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# Stoppa Approach for Anterior Plate Fixation in Unstable Pelvic Ring Injury

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**Background:** The Stoppa (intrapelvic) approach has been introduced for the treatment of pelvic-acetabular fractures; it allows easy exposure of the pelvic brim, where the bone quality is optimal for screw fixation. The purpose of our study was to investigate the surgical outcomes of unstable pelvic ring injuries treated using the Stoppa approach for stable anterior ring fixation.

**Methods:** We analyzed 22 cases of unstable pelvic ring injury treated with plate fixation of the anterior ring with the Stoppa approach. We excluded cases of nondisplaced rami fracture, simple symphyseal diastasis, and parasymphyseal fractures, which can be easily treated with other techniques. The average age of the study patients was 41 years (range, 23 to 61 years). There were 10 males and 12 females. According to the Young and Burgess classification, there were 12 lateral compression, 4 anteroposterior compression, and 6 vertical shear fracture patterns. The fracture location on the anterior ring was near the iliopectineal eminence in all cases and exposure of the pelvic brim was required for plate fixation. All patients were placed in the supine position. For anterior plate fixation, all screws were applied to the anterior ramus distally and directed above the hip joint proximally. Radiologic outcomes were assessed by union time and quality of reduction by Matta method. The Merle d'Aubigne-Postel score was used to evaluate the functional results.

**Results:** The average radiologic follow-up period was 16 months (range, 10 to 51 months). All fractures united at an average of 3.5 months (range, 3 to 5 months). According to the Matta method, the quality of reduction was classified as follows: 16 anatomical (73%) and 6 nearly anatomical (27%) reductions. There were no cases of screw or implant loosening before bone healing. The functional results were classified as 7 excellent (32%), 12 good (55%), and 3 fair (13%) by the Merle d'Aubigne-Postel score. There were no wound complications, neurovascular injuries, or other complications related to the surgical approach.

**Conclusions:** Stable anterior ring fixation placed *via* the Stoppa approach can result in excellent reduction and stable screw fixation with a low complication rate.

**Keywords:** *Pelvis, Fracture fixation*

The surgical goal for unstable pelvic injuries is to reduce and stabilize the anterior and posterior pelvic rings. Anatomical reduction and stable internal fixation of both the anterior and posterior rings can result in good radiologic

and clinical outcomes. The surgical approach and fixation method used are based on the fracture classification, the amount of displacement, soft tissue condition, associated injuries, and overall hemodynamic status of the patient.

Surgical fixation was focused on the posterior pelvic ring, which contributes about 60% of the overall pelvic ring stability, and then the anterior ring lesion is assessed for its need of fixation, if required. Matta and Tornetta<sup>1)</sup> have emphasized the importance of an accurate reduction and stable fixation for posterior ring injuries. Posterior pelvic ring fixation is traditionally associated with verti-

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cally unstable fractures. These injuries are associated with a substantial risk of retroperitoneal hemorrhage, presence of the Morel-Lavallee lesion, and 25% incidence of skin breakdown following internal fixation of these fractures. However, the visualization necessary for the reduction often requires significant soft tissue dissection and long operative times, which are problematic in unstable patients.

There are various surgical options for anterior ring fixation, including external fixator, retrograde intrapubic screw, and plate. The most commonly used surgical approach is a Pfannenstiel-type incision for the symphyseal disruption and medial ramus fracture. For the plate fixation of a displaced lateral ramus fracture and anterior column, an ilioinguinal approach, described by Letournel,<sup>2)</sup> is widely used as the exposure of choice, which may require a long operation time, meticulous handling around the neurovascular bundle, and significant blood loss. Based on the current concept of minimally invasive surgery that emphasizes less tissue dissection, the modified Stoppa approach has gained in popularity. The Stoppa approach has been introduced for the treatment of pelvic-acetabular fractures, allowing the easy exposure of the pelvic brim, where bone quality is optimal for screw fixation.<sup>3-6)</sup>

The purpose of our study was to investigate the surgical outcomes of unstable pelvic ring injuries treated using the Stoppa approach for stable anterior ring fixation.

## METHODS

A retrospective study of 46 polytrauma patients with pelvic ring injuries surgically treated between 2008 and 2012 was performed. We excluded 24 cases of nondisplaced rami fracture, simple symphyseal disruption, and parasymphiseal fractures, which were easily treated with other techniques. The patients who underwent the modified Stoppa approach during the mentioned period, with at least 1 year of radiologic follow-up were included in the study. We then evaluated 22 cases of unstable pelvic ring injuries treated with plate fixation of the anterior ring through the Stoppa approach.

Radiologic outcomes were assessed by union time and quality of reduction. Radiographic measurements of the residual displacement of the pelvic ring determined from the difference in the height of femoral head from a line perpendicular to the long axis of the sacrum. These results were then graded as excellent (0–4 mm), good (5–10 mm), fair (11–20 mm), or poor (> 20 mm).<sup>1)</sup> The Merle d'Aubigne-Postel score<sup>7)</sup> was used to evaluate the functional results and the complications related to the surgical approach were assessed. The overall score was graded as

excellent (18), good (15–17), fair (12–14), or poor (3–11).

## Surgical Technique

Operations were performed under general anesthesia in the supine position on a radiolucent operating table. Both hips and knees were slightly flexed to relax the iliopsoas muscle.

A 10–15 cm sized midline vertical skin incision was made between the rectus abdominis muscles from the umbilicus to the symphysis pubis. The rectus abdominis muscles were retracted laterally from the symphysis pubis without sharp dissection. The preperitoneal space was opened and bluntly divided down to the symphysis pubis. The fibers of the transverse abdominis muscle were dissected from the peritoneal sac, which was manipulated upwards and medially from the fracture site. The pelvic ring was exposed, starting from the superior pubic ramus near the symphysis. The anterior abdominal wall was reflected away from the peritoneal sac by inserting a Hoffmann retractor over the superior pubic ramus. A Deaver retractor was used to protect the external iliac vessels. Vascular anastomoses, including the corona mortis, were looked for and cut after ligation, if detected. The fascia of the psoas muscle was incised and the psoas muscle was mobilized to expose the pelvic iliopectineal line and the quadrilateral surface up to the cranial and medial border of the sacroiliac (SI) joint. This exposure can then be extended to the opposite side of the pelvic ring through the same skin incision, as necessary. The reduction of displaced anterior ring fractures could be obtained by usual pelvic reduction forceps, intraoperative skeletal traction of the injured lower extremity, and temporary external fixation. After reduction of the fracture on the anterior pelvic ring, a 3.5-mm reconstruction plate was applied on the medial side of the superior pubic rami and pelvic brim. We selected the correct length of plate and prebent it on the sawbones, depending on the fracture pattern, to obtain stable screw fixation on the dense cortical bone. All bicortical screws were applied to the anterior ramus distally and directed above the hip joint proximally.

In cases of crescent fractures, SI joint dislocation, and transiliac fractures, posterior ring reduction and fixation using a 3.5-mm reconstruction plate through the first window of the ilioinguinal approach was performed prior to anterior ring fixation. In cases of transsacral fracture patterns, we preferred to reduce and fix the anterior ring fractures first, which then made it easier to fix the posterior ring injury using an iliosacral screw as a minimally invasive method.

The surgical wound was repaired by layer, leaving a

suction drain. We encouraged the patients to move with a wheelchair or crutches 2–3 days postoperatively, if the postoperative pain was tolerable.

## RESULTS

The average age of the patients was 41 years (range, 23 to 61 years). There were 10 males and 12 females. The mechanism of injuries were 15 motor vehicle accidents and 7 falls from a height. According to the Young and Burgess classification, there were 12 lateral compression, 4 anteroposterior compression, and 6 vertical shear injuries. The fracture location on the anterior ring was near the iliopectineal eminence in all cases and exposure of the pelvic brim was required for plate fixation in each case. The patterns of posterior ring injuries were all also unstable (12 transsacral fractures, 5 crescent fractures, 3 SI joint dislocations, and 2 transiliac fractures).

Thirteen patients had associated chest, abdominal, and urological injuries and 5 patients sustained associated long-bone fractures. Five patients showed a hemodynamically unstable vital status on arrival, so we performed a temporary external fixation as a damage control surgery in 4 patients and an angiographic arterial embolization was needed in the remaining patient. The time interval from initial external fixation to definite fixation was 17.4 days (range, 11 to 30 days).

Anterior ring fixations were performed with single 3.5-mm reconstruction plates spanning from the pubic symphysis to the anterior aspect of the SI joint in all cases without double plating.

The methods for posterior ring stabilization were 11 percutaneous iliosacral screw fixations, 8 anterior plate

fixations on the SI joint, and 2 posterior transsacral platings. Anterior plate fixation only was performed in 1 case without posterior fixation.

The average radiologic follow-up period was 16 months (range, 10 to 51 months). All fractures united at an average of 3.5 months (range, 3 to 5 months). According to the Matta method,<sup>1)</sup> the quality of reduction was classified as follows: 16 anatomical (73%) and 6 nearly anatomical (27%) reductions. There were no cases of screw or implant loosening before bone healing.

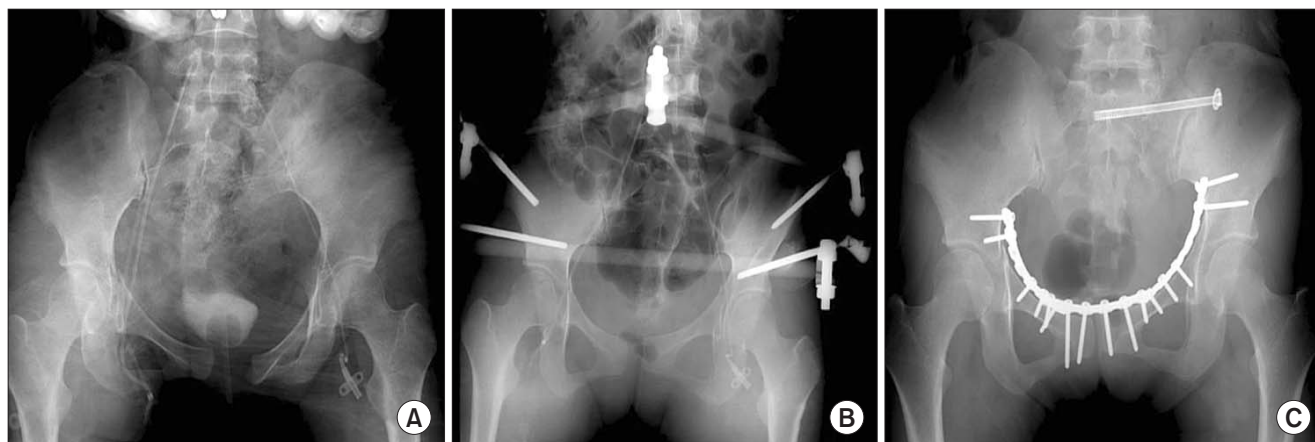
The functional results were classified as 7 excellent (32%) and 12 good (55%) by the Merle d'Aubigne-Postel score.<sup>7)</sup> Three patients (13%) showed unsatisfactory functional results, and were graded as fair. Two patients had pre-existing foot drop before the surgery and there was one case of postoperative lumbosacral plexus injury after an iliosacral screw fixation.

There were no wound complications, neurovascular injuries, or other complications related the surgical approach.

## DISCUSSION

Hirvensalo et al.<sup>5)</sup> and Cole and Bolhofner<sup>6)</sup> described an anterior intrapelvic extraperitoneal approach for the internal fixation of fractures commonly managed with an ilioinguinal approach. This approach was a modification of an intrapelvic approach described by Stoppa et al.<sup>8)</sup> for the repair of inguinal hernias using Dacron mesh.

The most notable difference between the ilioinguinal approach and the modified Stoppa approach is the avoidance of the dissection of the middle window, and thus the femoral neurovascular bundle, within the ingui-



**Fig. 1.** A 36-year-old female sustained a hemodynamically unstable pelvic ring injury. (A) The plain X-ray shows an anteroposterior compression pelvic injury with transsacral fracture and symphyseal disruption. There was also bilateral superior pubic ramus fracture. (B) Temporary external fixation was performed as a damage control surgery. (C) Definite anterior plate fixation was carried out through a single midline vertical incision.

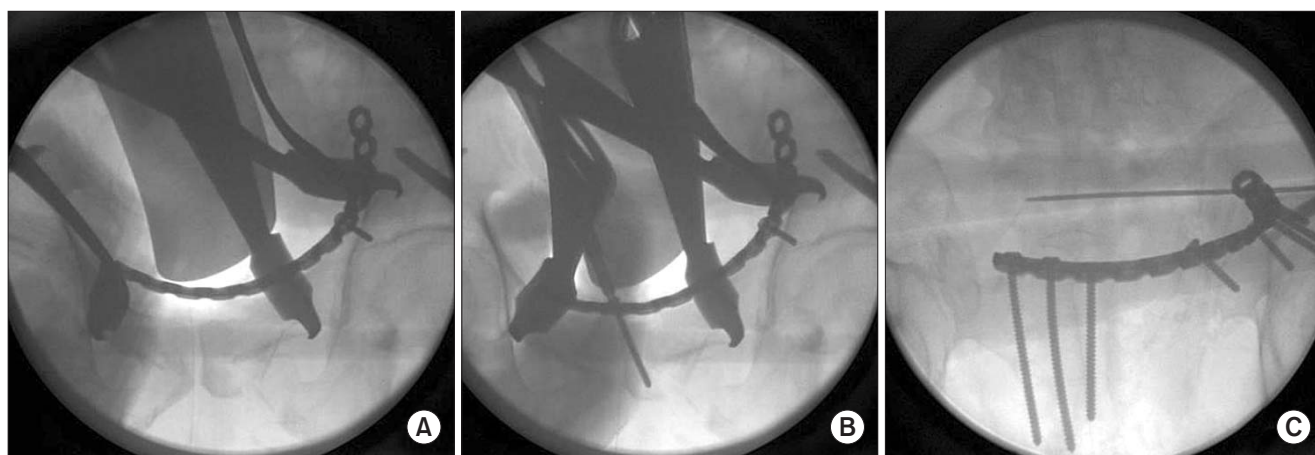
nal canal. The modified Stoppa approach provides direct visualization of the entire pelvic brim from the pubic symphysis to the anterior aspect of the SI joint. For anterior ring injuries that involve the symphysis as well as the lateral ramus, the surgeon can extend the exposure up the pelvic brim to gain fixation above the acetabulum.

Another advantage of this approach is that fixation of the bilateral pelvic ring and acetabulum fractures can be performed through a single Pfannenstiell incision.<sup>9)</sup> In the present study, 3 patients had bilateral anterior ring injuries combined with transsacral fractures. A single midline vertical skin incision above the symphysis pubis provided enough exposure for bilateral anterior plate fixation, which was a minimally invasive approach compared to the bilateral ilioinguinal approach (Fig. 1).

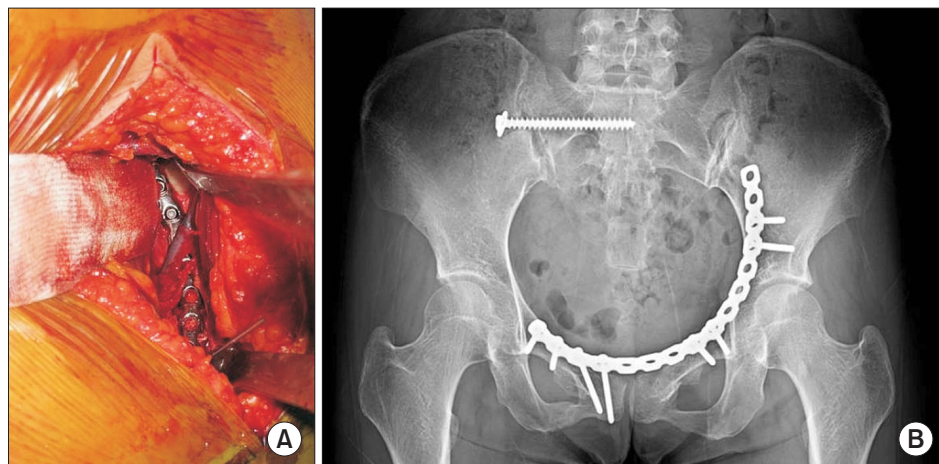
For the reduction of the displaced anterior ring fractures in our series, the usual pelvic reduction clamp and

forceps were useful tools, but a prebent plate was also a helpful reduction tool, as the fracture fragment was pulled toward the prebent plate (Fig. 2).

The horizontal Pfannenstiell incision is the preferred exposure for both the Stoppa approach and as the “medial window” of the ilioinguinal approach. However, the pubic vertical incision and deep dissection are familiar to urological, vascular, gynecological, and general surgeons and provide excellent access to the bladder and bladder neck for repair of associated urologic injuries. In our series, we performed midline vertical incisions for the Stoppa approach in all cases, but there was no limitation on the retraction of rectus abdominis, peripheral plate access, and the trajectory of peripheral plate screws (Fig. 3). We found that the Trendelenburg position and hip flexion could be used to release the tension of iliopsoas muscle, and also exposed the anterior margin of the SI joint through the



**Fig. 2.** The sequence of indirect reduction of a displaced anterior ring using a prebent plate is shown. (A) The prebent plate was applied on the disrupted anterior ring. (B) Displaced fracture was reduced to the plate by cortical screw insertion. (C) Acceptable reduction of the anterior ring could be obtained with the prebent plate.



**Fig. 3.** (A) Intraoperative photograph of a midline vertical incision. (B) There is no limit on the peripheral plate access or the trajectory of the peripheral plate screws.



midline vertical incision.

The posterior portion of the pelvis plays a significant role in the weight bearing of the pelvic ring.<sup>10)</sup> Therefore, the surgical procedures have been focused on the reduction and fixation of the posterior ring in type C pelvic injuries. Currently, many surgical fixation methods are available, such as direct posterior plate,<sup>11)</sup> iliosacral screw fixation,<sup>12,13)</sup> plate synthesis on the ventral side of the SI joint,<sup>14)</sup> and transsacral plate synthesis.<sup>11)</sup>

The choice of the operative method and the sequence of fixation depends on the overall hemodynamic status of the patient, associated injuries, condition of the soft tissue surrounding the pelvis, the configuration of the pelvic injury, as well as the preference of the surgical team. However, a major concern of the direct posterior approach is wound complications on the already-traumatized soft tissue. The prone position of the patients on the operative table is also problematic since combined injuries are common in unstable pelvic ring injuries.

We consider that the supine position is less damaging to an already hemodynamically compromised pelvic injury patient. The internal iliac approach (first window of ilioinguinal approach) in the supine position is our preferred approach for posterior ring injuries (crescent fracture, SI joint dislocation, and transiliac fracture); anterior ring fixation using the Stoppa approach is subsequently performed to restore stability in the entire pelvis.

In cases of transsacral fracture, attempts were first made to reduce and fix the anterior ring injury, which was useful to obtain the indirect reduction of a displaced transsacral fracture, and percutaneous iliosacral screw fixation was then performed.

In cases where there were 2 transsacral fractures, after plate fixation of the anterior pelvic rings, the posterior ring fractures were fixed with percutaneous transsacral plating in the prone position instead of iliosacral screw fixation. Iliosacral screw fixation was not performed due

to fractured fragments in the neural foramen, therefore compression of the fracture site, such as that associated with screw fixation, would increase the risk of neural injury.

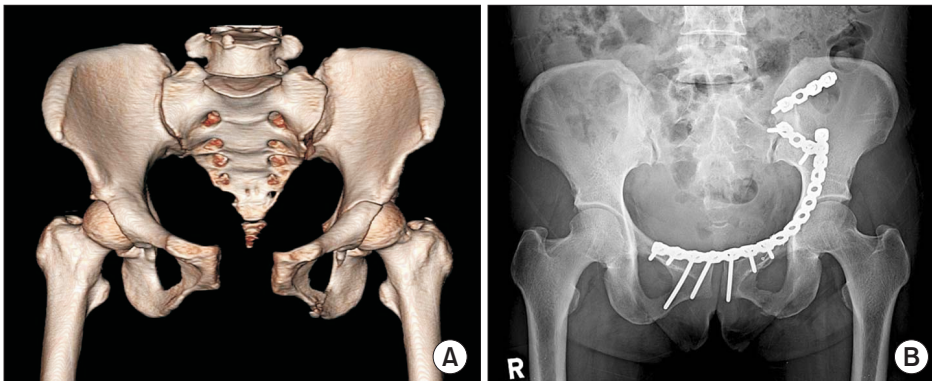
Thus, simultaneous operative fixation of the pubic fracture is necessary during the surgical fixation of the posterior ring injury if the patient's condition is tolerable.

Simonian et al.<sup>15)</sup> performed stability tests and found that significantly less movement was detected in the SI joint in surgically treated pubic fractures. The plate synthesis of the pubic fracture offered a greater stability than the retrograde pubic ramus screw.

Based on our experiences, anterior plate fixation using a Stoppa approach was very useful to restore stability to the entire pelvis in the treatment of unstable pelvic ring injuries (Fig. 4). Acceptable reduction was obtained in all cases and there was no case of nonunion and implant loosening caused by the unstable fracture fixation.

One of the most important surgical goals for pelvic ring injuries is the immediate mobilization of the patients to avoid the complications related to long standing immobilization. In order to obtain a secure fixation on the anterior pelvic ring, bicortical long screws should be fixed on the dense cortical area and exposure of the sciatic buttress area is needed, especially in cases where the fracture is located on the iliopectineal eminence. Management of pelvic ring injuries using minimally invasive techniques may be desirable if reduction and stability can be achieved. Potential benefits of minimally invasive anterior surgical pelvic fixation may include reduced blood loss, soft tissue complications, and infection, as well as faster rehabilitation of the patient with better pain control. The modified Stoppa approach can save operation time, while reducing intraoperative bleeding and hospital stay.<sup>16)</sup>

In conclusion, stable anterior ring fixation placed *via* the Stoppa approach can result in excellent reduction and stable screw fixation with a low complication rate for the treatment of unstable pelvic ring injuries.



**Fig. 4.** (A) Unstable pelvic ring injury in a 43-year-old female. (B) Stable anterior ring fixation combined with posterior fixation can increase the stability of the entire pelvis.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

## ACKNOWLEDGEMENTS

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