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Research Article

Does Percutaneous Lumbopelvic Fixation Result In Less Post-Operative Complications Compare To Open Lumbopelvic Fixation?

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Abstract

Background: Lumbopelvic fixation is commonly used to treat unstable sacral fractures; traditionally an open technique. Percutaneous lumbopelvic fixation is a viable substitute and may reduce wound-related complications. This study compares the incidence of complications associated with percutaneous lumbopelvic fixation versus open surgery.

Methodology: Retrospective chart review. Adult patients (age >18 years) who underwent lumbopelvic fixation for Spinopelvic dissociation injury or complete vertical shear sacral fracture who did not require open reduction and judged able to be treated both open and percutaneously.

Outcome of study: Thirty-one patients with unstable sacral fracture not requiring open reduction underwent lumbopelvic fixation, 15 with open lumbopelvic and 16 with percutaneous lumbopelvic fixation. There was no significant difference between the groups for AO fracture classification, age, gender, or BMI. Estimated blood loss was significantly lower in percutaneous group (137 ml) compared to the open fixation group (434 ml) (p=0.002) Average operative time for the percutaneous group was 130 min *vs.* 200 min (p=0.009). Five (36%) patients in the open fixation group developed wound infections requiring additional surgery. There was one unexpected return to the OR for infection in the percutaneous group. Patients in both groups were cleared for weight-bearing at 3 months follow-up.

Percutaneous lumbopelvic fixation is preferred to open fixation in patients with spino-pelvic dissociation and sacral vertical shear injuries requiring lumbopelvic stabilization without open reduction.

Keywords: Lumbopelvic fixation; Unstable sacral fracture; Lumbopelvic dissociation; Outcomes; Complications; Percutaneous fixation

Introduction

Spinopelvic dissociation is a functional separation of the lumbo sacral spine from the pelvis, presenting as "U" and "H"-type fractures that separate the upper central sacrum from the peripheral sacrum and pelvis. These injuries consist of transverse and vertical injury patterns. Although spinopelvic dissociation injuries are rare, they are commonly the result of high-energy trauma associated with additional pelvic and spine fractures as well as multi-system organ injuries and neurological dysfunction [1]. There are several surgical options for the management of lumbopelvic dissociation including iliosacral or transiliac-transsacral screw fixation, plate fixation, and lumbopelvic fixation [2-4].

Lumbopelvic fixation has historically been performed through an open approach, either through a midline approach or para median incisions, providing stability between the lower lumbar spine and the iliac wings [5,6]. It can also be used to treat patients with a complete vertical shear sacral fracture [7]. This technique is important for the maintenance of fracture reduction and early weight-bearing as other techniques have higher failure rates [8].

Open lumbopelvic fixation is associated with a relatively high rate of wound dehiscence, and infection, in the range of 16% to 26% [5,7]. There has been increasing use of percutaneous lumbopelvic fixation, with the goal of reducing wound complications associated with open lumbopelvic fixation [9]. Because injuries treated with open techniques would include more severe injuries that require open reduction and would therefore not be amenable to percutaneous fixation techniques, a direct comparison between complications of open versus percutaneous lumbopelvic fixation has been difficult.

The purpose of this study was to identify patients amenable to treatment with either open or percutaneous lumbopelvic fixation, and to compare postoperative complications. We hypothesize that percutaneous lumbopelvic fixation results in decreased blood loss, shorter operative time, lower infection and wound complications, and fewer unexpected returns to the operating room while maintaining comparable fracture stability to open lumbopelvic fixation.

Material and Methods

Data collection

Approval from our institutional review board was obtained. Current Procedural Terminology (CPT) codes for lumbopelvic

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fixation were used to identify patients who underwent lumbopelvic fixation between 2014 to 2019 at a single academic Level trauma center. All surgeries were performed by board-certified fellowship-trained spine surgeons. The inclusion criteria were adult patients (age >18 years) who underwent lumbopelvic fixation for Spinopelvic dissociation injury or complete vertical shear sacral fracture who did not require open reduction and judged able to be treated both open and percutaneously. Exclusion criteria included patients who required open reduction of their fracture, subacute injury, insufficiency fractures, pathologic fractures, non-unions, pediatric fractures, concomitant lumbar pathologies, including lumbar burst fractures, spondylolisthesis, and open fractures. Figure 1 is a consort diagram describing how our study sample was obtained. The use of open *vs.* percutaneous lumbopelvic fixation was based on the surgeon's preference. Operative reports for those patients treated with open fixation were reviewed to ensure that no open reduction was required, making the groups equivalent. The AO Spine Sacral Fracture Classification [10] was used to classify all fractures based on pre-operative CT scans. Fracture classification was determined by a fellowship-trained orthopedic spine surgeon. Demographic data included age, gender and mechanism of injury. Clinical data included operative time, blood loss, intraoperative transfusion, length of hospital stay, and unexpected returns to the operating room. Follow-up data include any additional surgeries related to the lumbopelvic injury with clearance for full weight-bearing status at 3 months. There was no patient or public involvement in this study.

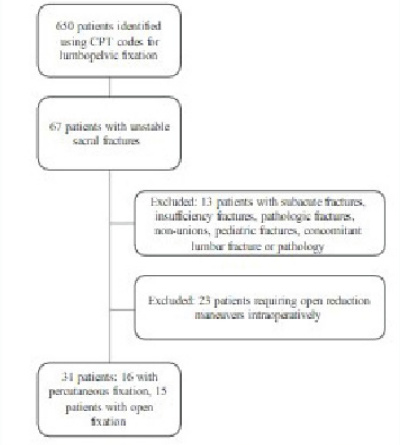

Figure 1: Inclusion and exclusion for cohort selection.

Surgical technique

At our institution, patients with lumbopelvic dissociations or complete vertical shear sacral fractures are jointly managed by the orthopaedic trauma and spine teams. The pelvic ring component is typically treated with either iliosacral or transiliac-transsacral screw fixation of the posterior ring and either plating or percutaneous pubic ramus screws for fixation of the anterior ring. The spinopelvic component is stabilized with lumbopelvic fixation, for additional stability. For the purpose of this study, patients undergoing spinopelvic fixation have already undergone closed pelvic reduction and stabilization and there is no need for open reduction of their sacral fracture, only for enhanced spinopelvic stability.

Open Fixation Technique (5)

A midline or wilste approach exposes the L5 pedicle screw starting point at the L4-L5 facet joint and the starting point for the iliac screw placement along the medical aspect of the posterior ilium. L5 pedicle screws and iliac screws are placed based on anatomic landmarks under fluoroscopic guidance. Our starting point for the iliac screws is at the level of S2, medial to the posterior superior iliac spine. The L5 and iliac screws are secured to longitudinal rods to complete the stabilization process. A sub fascial drain is routinely placed before wound closure (Figure 2 and 3).

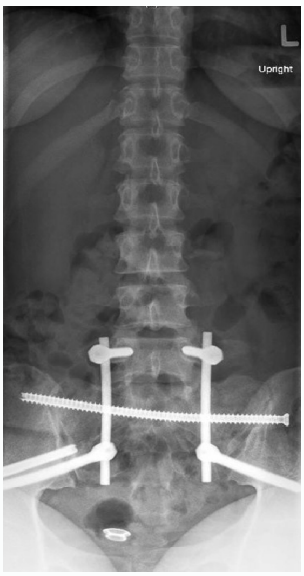

Figure 2: Anteroposterior view of lumbosacral area of showed L5 to iliac screw fixation placed by open lumbopelvic technique. Patient also has transiliosacral screw fixation and iliac wing fixation.

Figure 3: Lateral view of lumbosacral area of showed L5 to iliac screw fixation placed by open lumbopelvic technique. Patient also has transiliosacral screw fixation.

Percutaneous lumbopelvic fixation technique

We use the technique described by Williams et al. [11] in which a true Anterior-Posterior (AP) view of L5 is obtained and the L5 pedicle is identified and marked on the skin under fluoroscopic guidance. A 2 cm incision is made 1 cm to 2 cm lateral to the lateral projection of the L5 pedicle on the AP fluoroscopic image. Blunt soft tissue dissection is carried down through the muscle toward the facet joints. Under fluoroscopic guidance, a Jamshidi needle is placed on the lateral border of the L5 pedicle and then advanced anteriorly and medially. A Nitinol guide wire is placed through the Jamshidi needle

and an annulated pedicle screw is placed over the guide wire under fluoroscopic imaging. For iliac screw placement, a teardrop (obturator-outlet) view of the pelvis is obtained and the center of the teardrop is marked, usually near the midline at S1, where a 2 cm incision is made. A Jamshidi needle is then placed in the center of the teardrop under fluoroscopic guidance, between the inner and outer cortex of the iliac wing. An iliac screw is placed over a guide wire placed through the Jamshidi needle. A rod is then tunneled percutaneously to connect the L5 pedicle screw to the iliac screw. If an extra level of fixation is needed, an L4 pedicle screw is placed using a similar technique. The incisions are then closed in a layered fashion without a drain (Figure 4 and 5).

Statistical analysis

All data were analyzed using descriptive statistics. Statistical significance was set to $p< 0.05$. All analyses were done using Excel (Microsoft) and SPSS v 25 (IBM).

Figure 4: Anteroposterior view of lumbosacral area of showed L5 to iliac screw fixation placed by percutaneous lumbopelvic technique. Patient also has iliosacral screw fixation and postero-to-anterior pubic rami screw fixation.

Figure 5: Lateral view of lumbosacral area of showing L5 to iliac screw fixation placed by percutaneous lumbopelvic technique. Patient also has transiliosacral screw fixation and rami screw fixation.

Results

Demographics

A total of 67 patients underwent lumbopelvic fixation for spinopelvic dissociation or complete vertical shear sacral fracture during the six-year study period. Thirty-six patients were excluded: 23 patients underwent open reduction, 1 patient sustained a pathologic fracture, 3 had subacute fractures, 3 had lumbar fractures, 2 had spondylolisthesis, 1 had an insufficiency fracture secondary to low energy trauma, 2 with non-unions and 1 was less than 18 years of age. The remaining 31 patients were included in our study; 15 patients were treated with open lumbopelvic fixation and 16 were treated with percutaneous lumbopelvic fixation. There were no differences between the two treatment groups in terms of age, gender, mechanism of injury, and BMI (Table 1). Four patients in the percutaneous lumbopelvic fixation group and 2 patients in the open fixation group were diabetic (p=0.65).

All of the fractures were AO spine sacral fracture classification type B and type C injuries [11]. In the percutaneous group, there was 1 type B2 injury, 4 type B3 injuries, one Type C2 injury, and 10 types C3 "H" or "U" type sacral fractures (Table 1). In the open group, there were 6 type B3, 1 type C2, and 8 type C3 injuries. Eight of the 15 patients in the percutaneous group required bilateral lumbopelvic fixation and 13 out of 16 patients in the open lumbopelvic fixation group required bilateral lumbopelvic fixation.

Intraoperative data

In the percutaneous group, the average estimated blood loss was 137 ml, compared to 434 ml in the open fixation group (p=0.002). Four patients received blood products intraoperatively in the percutaneous lumbopelvic fixation group compared to 8 patients in the open fixation group (p=0.15). The average operative time in the percutaneous group was 130 minutes (Median 115) compared to 200 minutes (Median 169) in the open fixation group (p=0.009). One patient who underwent percutaneous lumbopelvic fixation early in our learning curve had an operative time of 358 minutes which was a substantial outlier compared to the other cases. The difference between the length of stay of 27 days in the percutaneous group and 24 days in the open group was not statistically significant. Two patients in the percutaneous group had hospital length of stays greater than 90 days due to lack of discharge placement availability.

In patients who underwent bilateral lumbopelvic fixation, the EBL was 464 ml for the open fixation group (Median 400) and 204 ml for the percutaneous group (Median 125) (p=0.03). Mean operative time was similar for patients treated with percutaneous fixation (146 minutes) (Median 120) compared to the bilateral open fixation group (206 minutes) (Median 187) (p=0.13). However, a significant difference was seen in operative time when an outlier in the bilateral percutaneous lumbopelvic fixation group was removed (p=0.001).

Follow up data

24 patients had follow up of at least 3 months, all of whom were bearing weight as tolerated without complications.

In the open group, 1 patient never returned for follow up and 2 patients only had 3 weeks of follow up. The remaining 12 patients had an average follow-up of 1 year, and a median follow-up of 352 days (103-515 days). Two patients underwent planned hardware removal based on the surgeon's preference, despite the patient being asymptomatic. There were no hardware revisions.

In the percutaneous lumbopelvic fixation group, 2 patients died during their initial hospital stay (one from multi-organ failure (day 3) and one from neurologic decline (day 10)) and 2 were seen for wound check at 3 weeks with no concerns and then lost to follow up before their 3-month clinic visit. The remaining 12 patients had more than 3 months of follow-up. The average follow-up was 284 days and the

Table 1: Patient Demographics.

Demographics	Open Fixation (n=15)	Percutaneous Fixation (n=16)	P value
Gender (no. [%] of patients)			0.156
Male	6 (0.4)	11 (0.84)	
Female	9 (0.6)	5 (0.16)	
Mean age (yr)*	40 ± 4.7	45 ± 3.4	0.365
Mechanism of injury (no. [%] of patients			0.905
Motor vehicle accident	7 (0.47)	4 (0.25)	
Fall from height	4 (0.27)	8 (0.5)	
Struck by auto	4 (0.27)	2 (0.125)	
Crush injury	0 (0)	2 (0.125)	
Diabetes (no. [%] of patients)	2 (0.13)	4 (0.25)	0.41

median was 259 days (114-427 days). There were no revision surgeries or planned hardware removals in this group.

Complications

In the open group, one patient was lost to follow up after discharge. Of the remaining 14 patients, 5 (36%) patients required irrigation and debridement for culture positive wound infections. Four of the 5 patients were diagnosed within 5 weeks of their index procedure which was during their initial hospital stay. The remaining infection occurred 6 months after their index procedure. In the percutaneous group there was one unexpected return to the operating room for infection or wound complication. One patient had a rod dislodge from the L5 screw at 6 weeks follow-up. The patient was asymptomatic and the fracture had healed, therefore no further surgical intervention was required.

Discussion

Open lumbopelvic fixation, regardless of whether unilateral or bilateral, has been associated with wound complication rates ranging from 16% to 26% [9]. Although the current literature suggests that percutaneous lumbopelvic fixation may be beneficial compared to open lumbopelvic fixation with regard to wound infection and complication rates, comparable groups have yet to be evaluated [12-14]. By its very nature, open fixation groups will tend to include more complex fracture patterns that have an inherently higher risk of complications, thus confounding the true effect of the open vs. percutaneous approach. We therefore specifically excluded patients that required open reduction in order to compare similar injuries, which would be amenable to either percutaneous or open lumbopelvic fixation.

Our results demonstrate that percutaneous lumbopelvic fixation significantly reduces blood loss and operative time. Patients who developed postoperative wound infections requiring additional surgery were primarily from the open fixation group. Although our sample size is limited, our results are sufficiently convincing to allow us to conclude that percutaneous lumbopelvic fixation is associated with a decrease in wound complications.

We did not see any difference in intraoperative blood transfusion rates and hospital length of stay between our percutaneous and open fixation groups. This may be attributed to the fact that the majority of our patients with spinopelvic injuries are polytrauma patients whose overall clinical situation has more to do with the length of their hospital stay and the need for blood transfusion than the surgical technique used for stabilizing their spinopelvic injury.

Although only 77% of our patients had more than 3 months of follow-up, we did not see a difference in hardware failure or unplanned revision. The rate of healing and weight-bearing status at 3 months did not differ between the two groups. Follow-up was similar in both groups in our cohort. One patient with percutaneous fixation had dislodgement of the rod from the pedicle screw, which did not seem to impact the patient's eventual fracture healing. Our results suggest that percutaneous lumbopelvic fixation has similar stability and therefore the same potential for eventual fracture healing as open lumbopelvic fixation.

This study had several limitations. This is a retrospective study with a small sample size despite having a six-year capture period. By eliminating patients who required open reduction of their fracture, our sample size was cut in half. Additionally, the small sample size for our percutaneous lumbopelvic fixation group is related to both the relatively short 4-year period during which we have adopted this technique, and the narrower injury profile that is amenable to percutaneous lumbopelvic fixation. Another limitation was that EBL is routinely an estimate. Planned hardware removal is not routine at our institution as previous studies have indicated no particular benefit to fusion or hardware removal [8]. Symptomatic implants may take a longer time to develop and further studies are warranted to address the need for secondary surgery especially in patients with percutaneous lumbopelvic fixation.

Conclusion

In conclusion, patients undergoing percutaneous lumbopelvic fixation for unstable sacral fractures had significantly lower blood loss, operative time, in-hospital wound complications, and infections requiring a return to the operating room compared to patients undergoing open lumbopelvic fixation. Thus we believe percutaneous fixation should be considered an option in this patient population.

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