria were non-completion of 1 year of follow-up, leaving follow-up, head trauma causing a lengthy period of immobilization and the application of a more extensive approach. Patients with additional preoperative ROM deficiency of the hip, those who did not regularly attend follow-ups, and those who required intensive care monitoring pre- or post-operatively were excluded from the study. Open fractures were also excluded from the study. Thirty-six patients were retrospectively evaluated. Nineteen patients were operated on by a single surgeon with the ilioinguinal approach (Group A). The remaining seventeen patients were operated on by two surgeons with the modified Stoppa approach (Group B). Mean age, mean follow-up period, mechanism of fracture, time to surgery and

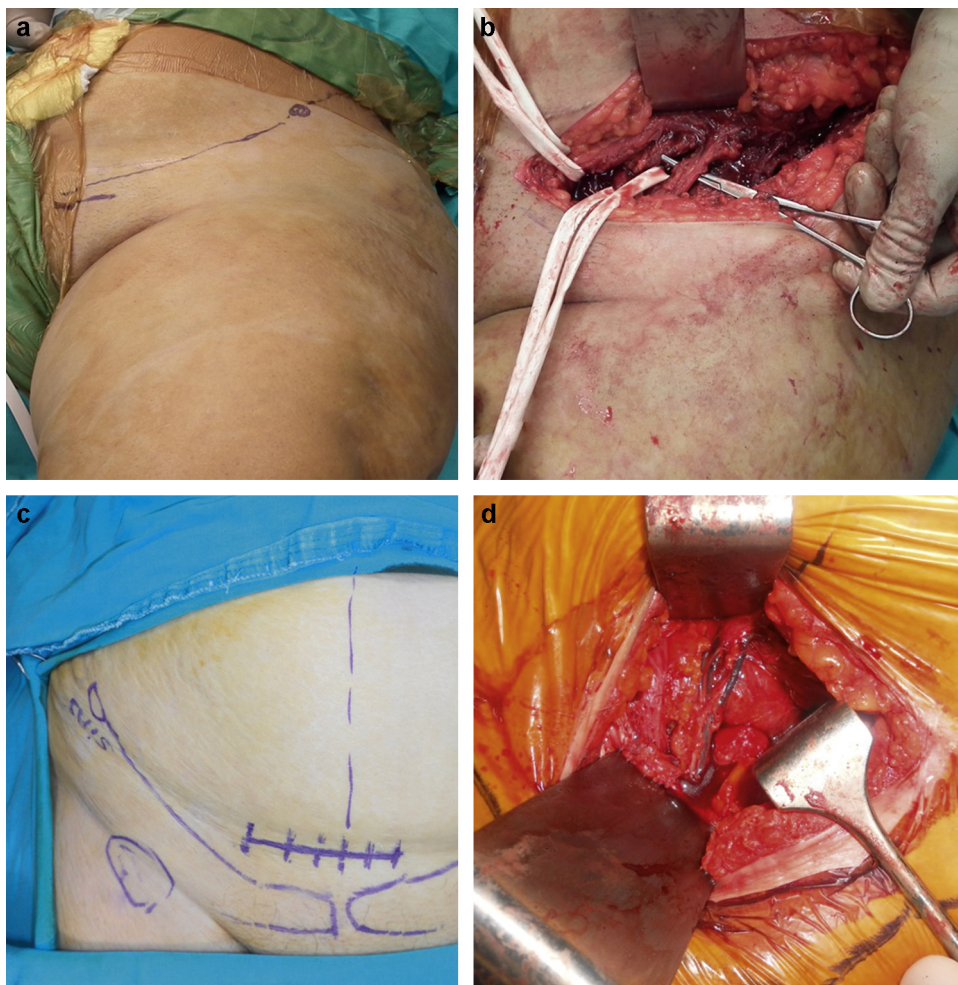


Fig. 1. Features of the dissection. a and b: skin incision and intraoperative view of the ilioinguinal approach, 3 different windows for the ilioinguinal approach are seen. c and d: skin incision and intraoperative view of the modified Stoppa approach, corona mortis is seen.

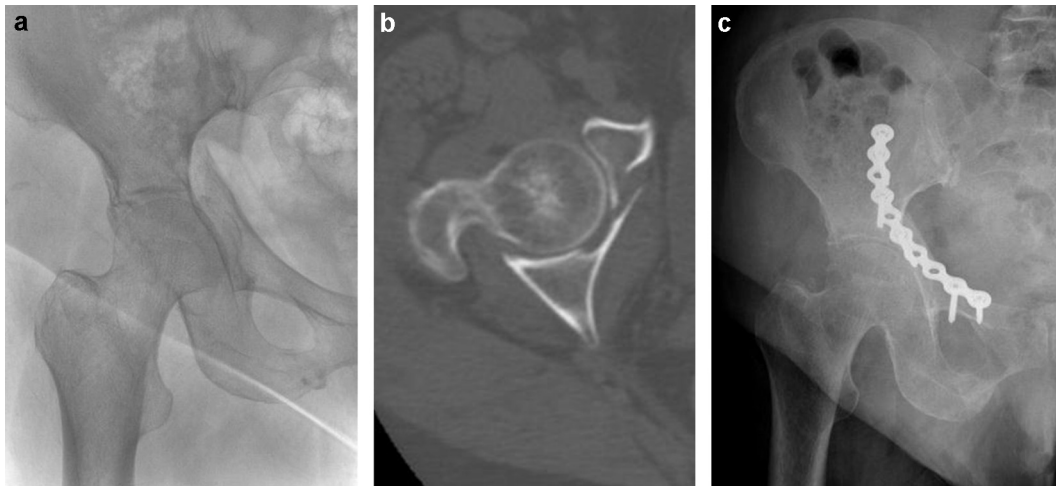


Fig. 2. a and b: preoperative radiograph and CT-scan of a patient undergoing the ilioinguinal approach to treat an anterior column fracture. c: postoperative radiograph showing adequate reduction.

Table 1

Demographic data: Gender, age, mean follow-up, time to surgery and fracture types.

	Group A	Group B	P values
	Ilioinguinal	Stoppa	
Gender F/M	6/13	3/14	$P=0.357$
Age	52.1	49.3	$P=0.209$
Mean follow-up	32.4 months	29.7 months	$P=0.177$
Time to surgery	3.9 days	3.5 days	
Anterior column	13 (68%)	10 (58%)	$P=0.101$
Transverse type	2 (10%)	3 (17%)	
Anterior column + posterior hemitransverse	4 (20%)	4 (23%)	

surgical methods were recorded. The demographic data of the two groups are given in Table 1.

Patients operated on for acetabulum fractures between 2004 and 2011 were retrospectively reviewed and 36 patients with a mean follow-up of 29,6 (24–99) months were included in the study. Nineteen patients were treated with the ilioinguinal approach (Fig. 2a–c) with a mean follow-up of 32,4 months (Group A) and 17 patients were treated with the modified Stoppa approach (Fig. 3a–c) with a mean follow-up of 29,7 months (Group B). The patients were operated on by 3 surgeons (1 professor and 2

attending surgeons) and surgery types were chosen according to the surgeons' experience.

In Group A, the fracture type was anterior column in 13 patients (68%), transverse type in 2 patients (10%) and anterior column + posterior hemitransverse in 4 patients (20%). In Group B, the fracture type was anterior column in 10 patients (58%), transverse type in 3 patients (17%) and anterior column + posterior hemitransverse in 4 patients (23%). In Group A there were concomitant fractures of the femur in 1 patient, L1 vertebra in 1, and distal radius in 1 patient. In Group B, concomitant fractures were tibial in 1 patient, distal radius and scaphoid in 1, humeral neck in 1 patient.

2.2. Surgical method

Fixation of both columns by applying a more extensive approach was not made in any patient. Informed consent was obtained from all the patients. First generation cephalosporin (3 mg/kg) was administered as prophylactic antibiotics. The postoperative protocol was identical for both Group A and Group B. Post-operatively, crutches were used for 6 weeks and then a single crutch for a further 6 weeks. In the first six weeks, weight-bearing was not permitted then patients were allowed partial weight-bearing. Stitches were removed at the end of the second week post-operatively. Active

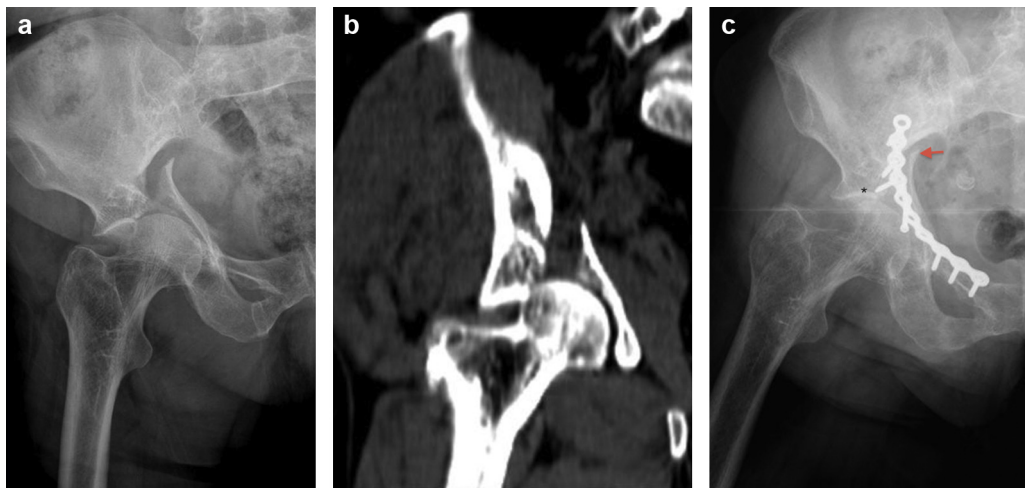


Fig. 3. a and b: preoperative radiograph and CT-scan of a patient undergoing the modified Stoppa approach to treat a transverse fracture. c: postoperative radiograph showing incomplete reduction (arrow) and incomplete correction of congruency (*).

Table 2
Range of motion values, Harris Hip Score and Merle D'Aubigné score.

	Group A	Group B	P values
	Ilioinguinal	Stoppa	
<i>Harris Hip score</i>			
Excellent	11	10	P = 0.169
Good	6	6	
Fair	2	1	
Mean (Min–Max) Harris Hip score at follow-up	89.4 (73–99)	88.4 (75–97)	
<i>Merle D'Aubigné scoring</i>			
Excellent	9	9	P = 0.270
Good	8	6	
Fair	2	2	
Mean (Min–Max) Merle d'Aubigné Hip score at follow-up	16.8 (13–18)	16.5 (13–18)	
Final Hip Flexion	106.83 ± 12.47	103.71 ± 14.32	P = 0.678
Final Hip Extension	10.33 ± 6.12	10.69 ± 8.17	P = 0.445

and passive ROM exercises were started in the early postoperative period.

2.3. Method of assessment

The patients were called to hospital for final follow-up examinations, mean follow-up durations were calculated and the functional evaluation of patients was made with measurement of range of motion (ROM), Harris Hip Scores, and Merle D'Aubigné scores [6,7]. The patients were examined radiologically and clinically by the responsible surgeon. The mean duration from injury to surgery was 3.9 days (range; 2–12 days) in Group A and 3.5 days (range; 2–7 days) in Group B. All the patients underwent open reduction and internal fixation in line with AO principles. Of the patients in Group A, 6 (31%) were female and 13 (69%) were male, and the mean age was 52.1 years. Group B consisted of 3 (17%) females and 14 (83%) males with a mean age of 49.3 years.

Fracture union was evaluated with antero-posterior, obturator oblique and iliac oblique X-rays of the hip until full fracture union was achieved. Functional evaluation of the patients at the final follow-up examination was carried out with goniometric measurement of the hip joint ROM, Harris Hip Score [6] and Merle D'Aubigné [7] scores. All the fractures were classified according to the Judet and Letournel classification [8].

2.4. Statistical analysis

Analysis of the data was performed using SPSS 11.5 (SPSS, Chicago, IL, USA). Descriptive statistics were expressed as means ± standard deviations for continuous variables, while nominal variables were expressed as % values and case numbers. Statistical significance between continuous variables with a normal distribution was analyzed with the Student's *t* test, non normal distribution was analyzed with the Mann-Whitney *U* test and the significance between the groups in terms of gender, complications and implants used was evaluated using Fisher Exact test. The existence of the fractures was analyzed between the groups using Fisher's exact test. A value of $P < 0.05$ was considered statistically significant.

3. Results

Patients were first evaluated in terms of their demographics. No significant differences were observed between the groups in terms of gender ($P = 0.357$), age ($P = 0.209$), follow-up ($P = 0.217$) and fracture types ($P = 0.101$) (Table 1). Blood loss was determined as mean 1170 mL (range, 750–2150 mL) in Group A and as mean 1110 mL (range, 450–2000 mL) in Group B and this was not found to be statistically significant ($P = 0.168$). Corona mortis was seen in all the

Table 3
Complications.

	Group A	Group B
	Ilioinguinal	Stoppa
Soft tissue infection	2	2
Delayed union	2	–
Screw penetration	–	1
Sciatic nerve problem	–	1
Lateral femoral cutaneous nerve injury	2	–

Stoppa approach cases and was noted as 12 venous and 5 arterial (Fig. 1d). The venous cases were cauterized and ligation was applied to the arterial cases using hemo clips. Corona mortis was not recorded in the ilioinguinal approach.

Fracture healing was achieved according to the clinical and radiological evaluation of all patients in the follow-up period. The results in Group A according to HHS scoring were excellent in 11, good in 6 and fair in 2 patients, with a mean Merle D'Aubigné score of excellent in 9, good in 8 and fair in 2 patients. The results in Group B were excellent in 10, good in 6 and fair in 1 patient, with a mean Merle D'Aubigné score of excellent in 9, good in 6 and fair in 2 patients. The mean HHS scores (group A = 89.4 [73–99] and group B = 88.4 [75–97]) and Merle D'Aubigné scores (group A = 16.8 [13–18] and group B = 16.5 [13–18]) showed no significant difference between the groups ($P = 0.169$) (Table 2).

At final follow-ups of the patients, the mean hip flexion was found to be 106.83 ± 12.47 and the extension of the hip was 10.33 ± 6.12 in Group A, while these values were 103.71 ± 14.32 and 10.69 ± 8.17 , respectively, in Group B. Comparing the flexion and extension values there were no significant differences between the two groups (flexion $P = 0.678$, extension $P = 0.445$) (Table 2).

The mean complication rate was 31% in Group A (6 patients) and 23% in Group B (4 patients) ($P > 0.05$) (Table 3). In group A, loss of sensibility secondary to lateral femoral cutaneous nerve injury developed in 2 patients and not recovered. Soft tissue infection developed in 2 patients and was treated with superficial wound debridement and antibiotic therapy. In addition, delayed union was observed in 2 patients in Group A. In Group B, sciatica symptoms developed in 1 patient during fracture reduction of posterior column and recovered after 6 weeks. Soft tissue infection (treated with antibiotic therapy) was observed in 2 patients. In 1 patient the screw place was changed on postoperative day 1 because of articular penetration by screw. At the end of the postoperative 12th week, bone healing was achieved in all patients.

4. Discussion

In this study, the functional results and complications were compared of the modified Stoppa approach and ilioinguinal approach

both of which are used successfully in acetabular fractures. An answer is being sought to the debate as to whether the complication rate and amount of blood loss is minimal if the modified Stoppa is considered to be minimally invasive, compared to the widely-used ilioinguinal approach. In terms of blood loss and complications there was no difference between the ilioinguinal approach and the modified Stoppa approach.

The main limitations of the study were that it was retrospective and that the number of patients in each of the 2 groups was limited. Fractures of the acetabulum are rarely seen. As they result from severe trauma, many patients need to be admitted in an intensive care unit for a long time and there are additional injuries such as head trauma. The study included acetabulum anterior column, transverse type and fractures of both columns, selected for treatment with the anterior approach. Patients with posterior column fractures including anterior fixation and additional injuries were excluded from the study so as not to affect the study results. For all these reasons, the group numbers were reduced.

Compared to other fractures, acetabular fractures are rarely seen and for surgeons to apply treatment successfully, particular experience is required [9]. To define the correct approach, the fracture must be examined in detail. New approaches are being developed to reduce complications and increase reduction quality. Was one of the aims of the study to achieve a reduction in the complication rate and amount of blood loss in newly-developed methods? Great advances have been recorded in recent years in acetabular fracture surgery and the optimal treatment protocol is still being discussed [10]. In particular, an increasingly elderly population has shown an increase in lateral compression fractures and therefore an increase is seen in medial displacement of quadrilateral plate and superomedial dome impaction [11]. Since described in 1960 by Letournel, 3 different windows for the ilioinguinal approach have been used successfully, particularly in anterior fractures of the acetabulum, although for acetabular dome fractures or when intra-articular inspection is needed, these have not provided sufficient visualization and reduction quality has decreased [4,12]. In addition, complications such as hernia, thrombosis, neurovascular injuries and haematoma are seen at rates of approximately 10% in the ilioinguinal approach [13]. New approaches have emerged to reduce morbidity in the surgical area, to reduce complications and to reach fractures involving the dome and quadrilateral plate, thus intrapelvic approaches have become more important and the modified Stoppa technique has been used as an intrapelvic approach since the 1990s [11]. Besides the Stoppa technique, approaches such as the subinguinal retroperitoneal approach, the pararectus approach and the minimally invasive two incision approach have been developed for the same reasons [12–14]. Successful results have been reported from the use of these approaches in acetabular fracture surgery [5,12–16]. In the current study, the functional results of both approaches were found to be satisfactory, which we associated with the reduction quality and strong fixation.

In acetabular fractures with anterior displacement, the widely used ilioinguinal approach and particularly the extended iliofemoral, transtrochanteric and triradiate approaches are traumatic approaches with high morbidity [10]. The lymphatic veins with the neurovascular band and the preparation of the funicular structures carry a risk as extra time is needed and consequently scar formation may occur on important structures [10,17]. Most complications of the ilioinguinal approach are particularly related to the soft tissue of the middle window and in new approaches dissection of tissues in this window is avoided [10,12,13,17,18].

When studies which include the modified Stoppa and ilioinguinal approaches are examined, Taller et al. [16] applied 15 Stoppa approaches to a series of 14 cases and obtained evidence that the Stoppa technique was more minimally invasive than the ilioinguinal approach and did not threaten the femoral cutaneous nerve.

Matta [15] reported from 10 years' experience of acetabular fractures that the ilioinguinal approach was cosmetic, caused minimal ectopic bone formation and provided rapid recovery of muscle function. Fan et al. [19] applied the modified Stoppa approach to 16 cases of pelvis and acetabular fracture and reported that the fracture could be easily manipulated and the complication rate was low. On the other hand, Khoury et al. [20] reported 15 minor and major complications in 60 acetabular fractures treated with the modified Stoppa approach. An examination of previous studies showed that the modified Stoppa approach is particularly effective in the quadrilateral surface placement and in medial displacements, visualization is provided more easily [11,16–19]. Meena et al. [21] determined that there was certainly a relationship between poor prognosis and poor reduction, associated injuries, fracture displacement of >20 mm, joint dislocation and late surgery in an extensive series of 118 cases. To increase reduction quality, sufficient exposure and an appropriate field of movement must be obtained and this can be achieved with a suitable surgical approach [22].

In the ilioinguinal approach, the external iliac veins are suspended with the medial lymphatics (Fig. 1b) and thus separate dissection should be avoided so as not to damage these structures [2,4] and damage the external iliac veins occurs it may cause major bleeding. In the modified Stoppa approach, anastomosis may be seen between the obturator veins and the external iliac veins or the inferior epigastric veins which are a branch of those [2,4]. To prevent bleeding in this arterial and venous anastomosis (corona mortis) (Fig. 1d) surgical area, tying or cauterization is required [4]. Corona mortis was seen in all the Stoppa approach cases and was noted as 12 venous and 5 arterial. The venous cases were cauterized and ligation was applied to the arterial cases using hemo clips. So initially, the risk of major bleeding is under control. Corona mortis was not recorded in the ilioinguinal approach. It can be seen that great care towards the vascular structures is needed in both approaches. The mean blood loss in the pararectus approach has been reported as 1700 mL (range, 250–6000 mL) and as 1000 mL (range, 732–1630 mL) in the minimally invasive 2-incision approach [12,13]. In a study by Fan et al. [19] which included pelvic and acetabular fractures, the mean blood loss in the modified Stoppa technique was reported as 320 mL (range, 100–1200 mL). In the current study comparing the ilioinguinal and modified Stoppa approaches, no difference was found in respect of blood loss.

The Stoppa approach can be applied successfully in anterior acetabulum and selected posterior surgery and satisfactory results can be obtained. Although the Stoppa approach is an extremely cosmetic surgery in terms of scar size, there is no significant difference in respect of complications and bleeding, compared to the classic ilioinguinal approach. The advantages of the modified Stoppa approach are that bilateral fractures can be treated with a single incision and better visualization is provided in lateral compression fractures.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References

- [1] Stoppa R, Petit J, Abourachid H, et al. Original procedure of groin hernia repair: interposition without fixation of Dacron tulle prosthesis by subperitoneal median approach. *Chirurgie* 1973;99:119–23.
- [2] Jimenez ML, Vrahas MS. Surgical approaches to the acetabulum. *Orthop Clin North Am* 1997;28:419–34.
- [3] Keel MJ, Ecker TM, Siebenrock KA, Bastian JD. Rationales for the Bernese approaches in acetabular surgery. *Eur J Trauma Emerg Surg* 2012;38:489–98.

- [4] Cole JD, Bolhofner BR. Acetabular fracture fixation via a modified Stoppa limited intrapelvic approach. Description of operative technique and preliminary treatment results. *Clin Orthop Relat Res* 1994;305:112–23.
- [5] Kacra BK, Arazi M, Cicekcibasi AE, Büyükmumcu M, Demirci S. Modified medial Stoppa approach for acetabular fractures: an anatomic study. *J Trauma* 2011;71:1340–4.
- [6] Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am* 1969;51:737–55.
- [7] Merle D'Aubigné R. Numerical classification of the function of the hip. *Rev Chir Orthop* 1990;76:371–4.
- [8] Judet R, Judet J, Lanzetta A, Letournel E. Fractures of the acetabulum. Classification and guiding rules for open reduction. *Arch Orthop* 1968;81:119–58.
- [9] Rommens PM, Broos PL, Vanderschot P. Preparation and technique for surgical treatment of 225 acetabulum fractures. 2 year results of 175 cases. *Unfallchirurg* 1997;100:338–48.
- [10] Hirvensalo E, Lindahl J, Kiljunen V. Modified and new approaches for pelvic and acetabular surgery. *Injury* 2007;38:431–41.
- [11] Keel MJ, Bastian JD, Büchler L, Siebenrock KA. Anterior approaches to the acetabulum. *Unfallchirurg* 2013;116:213–20.
- [12] Keel MJ, Ecker TM, Cullmann JL, et al. The Pararectus approach for anterior intrapelvic management of acetabular fractures: an anatomical study and clinical evaluation. *J Bone Joint Surg Br* 2012;94:405–11.
- [13] Ruchholtz S, Buecking B, Delschen A, et al. The two-incision, minimallyinvasive approach in the treatment of acetabularfractures. *J Orthop Trauma* 2013;27:248–55.
- [14] Farid YR. The subinguinalretroperitoneal approach for fractures of the acetabulum: a modified ilioinguinal approach. *J Orthop Trauma* 2008;22:2705.
- [15] Matta JM. Operative treatment of acetabular fractures through the ilioinguinal approach: a 10-year perspective. *J Orthop Trauma* 2006;20(1 Suppl.):S20–9.
- [16] Taller S, Srám J, Lukás R, Krivohlávek M. Surgical treatment of pelvic ring and acetabular fractures using the Stoppa approach. *Acta Chir Orthop Traumatol Cech* 2010;77:93–8.
- [17] Kloen P, Siebenrock KA, Ganz R. Modification of the ilioinguinal approach. *J Orthop Trauma* 2002;16:586–93.
- [18] Sagi HC, Afsari A, Dziadosz D. The anterior intra-pelvic (modified rives-stoppa) for fixation of acetabular fractures. *J Orthop Trauma* 2010;24:263–70.
- [19] Fan L, Jin YJ, He L, Lü Z, Fan HH. Modified Stoppa approach in treatment of pelvic and acetabular fractures. *Zhongguo Gu Shang* 2012;25:810–2.
- [20] Khoury A, Weill Y, Mosheiff R. The Stoppa approach for acetabular fracture. *Oper Orthop Traumatol* 2012;24:439–48.
- [21] Meena UK, Tripathy SK, Sen RK, Aggarwal S, Behera P. Predictors of post-operative outcome for acetabular fractures. *Orthop Traumatol Surg Res* 2013;99:929–35.
- [22] Glas PY, Fessy MH, Carret JP, Bėjui-Hugues J. Surgical treatment of acetabular fractures: outcome in a series of 60 consecutive cases. *Rev Chir Orthop* 2001;87:529–38.