

**RESEARCH ARTICLE**

# Outcomes of the Modified Stoppa Approach in Acetabular Fracture Management: Incidence of Nerve Injuries

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**Abstract**

**Objectives:** Displaced acetabular fractures are complex injuries that necessitate precise surgical intervention. Obturator nerve injuries occur in approximately 2% of cases. The modified Stoppa approach, offering enhanced exposure of the quadrilateral plate, has gained attraction as an alternative technique for anterior acetabular fractures. However, its proximity to the obturator nerve poses a risk of iatrogenic injury. This study aimed to investigate the incidence of nerve injuries and functional outcomes in patients undergoing the modified Stoppa approach for traumatic acetabular fractures.

**Methods:** This retrospective study involved 86 patients with anterior column fractures, whose data were prospectively collected. The fractures were treated using the modified Stoppa approach. Exclusion criteria were pathological fractures, alternative surgical approaches, prior nerve injuries, hip issues, refusal to participate, or inadequate follow-up. Data collection involved pre-operative imaging, thorough post-operative neurological assessments, and post-operative radiographic evaluation. Functional outcomes were assessed using the Harris Hip Score (HHS).

**Results:** Most patients were male (n=54) with a mean age of 40±17.3 years. Post-operative infection occurred in six cases, with resolution in four through antibiotics and two necessitating device removal. Obturator nerve damage was detected in 14 patients, comprising nine traumatic and five iatrogenic cases. During the follow-up, symptoms improved in all patients, except for the four patients with iatrogenic nerve damage.

**Conclusion:** Traumatic nerve injuries generally heal naturally over time. In contrast, iatrogenic injuries have a less optimistic prognosis, potentially resulting in lasting neurological deficits.

**Level of evidence:** III

**Keywords:** Acetabulum, Fracture fixation, Iatrogenic disease, Nerve injury, Obturator nerve

**Introduction**

Displaced acetabular fractures are complex injuries that require precise surgical intervention to achieve optimal outcomes. These fractures can be associated with nerve injuries, which may result from both trauma and surgical procedures. These injuries are most commonly associated with fracture dislocations involving the posterior column and wall of the acetabulum, with an overall incidence rate of approximately 7%, only 2% of which are iatrogenic in nature.<sup>1</sup>

Nerve injuries in anterior column acetabular fractures are relatively uncommon. Nevertheless, the close anatomical proximity of the obturator nerve to the quadrilateral plate of the acetabulum introduces the potential for traumatic injury during the fracture or iatrogenic injury during surgical procedures.<sup>2</sup>

The obturator nerve traverses deeply within the pelvis before entering the medial aspect of the thigh. It is

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susceptible to injury during various orthopedic procedures, including improper placement of acetabular screws, cement extrusion in total hip arthroplasty, and fixation of anterior column fractures. Clinical manifestations of obturator nerve injury often include sensory deficits or paresthesia in the upper medial aspect of the thigh. In severe cases, motor deficits may also occur, involving weakness in the adductor muscle group.<sup>3</sup>

Since the introduction of the modified Stoppa surgical technique by Cole and Bolhofner in 1994 for anterior column acetabular fractures, it has gained substantial attention in the field of hip surgery.<sup>4</sup> This approach offers superior exposure of the quadrilateral plate and has garnered attention as an alternative to the traditional ilioinguinal approach.<sup>5</sup>

However, the growing utilization of this surgical approach has also led to reports of obturator nerve injuries. These reports are predominantly in the form of case reports and series, and the incidence of these injuries varies significantly across different studies, ranging from 8% to 29%.<sup>6</sup> Unfortunately, these studies have explored the potential causes of these injuries to a lesser extent, hindering the development of preventive measures.

The present study aimed to investigate the incidence of obturator nerve injuries in patients with anterior column acetabular fractures treated with the modified Stoppa approach. Through the conduction of a multicentric analysis, it was sought to assess the extent of obturator nerve injuries and comprehensively evaluate the outcomes in patients affected by this condition.

## Materials and Methods

### Study Design and Participants

In this retrospective investigation, data from 98 patients with anterior column acetabular fractures were prospectively collected. The study lasted four years, from January 2019 to January 2023, at two prominent hospitals—Imam Hussein Hospital and Taleghani Hospital, both affiliated with Shahid Beheshti University of Medical Sciences in Tehran, Iran. Patient enrollment occurred from January 2019 to January 2022.

Patients were eligible if they presented with traumatic anterior column acetabular fractures. The surgical procedures were performed by two senior hip surgeons, who are highly experienced in the modified Stoppa approach. Patients of various age groups, genders, and fracture types were included in the study.

### Exclusion Criteria

The exclusion criteria consisted of pathological acetabular fractures, surgical fixation using approaches other than the modified Stoppa approach, a documented history of prior nerve injury, pre-existing hip problems on either the injured or uninjured side, unwillingness to participate in the study, conservative treatment or passing away before surgery, and follow-up period of less than 12 months.

In total, 12 patients were excluded from the study based on these exclusion criteria, leaving 86 patients remaining in the study.

### Data Collection

Pre-operative radiographs and computed tomography

scans were obtained for each patient and meticulously evaluated. Fractures were classified according to the Judet and Letournel Classification for acetabular fractures.<sup>7</sup> Comprehensive data regarding the mechanism of injury, fracture patterns, and any concurrent injuries were collected through thorough pre-operative investigations.

Nerve injuries, including obturator nerve injuries, were assessed by experienced orthopedic surgeons, preoperatively. A comprehensive physical examination was conducted, including an evaluation of muscular strength and sensory disturbances in the medial aspect of the thigh. Sensory examination was performed using a pinprick applied to the medial thigh. Assessment of adductor muscle function involved the evaluation of their contractility, taking into consideration the potential limitations imposed by severe pain induced by thigh movement. Patients were examined both before surgery (baseline) and immediately after surgery to identify any nerve injuries.

Post-operative radiographs were meticulously reviewed to assess the quality of fracture reductions by senior orthopedics residents. Reductions were categorized into the three following groups:

1. Excellent reduction: No observable fracture line.
2. Acceptable reduction: Fracture line shorter than 2 mm.
3. Unfavorable reduction: Fracture line longer than 2 mm.

### Follow-up and Functional Assessment

Patients underwent rigorous follow-up assessments for at least 12 months. Those who had experienced nerve injuries were closely monitored for signs of recovery. The Harris Hip Score (HHS) was used for comprehensive clinical evaluation during the final follow-up visit.

### Statistical Analysis

Descriptive statistics, including means, standard deviations, and frequencies, were calculated to summarize patient demographics, fracture characteristics, and clinical outcomes. Comparative statistical analyses were performed to evaluate differences between groups as follows: for continuous variables, such as age and HHS, an independent t-test was employed. Moreover, categorical variables, including fracture types and the incidence of nerve injuries, were analyzed using the chi-square test. All statistical analyses were performed using IBM SPSS (version 22) with a predetermined significance level ( $\alpha$ ) set at 0.05.

### Ethical Considerations

All procedures were performed in accordance with the Declaration of Helsinki and were approved by the Research Ethics Committee of the School of Medicine at Shahid Beheshti University of Medical Sciences, Tehran, Iran (code: IR.SBMU.MSP.REC.1398.688). All patients signed a written informed consent to participate in the present study.

## Results

In this study, 86 patients were followed up, the majority of whom were males ( $n=54$ ) with a mean age of  $40 \pm 17.3$  years, over a period of 12-20 months. Surgical approaches included 64 patients with the modified Stoppa technique alone and 22 with a combined anterior and posterior

approach. Table 1 summarizes the patient characteristics [Table 1].

Table 1. Characteristics of patients	
Characteristic	Value
Total number of patients	86
Gender (male/female)	54/32
Age (mean±SD)	40±17.3
Fracture side distribution	
- Right hip fractures	42
- Left hip fractures	39
- Bilateral hip fractures	5
Surgical approaches	
- Modified Stoppa Alone	64
- Combined anterior and posterior	22
Trauma etiology	
- Vehicular accidents	58
- Falls from height	28
Device failures	0
Vascular injuries	0

Fracture distribution among patients showed a predominant occurrence of only anterior column fractures (34.8%) [Table 2]. No cases of unfavorable reduction were observed in the post-operative imaging of the patients [Table 3]. Post-operative infection occurred in six patients (7%), with resolution through antibiotics in four cases and device removal in two cases.

Table 2. Characteristics of fractures	
Fracture type	Percentage
Anterior column	34.8%
T-shaped	23.6%
Transverse	18.6%
Anterior column and posterior hemitransverse	13.95%
Both columns	9.3%

Table 3. Reduction quality	
Fracture reduction	Percentage
Excellent	32.6%
Acceptable	67.4%

Overall, 14 patients (16.3%) experienced obturator nerve injuries, with 9 cases being traumatic and 5 cases iatrogenic in nature. Moreover, 8 out of these 14 cases exhibited motor weakness in the adductor muscles, four traumatic and four iatrogenic cases. At the final follow-up, four iatrogenic injuries did not recover from their injuries and exhibited muscle atrophy. All the traumatic injuries recovered from their nervous deficits. Among patients with obturator nerve injury, six had transverse fractures, six had T-shaped fractures, and four had fractures involving both columns. No other nerve injuries were observed.

Continuity of the obturator nerve was preserved in none of the traumatic injuries, and the obturator nerve underwent contusion to some degree in all 9 patients, as evident by the observed bruising.

The HHS results are presented in [Table 4]. The mean HHS score was 80, with a standard deviation of 21.3. Statistical analysis did not reveal significant correlations between HHS scores and fracture type ( $P$  value=0.8), pain, gender, or the type of used surgical approach.

Table 4. Final Harris Hips score (HHS) of the patients					
	N	Minimum	Maximum	Mean	Standard Deviation
Total HHS	86	30.00	100.00	81.8605	21.34811
HHS (pain)	86	10.00	44.00	35.2093	10.43017
HHS (limp)	86	.00	11.00	9.0930	2.75866
HHS (support)	86	.00	11.00	9.1163	3.11073
HHS (distance walk)	86	.00	11.00	8.8837	3.08768
HHS (sitting)	86	.00	5.00	4.4651	1.07679
HHS (enter public transportation)	86	.00	1.00	.8837	.32435
HHS (stairs)	86	.00	4.00	3.0465	1.34436
HHS (socks and shoes)	86	.00	4.00	3.4419	1.25930
HHS (deformity)	86	.00	4.00	3.0698	1.70985
HHS (range of motion)	86	2.00	5.00	3.8372	.92402

## Discussion

The primary objective of this study was to investigate the incidence of nerve injuries and the functional outcomes in patients with acetabular fractures who underwent open reduction and internal fixation surgery utilizing the modified Stoppa approach. The findings revealed that the incidence of obturator nerve injury was 16.3%, and traumatic nerve injury occurred in 10.5% of cases, with the majority experiencing recovery.

The modified Stoppa approach has gained increasing popularity in recent years due to its efficacy in fixing the quadrilateral plate. However, the proximity of the obturator nerve to the surgical site necessitates careful visualization to prevent iatrogenic injury. Results of the present study align with those of previous studies that have reported favorable outcomes with this approach.

Sagi et al. reported a 92% success rate in 50 patients undergoing the modified Stoppa approach, with only a small fraction experiencing complications.<sup>8</sup> Similarly, in a larger series of 164 patients with acetabular fractures, an HHS exceeding 80 was achieved in 75% of cases, and no nerve injuries were observed.<sup>9</sup> Yao et al. found a 4.2% obturator nerve injury rate in their comparison of Stoppa and ilioinguinal approaches, all of which spontaneously recovered within a year post-surgery.<sup>10</sup>

Soni et al. performed a meta-analysis on 609 patients with pelvic fractures treated mostly with the modified Stoppa approach. They reported obturator nerve injury as the most common complication, which was observed in 21 patients, with 20 showing spontaneous recovery within 3-6 months.<sup>11</sup> Simske et al. studied 975 patients with acetabular fractures, 32 of whom developed nerve damage, primarily due to trauma.<sup>12</sup> Elmadag et al. reported a single case of obturator nerve injury among 36 patients undergoing surgery with the modified Stoppa approach, which resolved spontaneously within three months, though their mean HHS was slightly lower at 77.9.<sup>13</sup>

One of the reasons for the variation in obturator nerve injury rates in various studies, including the present study, could be the challenging nature of the diagnosis of such injuries in the clinical setting of acetabular fractures. In these patients, due to acute trauma and severe pain, the performance of electrophysiological assessments before surgery is often infeasible. Clinical examinations for the diagnosis of these injuries demand a high level of clinical expertise and meticulous evaluation, which many emergency physicians may lack. Therefore, in order to prevent potential legal issues, it is recommended to have a thorough clinical examination by orthopedic specialists.<sup>14</sup> Furthermore, considering that obturator nerve injury may not always result in motor deficits, assessment of sensory function in the upper medial thigh is crucial, especially when adductor muscle contraction strength remains intact.

Although these studies consistently identify nerve injury as a potential complication of the modified Stoppa approach, it is noteworthy that the incidence rate remains relatively low. This approach continues to prove its utility in the management of acetabular fractures.

To minimize the risk of iatrogenic obturator nerve injury, it is crucial to take specific precautions, as guided

by existing literature and the surgical experience in the management of such cases. These measures are especially vital in high-risk patients, which include patients with extensive quadrilateral plate displacement, obesity, and substantial intraoperative bleeding.<sup>15</sup>

The primary step is to meticulously explore and protect the obturator nerve. This is achieved by the usage of a vascular loop to isolate and secure the nerve. Given that the nerve is most susceptible to manipulation during the reduction process, extreme caution is exercised when positioning surgical instruments for exposure and reduction, such as retractors and collinear clamps. Maintenance of a focused gaze on the nerve during fracture reduction is essential to prevent nerve entrapment within the fracture site. Once a successful reduction is achieved, the final precautionary step is to ensure that the nerve remains unimpeded beneath the fixation plate.

Adherence to these protocols is aimed to significantly reduce the incidence rate of obturator nerve injury in challenging surgical cases. However, certain limitations in the present study should be acknowledged, including its retrospective nature and relatively small sample size. Furthermore, preoperative and postoperative electrodiagnostic studies were not performed, relying instead on thorough physical examinations. It is important to recognize that electrodiagnostic studies may lack sensitivity during the acute phase of injury, which further emphasizes the importance of meticulous physical examination.

## Conclusion

Findings of the present study indicated that the majority of traumatic nerve injuries resulting from nerve traction are associated with fracture edge displacement. Remarkably, these injuries tend to exhibit a favorable natural healing process over time. In contrast, when nerve injuries are iatrogenic in origin, the prognosis is less optimistic, compared to traumatic cases, and there exists a potential for enduring neurological deficits.

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