

# A New Effective and Reliable Technique for Bleeding Control in The Modified Stoppa Approach to Acetabulum Quadrilateral Region Fractures; Ligate the Obturator Artery

## Asetabulum Quadrilateral Bölge Kırıklarına Stoppa Yaklaşımında Kanama Kontrolünde Etketif ve Güvenilir Yeni Bir Teknik; Obturatör Arteri Bağlamak

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### ABSTRACT

**Objectives:** This study aims to share the methods of managing foci that cause bleeding in the modified Stoppa approach to acetabulum quadrilateral region fractures. In addition, it is to reveal the amount of perioperative bleeding and the clinical effect of ligated arteries in patients whose surgery was performed with advanced bleeding control technique.

**Patients and Methods:** Between May 1, 2020, and June 30, 2023, perioperative bleeding data of 13 patients with acetabulum quadrilateral region fractures operated on with a modified Stoppa approach and advanced bleeding control technique were evaluated retrospectively. Age, gender, fracture mechanism, fracture side, fracture type, amount of perioperative bleeding, and follow-up periods were determined. The clinical effect of ligated arteries was observed in the postoperative period. In the CT scans taken in the postoperative period, the diameters of the gluteal muscles and adductor muscles were compared to the healthy side.

**Results:** Of the 13 patients included in the study, 5 were women, and 8 were men. While the average age was 35.6 years, the average follow-up period was 15.3 months. The average number of sponges used during the modified Stoppa approach and the amount of bleeding measured with an aspirator was 284.2 ml. The middle area of the gluteal muscles compared to the healthy side was 0.89, while the average area of the adductor muscles was 0.89. No problems related to the ligated vessels were observed in any patient during the postoperative period and outpatient follow-up.

**Conclusion:** Routine ligation of the obturator artery does not have any clinically observable adverse effects, and with advanced bleeding control, it facilitates both the hemodynamic management of the patient in terms of anesthesia and the management of the surgical field for the surgeon.

### ÖZ

**Amaç:** Bu çalışmanın amacı asetabulum quadrilateral bölge kırıklarına modifiye stoppa yaklaşımında kanamaya neden olan odakların yönetimi konusunda elde edilen çözüm metodlarını paylaşmaktır. Ayrıca ileri kanama kontrolü tekniği ile cerrahisi sağlanan hastaların perioperatif kanama miktarını ve bağlanan arterlerin klinik etkisini ortaya çıkarmaktır.

**Hastalar ve Yöntem:** 1 Mayıs 2020-30 Haziran 2023 tarihleri arasında asetabulum quadrilateral bölge kırığına sahip, modifiye stoppa approach ve ileri kanama kontrolü tekniği ile opere edilen 13 hastanın perioperatif toplanan kanama verileri geriye dönük olarak değerlendirildi. Yaş, cinsiyet, kırık mekanizması, kırık tarafı, kırık tipi, perioperatif kanama miktarı ve takip süreleri belirlendi. Postoperatif dönemde bağlanan arterlerin klinik etkisi gözlemlendi. Ameliyat sonrası dönemde çekilen bilgisayarlı tomografilerde gluteal kasların ve addüktör kasların çapları sağlıklı tarafla karşılaştırıldı.

**Bulgular:** Çalışmaya alınan 13 hastanın 5'i kadın iken 8'i erkek idi. Ortalama yaş 35,6 iken ortalama takip süresi 15,3 ay idi. Modifiye stoppa approach esnasında kullanılan spanç sayısı ve aspiratör ile ölçülen kanama miktarı ortalama 284,2 cc olarak hesaplandı. Gluteal kasların sağlıklı tarafa göre ortalama alanı 0,89, addüktör kasların ortalama alanı ise 0,89 olarak belirlendi. Postoperatif dönemde ve poliklinik takiplerinde hiçbir hastada bağlanan damarlar kaynaklı problem gözlenmedi.

**Sonuç:** Obturatör arterin rutin bağlanması klinik olarak gözlenebilen bir olumsuz etkisi olmadığı gibi ileri kanama kontrolü ile hem anestezi açısından hastanın hemodinamik yönetimini, hem de cerrah açısından cerrahi alan yönetimini kolaylaştırmaktadır.

**Key Words:** Acetabulum quadrilateral fractures, modified Stoppa approach, bleeding foci, obturator artery

**Anahtar Kelimeler:** Asetabulum quadrilateral bölge kırıkları, modifiye stoppa yaklaşım, kanama odakları, obturatör arter

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## Introduction

Acetabular fractures often occur with high-energy injuries in young people and can be a part of multiple injuries. The need for surgery often arises in the treatment. The most common forms are the posterior column, anterior wall, anterior column fractures, and quadrilateral region fractures involving both columns. Surgical approaches are preferred according to the location of the fracture, such as posterior, anterior, or combined.<sup>1,2</sup>

The ilioinguinal and modified Stoppa approaches are the most commonly preferred approaches for acetabulum quadrilateral region fractures. The preference for the modified Stoppa approach is increasing due to its better field of view for the quadrilateral region and its more minimally invasive approach. The modified Stoppa is entered through an approach phannelstein incision, and the bladder is excluded. It provides access to the quadrilateral region of the acetabulum from under the rectus muscle.<sup>3,4</sup> In these approaches, many bleeding foci occur due to the proximity to the external and internal branches of the iliac artery.<sup>5</sup> Bleeding with a very high flow rate causes severe blood loss during the operation, and sometimes, support from cardiovascular surgery may be requested. By effectively managing these bleeding foci, less blood loss, precise surgical field evaluation, better anesthesia hemodynamics, and reduced mortality and morbidity can be achieved.

This study, which aims to share the solution methods obtained in the management of these foci that cause bleeding in the modified Stoppa approach to acetabulum quadrilateral region fractures, also seeks to reveal the amount of perioperative bleeding and the clinical effect of the ligated arteries in patients who underwent surgery with advanced bleeding control technique.

## Patients and Methods

Between May 1, 2020, and June 30, 2023, the perioperative collected data of 13 patients with acetabulum quadrilateral region fractures operated on with a modified Stoppa approach and advanced bleeding control technique were evaluated retrospectively. Approval was obtained from the local ethics committee (KA EK/2023.01.04).

Patients over 18 years of age who had acetabulum quadrilateral region fractures and were operated on with a modified Stoppa approach were included in the study. Patients who were not operated on with advanced bleeding control techniques and patients who were delayed for more than three weeks were not included in the study.

Antithrombotic prophylaxis (Low molecular weight heparin) was started in all patients from the moment of hospi-

talization and continued for one month. The same implant material and system (TST Medical Instruments Industry and Trade Ltd. Co. Pendik/Istanbul, Turkey) (**Figure 1**) was used in all patients.



**Figure 1.** Quadrilateral anatomical plate.

**Surgical preparation phase:** All surgeries were performed under general anesthesia, and at least six units of erythrocytes were prepared before surgery. After the patient is transferred from anesthesia, fluoroscopy checks of the pelvic region are performed on the radiolucent table. After ensuring that inlet, outlet, and judet radiographs can be taken without any problems, the patient is sterilely painted and draped. In fractures that do not require manual traction, only the pubic region is left open, while in fractures that will require traction and extremity maneuvers, the extremity of the relevant side is also left exposed, and the painting and covering process is applied.

## Approaching The Surgical Field And Finding And Managing Bleeding Foci

**Advanced bleeding control technique:** It is the name that is deemed appropriate for the process of exposing the surgical field with slow and sponge-assisted blunt dissections during surgery and identifying and ligating or cauterizing previously detected arterial foci that cause bleeding without spontaneous rupture during the dissection.

**1. bleeding focus (corona mortis):** After draping the surgery area, a 10 cm transverse Phannelstein incision is made 1-2 cm above the pubic arm. The linea alba and rectus muscles are then cut longitudinally and opened. The bladder is excluded and protected. It is removed by cutting the rectus muscle from where it connects to the pubic arm towards the side where the fracture is located. The area is exposed by pushing the tissues along the iliopectal line with slow and blunt dissections over the inguinal arm.

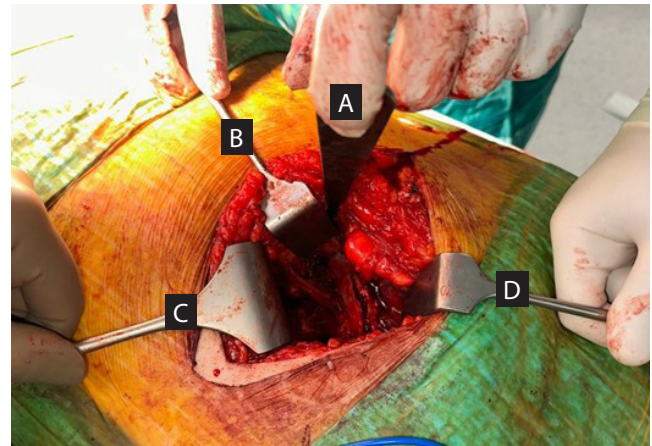
The initial bleeding focus is the corona mortis structure here, and it must be located, identified, and ligated or cauterized.

**2. bleeding focus (external iliac artery and vein):** After the corona mortis is ligated, blunt dissection is continued along the iliopectinal line towards the sacrum. The iliopectinal fascia is cut open with a scalpel along the iliopectinal line. Then, the area that is opened bluntly by staying on the bone from the bottom of the rectus muscle to the middle part of the iliac wing is fixed by inserting a pointed "S" retractor into the bone, and the rectus muscle and iliacus muscle are retracted. Especially the external iliac vessels above and lateral to the iliacus muscle will be protected and removed from the area with this maneuver.

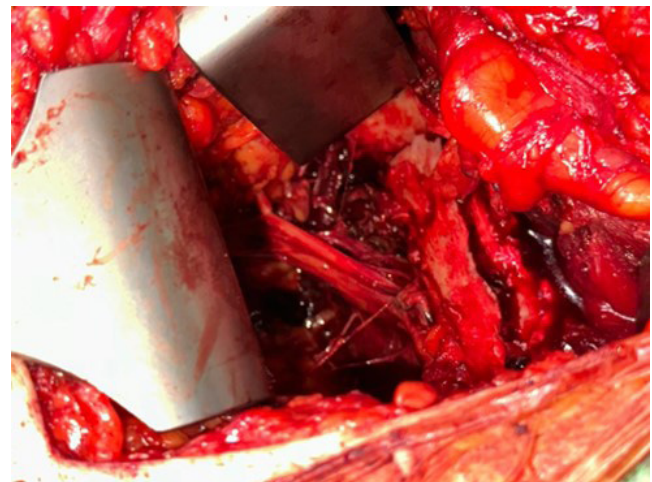
**3. bleeding focus (superior gluteal artery):** As we approach the sacrum, the second bleeding focus is the superior gluteal artery, which we will encounter here. If necessary, the parts close to the sacrum should be exposed during the implant placement phase. While it may be excluded during dissection, it may also rupture and cause bleeding. Because it is so deep, it isn't easy to ligat or sear it. Bleeding can usually stop on its own. However, in young people, bleeding may not stop spontaneously and may disturb the surgical area with simple leaks. At this stage, the anesthetist may be asked to reduce the blood pressure as much as possible to control this bleeding. Additionally, sponges impregnated with 1/6 diluted adrenaline and transamine can be placed in this area as a tampon (in order not to forget a sponge inside the patient, the circulating nurse should be warned about all sponges left inside and be careful about counting. In addition, fluoroscopy checks should be made using x-ray-marked sponges and pads).

**4. bleeding focus (presacral veins):** As the sacrum is exposed, the presacral veins bleed, but there is no need to worry. Bleeding can be stopped with a simple sponge or tampons. There is generally no need to expose the sacrum in quadrilateral region fractures. Since the sacrum is deep and challenging to manage, it should be avoided as much as possible.

**5. bleeding focus (obturator artery):** After the pubic arm, anterior corner of the sacrum, and iliopectinal line are entirely exposed, the quadrilateral area is exposed by going deep from the side of the bladder with blunt deduction over the bone. The fifth and most frightening bleeding may occur at this stage. The obturator vessel and nerve bundle pass close to the wall and are also seen to be tense (**Figure 2-3**). The tension of this artery and its proximity to the quadrilateral region almost always results in its rupture and bleeding. Bleeding from this artery may occur from the proximal, middle, or distal areas where it enters the obturator ring. While midsection bleeding can be con-



**Figure 2.** Modified Stoppa approach, **A;** Retractor that excludes the iliac vessels, rectus muscle, and iliacus muscle, **B;** Retractor revealing the part of the iliopectinal line leading towards the sacrum, **C;** retractor protecting the bladder, **D;** retractor that exposes the pubic arm and exposes the area where corona mortis is located



**Figure 3.** Obturator vessel and nerve bundle

tained and ligated, proximal and distal bleeding can be very difficult to control. Most of the time, bleeding in these parts stops with tamponade of the pads and bleeding of the arteries until they spontaneously thrombose. If you do not remain calm during this bleeding, uncontrollable severe bleeding may occur. Most of the time, the surgeon becomes extremely worried at this stage, and a cardiovascular surgeon is invited to the case. As in the superior gluteal artery, here, too, the patient's blood pressure should be reduced by tamponade at first, and the arteries should be thrombosed with pads impregnated with adrenaline and transamin. The bleeding should be expected to stop spontaneously. At this stage, bleeding from the obturator artery can be prevented by tying it in the middle and cutting it without risking bleeding from the obturator artery.



In addition, the color and consistency of the obturator nerve, with which it travels, is quite different from the artery. Still, care should be taken not to connect the nerve accidentally. During the implant placement, the obturator nerve should be prevented from entering between the implant and the bone (**Figure 4**).



**Figure 4.** Postoperative image of the implant

**Tracked parameters:** Age, gender, fracture mechanism, fracture side, fracture type (Letournel Classification), and follow-up periods were determined.

The amount of perioperative bleeding was determined by blood in the aspirator and sponge counting. The amount of blood in the aspirator was calculated by subtracting the liquid used for washing. All sponges are considered half wet and correspond to 5 cc of bleeding. In multi-traumas, bleeding during the modified Stoppa approach was calculated separately. The clinical effect of ligated arteries was observed in the postoperative period. In the computer tomography (CT) scans taken in the postoperative period, the gluteal and adductor muscles' diameters were compared to the healthy side.

**Statistical analysis:** Microsoft Excel (2007) (USA) program was used for statistical analysis. Only descriptive statistics (mean, standard deviation, median, frequency, rate, range) were made.

## Results

Of the 13 patients in the study, 5 were women and 8 were men. While the average age was 35.6 years, the average follow-up period was 15.3 months. Three patients had motor accidents (MA), three patients had fallen from height (FFA), three patients had non-vehicular traffic accidents (NVT), two patients had in-vehicle traffic accidents (IVTA), and two patients had work accidents (WA). While the injured side of 6 patients were on the right side, seven

were injured on the left side. According to the Letournel classification, six patients had anterior column + posterior hemitransverse fractures, 3 had transverse fractures, 3 had both column fractures, and 1 had a t-shaped fracture type (Table I).

While the average number of sponges used during the modified Stoppa approach was  $31.9 \pm 7.2$ , the estimated amount of bleeding resulting from these sponges ( $\times 5$  ml) was 159.6 ml. The average amount of bleeding measured with an aspirator was 123.8 ml. When the sum of the bleeding in the sponge and aspirator was calculated, the moderate bleeding was calculated as  $284.2 \pm 32.2$  ml (Table I).

No patient received blood replacement during the operation. No problems related to the ligated vessels were observed in any patient during the postoperative period and outpatient follow-up. In the last CT image, the average area of the gluteal muscles compared to the healthy side was 0.89, while the middle area of the adductor muscles was 0.89.

In 1 patient, a superficial infection developed at the wound site and resolved without any problems with wound care and debridement in the outpatient clinic. One patient developed avascular necrosis of the femoral head and was treated with total hip arthroplasty. In one patient, heterotopic ossification developed and was excised after maturation due to restriction of hip movements.

## Discussion

In this study, it was revealed that surgeries for quadrilateral region fractures could be completed with a minimal amount of bleeding with advanced bleeding control techniques. In addition, the bleeding foci were detailed, and it was observed that no clinical problems occurred due to the routine ligation of these foci. Additionally, there was no significant necrosis or atrophy in the CT scans of the gluteal and adductor muscles.

There are great difficulties in the surgery of pelvis-acetabulum fractures due to the proximity to the pelvic internal organs, large arteries, and their branches. The most common cause of death from pelvic injuries is bleeding.<sup>5</sup> Knowing the anatomic position of the arteries and managing them operatively to control abdominal bleeding during surgery is the main element of pelvic surgery. In addition, many variations have been identified in cadaver studies, and these anatomical variations must also be defined to ensure surgery.<sup>6</sup> The possible variations of corona mortis and obturator artery are numerous, and knowing these variations during approach will be even more helpful in bleeding control.<sup>7,8</sup>

Advanced bleeding control technique creates a bloodless area for the surgeon. Due to its proximity to large arteries,

**Table 1.** Demographic data of patients and parameters that are followed

Cases	Age	Gender	Fracture mechanism	Fracture side	Fracture type (LetourneI)	Follow-up time (months)	Amount of sponge bleeding (ml)	Amount of aspirator bleeding (ml)	Amount of perioperative bleeding (ml)	Gluteal muscles area rate*	Adductor muscles area rate*
1	36	F	NVTA	R	Transvers	6	150	140	290	-	-
2	24	M	MA	L	Transvers	24	200	100	300	-	-
3	52	M	WA	R	T-Shaped	8	125	130	255	0.95	0.89
4	18	M	FFA	R	Ant. colon + post. ht	10	175	160	335	0.83	0.91
5	23	F	İVTA	R	Both colon	12	100	80	180	0.91	0.89
6	41	M	MA	L	Ant. colon + post. ht	14	125	100	225	0.96	0.9
7	63	M	MA	L	Ant. colon + post. ht	15	150	120	270	0.91	0.95
8	36	M	NVTA	L	Both colon	17	225	70	295	0.85	0.89
9	34	F	NVTA	R	Ant. colon + post. ht	19	125	140	265	0.89	0.91
10	27	F	İVTA	R	Transvers	21	150	120	270	0.81	0.84
11	21	F	FFA	L	Ant. colon + post. ht	23	175	110	295	0.93	0.91
12	46	M	FFA	L	Ant. colon + post. ht	13	200	160	360	0.85	0.92
13	42	M	WA	L	Both colon	17	175	180	355	0.9	0.88
A	35,6	-	-	-	-	15,3	159,6	123,8	284,2	0,89	0,89
Sd	13,2	-	-	-	-	5,5	36,1	32,2	49,8	0,04	0,02

A: Average

Sd; Standart deviation

\* The last postoperative CT scans obtained were evaluated. (average 1-2th month CT scans)

bleeding tends to occur and makes the management of the surgical field difficult, while excessive blood aspiration drives the surgeon into panic. Therefore, controlling these foci before bleeding develops should be the primary method to ensure a safe environment for these surgeries. In addition, it is tough to find and hold the focus of sudden bleeding due to the deep anatomy of the region. For this reason, it will be more comfortable to identify and extinguish the foci before bleeding develops.

Although the diameter and positional variations of corona mortis, which is the first bleeding focus we encounter, may make it difficult to control bleeding, it can be easily found and tied with a blunt and meticulous approach. Since it is anatomically close to the surface, tying and burning can be done safely.<sup>9</sup>

While removing the external iliac vessels from the surgical field with a retractor thanks to the iliacus muscle, waiting for the retractor tension to open spontaneously as the approach expands and not keeping it excessively tense will prevent injury to the external iliac vessels. Although the superior gluteal artery, which can be encountered close to the sacrum as it descends deep into the ilipectinal line, can sometimes be traumatically injured and bleed, its bleeding can be stopped without causing any clinical problems.<sup>10</sup> Sometimes, there is a need to open the superior areas of the sacrum and iliac crest to reveal the fracture line or the area where the implant needs to be fixed, and this vessel may be encountered at this deepening stage. Surgery can be performed only if it is required.

After the ilipectinal line is revealed, a deep dissection between the bladder and the bone must disclose the quad-

lateral area. At this stage, utmost care is needed to avoid damage to the obturator vessel and nerve bundle that appear when we go deeper with blunt dissections. In our previous experience, the bleeding we frequently encountered in this region is excessive and dangerous, and to stop it, it is necessary to use pressurized tamponade and wait for spontaneous thrombosis. Due to deep bleeding, it is not possible to catch and tie the bleeding acutely. In addition, as this vessel develops from the proximal or distal, bleeding runs the risk of getting out of control, which may cause mortality. This risk can be overcome with routine ligation of this vessel, and access to the quadrilateral region and implant placement will be easier. Better reduction quality can be achieved in a bloodless field. In addition, completely exposing the area where the implant will be placed can ensure the reduction's safe, stable, and anatomical fixation. Improving the quality of reduction and fixation will improve clinical and radiological parameters. Bleeding and interventions of the obturator artery have been previously reported in several cases in the literature. The first of these is the iatrogenic bleeding from the obturator artery after nailing for hip fracture, which did not stop spontaneously and was tried to be solved by embolization.<sup>11</sup> The second is that the obturator artery was torn and retracted during surgery in the obturator groove. For the solution, the artery was reached with pubic arm osteotomy, and the bleeding was stopped with difficulty.<sup>12</sup> Embolization is preferred by interventional radiology in some internal iliac artery branches and obturator artery injuries and does not cause any clinical loss.<sup>13</sup> In this study, as a result of postoperative observations, no pathology related to the routine ligation of the obturator artery developed.

Some previous studies determined that the amount of bleeding in the modified Stoppa approach was around 450-2000 ml.<sup>3,4</sup> In this study, the average amount of bleeding remained around 284 ml, thanks to the advanced bleeding control technique. While this technique considerably reduces the amount of bleeding, it can also provide a significant advantage to anesthesia in managing the patient's hemodynamic control.

The use of transaminic acid to reduce bleeding seems controversial. Publications are reporting that it is ineffective, as well as publications reporting that it reduces bleeding.<sup>14,15</sup> However, in this study, although not systemically, the coagulative effect of the sponges was impregnated with adrenaline as well as transamine, locally, not systemically, to control bleeding, and thus effective bleeding control could be achieved for leaky vessels. Compared to the ilioinguinal approach, which is an alternative to the modified stoppa approach, the stoppa approach has the advantage of less bleeding.<sup>3,4</sup> Although it was preferred in this study due to better access to the quadrilateral region, this approach contributes extra to bleeding control.

It was observed that the patient's gluteal and adductor muscle groups were atrophic at an average rate of around 10 percent. Although the cause of this atrophy may be long-term disuse of the relevant extremity, muscle infarction may also play a role in the etiology. The low atrophy rate is encouraging. Although clinical problems that may develop regarding the ligation of the obturator artery have not been observed, it would be better to closely follow the subcutaneous evaluations and sensory examinations of the gluteal muscle and adductor muscles, as well as the examination of the bladder and intestinal systems during the postoperative period. In addition, ligation of the obturator artery should only be preferred when deep dissection is required when placing an anatomical plate in the quadrilateral region.

**Limitations of this study:** The number of cases is quite limited, and a control group must be needed. This study may lead to multicenter and prospective studies in the future.

**As a result,** the most common source of bleeding during the modified Stoppa approach appears to be the obturator artery as a result of perioperative observations. Routine ligation of the obturator artery has no clinically observable adverse effects. Advanced bleeding control facilitates both the hemodynamic management of the patient in terms of anesthesia and the management of the surgical field for the surgeon.

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