Chapter Nine

The Lateral View in Fluoroscopic Positioning of Sacroiliac Screws

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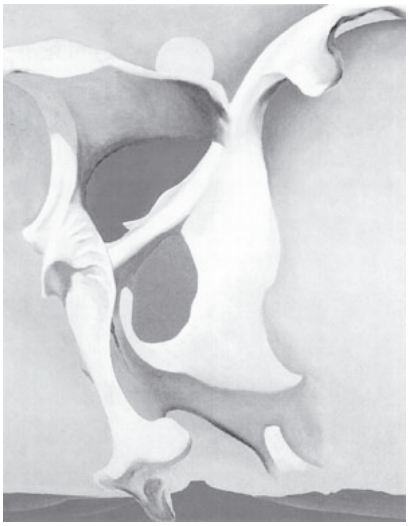

SUMMARY

Introduction.

Fluoroscopic placement of guided sacroiliac screws is a well-established method of fixation of the posterior pelvic ring. Although it is recommended to use a lateral view in addition to inlet and outlet view, there have been few publications about the importance of this view.

Methods.

74 patients, in whom the posterior pelvic ring was stabilized for several indications, were reviewed retrospectively. On peroperative radiographs and postoperative C.T. scan positioning was scored for 222 screws and compared to clinical results.

Results.

Sacroiliac screw positioning was evaluated in 74 patients with an average follow-up of 12.6 months. Three patients had temporary neuralgia or sensory deficit, which was caused by malpositioning of the sacroiliac screws, which was seen on C.T. and could, retrospectively be suspected on fluoroscopy. Lateral view proved to be a significantly more accurate predictor on both dorsoventral as well as craniocaudal position of the sacroiliac screw than inlet view or outlet view.

Discussion.

Despite the peroperative disadvantages of the lateral view with regards to fluoroscopy time, it improves the accuracy of the sacroiliac screw positioning and may decrease postoperative malpositioning and finally neurological complications.

INTRODUCTION

Sacroiliac screw positioning is an increasingly popular method of stabilizing the posterior pelvic ring, both after trauma as well as for nonunion. Open reduction and internal fixation of the posterior pelvic ring is associated with a high complication rate of which peroperative haemorrhage and postoperative infection are the most common. Several biomechanical studies have shown that sacroiliac screws have similar properties as plate fixation, with the additional advantage of percutaneous positioning, thus avoiding large wounds and associated wound infections[1-3]. Several methods of positioning are used guided by conventional fluoroscopy, computer-navigated fluoroscopy or C.T.-guided navigation. Conventional fluoroscopy still remains the most commonly used method. During positioning of the sacroiliac screw both inlet, outlet and lateral views guide the surgeon's hand. The inlet view shows the relationships of the spinal canal and the sacroiliac joint and the outlet demonstrates the upper border of the sacrum and the sacral foramina[4]. Finally the lateral view illustrates the anterior border of the sacrum most clearly. In a cadaveric study by Xu e.a. the inlet and outlet views seemed to be most important in prevention of misplacement of sacroiliac screw[5].

Because previous study has shown that neurological injury from sacroiliac screw positioning occurred in about 8%, several improvements have been added to the technique[6]. The positioning of the lower screw in the second sacral vertebral body was associated with a higher change of neurological impairment and, therefore, is avoided if possible. The addition of a lateral view in order to determine both dorsoventral as well as craniocaudal position more closely, was suggested by Routt[7]. Especially the recognition of the sacral alar slope might be useful in positioning the screw in the mid portion of the ala[8]. Although they concluded that the addition of the true lateral view seemed to decrease the risk of neurological injury to the sacral roots, they did not examine the relationship between the positioning as seen on the lateral view in comparison with C.T. scan. The question whether the lateral view is required in order improve the safety of sacroiliac screw positioning, is still unanswered. Since the lateral view requires additional operative time and increases the fluoroscopy time, this is an important consideration for safe sacroiliac screw positioning.

In this study we examined the correlation between the positioning on the inlet and outlet view and especially on the true lateral view in correlation with postoperative C.T. scan, in order to determine the necessity of the lateral view. In total 222 sacroiliac screws positioned in 74 patients were examined.

MATERIAL AND METHODS

Retrospectively the charts and radiographs were reviewed of all patients in whom the posterior pelvic ring was stabilized using canulated sacroiliac screw fixation, between 1 January 2000 and 1 January 2002. The operative procedure has been described previously and consisted of posterior pelvic ring fixation with one or two sacroiliac screws under fluoroscopic guidance usually in combination with anterior plate or screw fixation[6]. In total 111 patients were operated of which 23 were re-operations and were therefore excluded. In 14 patients insufficient data (mainly peroperative fluoroscopy) was present. The indications for fixation were trauma patients with unstable pelvic ring fractures, Tile B or C type, as well as posttraumatic nonunion or posttraumatic pain syndrome and permanent disability due to post partum pelvic pain. Postoperative complications were scored.

The inlet view was used to score screw placement in dorsoventral direction i.e. the relation to the vertebral body and the sacral canal. The vertebral body was divided into three zones (anterior, midvertebral and posterior). If the screw protruded from the corpus it was scored as ventrally extra-osseous or protruding into the sacral canal. The outlet view was used to score screw placement in craniocaudal direction i.e. the relation to the sacral foramina. In this view the craniocaudal distance between two levels of vertebral roots was also divided into three categories. If protrusion into the foramina was suspected, this was scored as reported previously[6]. On the lateral view both craniocaudal position of the tip of the screw, as well as dorsoventral position were scored and categorized in similar categories as the inlet and outlet view. The results from peroperative fluoroscopy (inlet, outlet and lateral) views were compared to C.T. scan. Similar scoring as for conventional radiography was used for C.T. scan, dividing the sacral body in three zones, both dorsoventral as well as craniocaudal. The relationship with the sacral foramina was also scored. Charts and radiographs were reviewed independently by the authors. Examples of the radiological views are shown in figure 1.

All data were analyzed with SPSS using Student t-test, Pearson nonparametric correlation, and Chi square test.

RESULTS

In 74 patients (51 women and 23 men) the posterior pelvic ring was stabilized using canulated screws. The average age was 37.6 years. 23 patients were operated for trauma (mainly motor vehicle accidents or falls from height). In Tile B fractures (13 patients) usually one sacroiliac screw was used, while in Tile C fracture (10 patients) two sacroiliac screws were used. In two patients it was necessary to perform an open procedure in order to achieve adequate reduction, in all other cases the screws were inserted percutaneously. In 42 patients with post partum pelvic pain the posterior pelvic ring was stabilized with two sacroiliac screws, bilaterally in almost all cases. The remaining eight patients were operated for non-union.

Two patients died after trauma because of neurological injury. In 63 patients the posterior fixation was combined with anterior fixation. Average follow-up was 12.6 months (3-27 months). Three patients reported postoperative neurological complaints based on sacroiliac screw malpositioning. In one of these patients sensory deficit of the fifth lumbar root was noted, no motor deficiency was seen. All complaints improved after repositioning of the screws. In two cases malpositioning

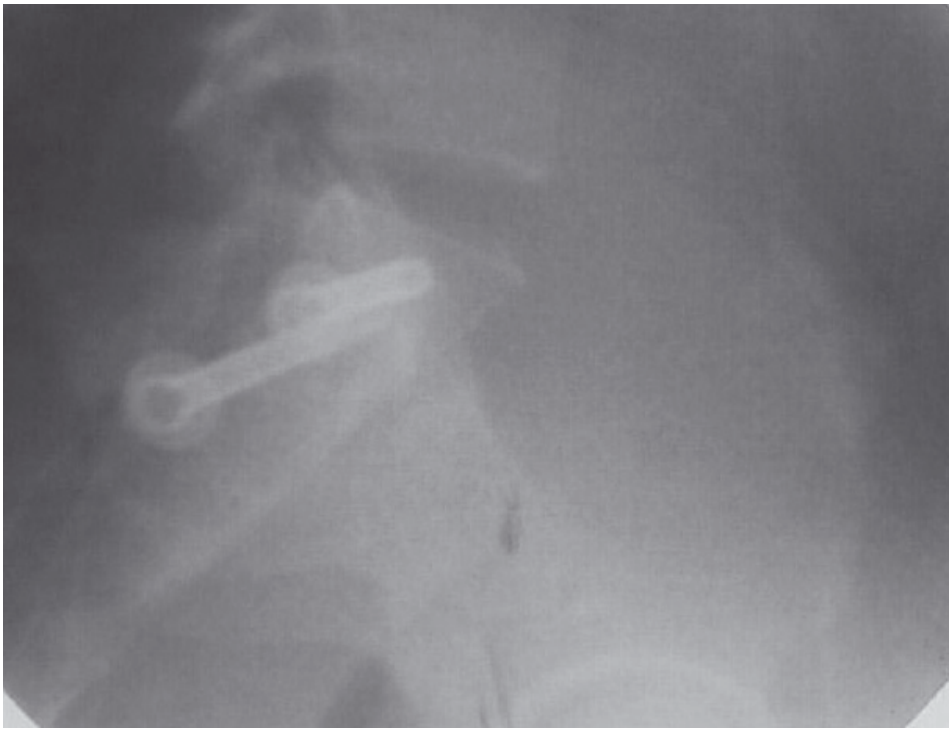

Figure 1. Example of a lateral view with two sacroiliac screws accurately positioned in the first sacral vertebral body. Note that it is not a perfect lateral view as demonstrated by the fact that the border of the obturator foramina do not exactly project over each other.

was clear on C.T. scan and, in retrospect, malpositioning could be suspected on the peroperative fluoroscopy. In the third case no malpositioning was seen. Other complications were anterior wound infection in four patients, which required removal of the osteosynthesis in one patient. No posterior wound infections or haematomas were seen.

In total 222 screws were evaluated. Of the 222 screws 28 (13.1%) were positioned in the second vertebral body. Peroperative radiographs could be evaluated in 211 screws and for 219 screws C.T. was present. In table 1 and 2 the overall positioning of the screws on C.T. is given. Peroperatively 93.8% (198/211) of the screws were positioned intraosseously without intrusion of vital structures, on C.T. 92.6%(203/219). The correlation between the anteroposterior position on C.T. and peroperative inlet was 0.45 and 0.70 for the lateral view. If corrected for the position on the inlet view there was a significant correlation between the position on lateral view and on C.T. ($r=0.6$, $p<0.001$). Similar findings were found for the craniocaudal position. The lateral view was able to predict the craniocaudal position more accurately than the outlet view ($r=0.77$ for outlet and 0.82 for lateral, significantly better $p<0.001$). The anteroposterior position of the screw on the inlet view was scored significantly more anteriorly than on the C.T. scan ($p<0.001$), similar findings but to a lesser degree were found for the lateral view ($p=0.046$).

Besides the position of the tip of the screw in the vertebral body, suspicion of malpositioning either in ventrally of the sacral ala or into the vertebral foramen was scored. Peroperatively in 11 cases intrusion of the sacral foramina was suspected. In 2 cases intrusion of less than 50% of the screw diameter could be confirmed, while in the others no intrusion was seen. However, additionally 3 screws clearly

		Dorsoventral position on CT scan					
		ventrally extraosseous	ventral in corpus	center of corpus	dorsal in corpus	dorsal in to canal	**Total**
Per-operative dorso-ventral position	ventrally extra-osseous	3 (1.4%)	5 (2.4%)				8
	ventral in corpus	2 (1.0%)	43 (20.6%)	40 (19.1%)	9 (4.3%)		94
	center of corpus		13 (6.2%)	49 (23.4%)	23 (11.0%)	1 (0.5%)	86
	dorsal in corpus		4 (1.9%)	6 (2.9%)	9 (4.3%)	1 (0.5%	20
	dorsal into canal					1 (0.5%)	1
	Total	5	65	95	41	3	209

Table 1. Peroperative dorsoventral position versus dorsoventral position on C.T. scan

penetrated the foramen on C.T. scan and 13 screws were positioned very close to the foramen and the cortex of the foramen seemed to be penetrated. However none of these patients had any complaints. A position ventral to the sacral ala was suspected in 2 screws, and confirmed by C.T.. Nine additional screws were positioned partially anterior of the sacral ala without complaints or deficit in these patients. An example is shown in figure 2.

In the three patients who had neurological complaints or deficit two screws were positioned too posterior on the ilium and intruded into the sacral canal. In all cases the lower screw seemed to be malpositioned. In the last patient the lower screw was positioned close to the cortex of the foramen although intrusion was not very clear. Despite this fact his complaints resolved completely after removal.

		Craniocaudal position on CT scan					
		too high	high in corpus	center of corpus	low in corpus	too low	total
Per-operative cranio-caudal position	too high	3 (1.4%)	1 (0.5%)				4
	high in corpus	2 (0.9%)	58 (27.0%)	18 (8.4)			78
	center of corpus		7 (3.3%)	55 (25.6%)	13 (6.0%)		75
	low in corpus	1 (0.5%)	2 (0.9%)	10 (4.7%)	43 (20.0%)	2 (0.9%)	58
	total	6	68	83	56	2	15

Table 2. Peroperative craniocaudal position versus craniocaudal position on C.T. scan

DISCUSSION

Positioning sacroiliac screws percutaneously using fluoroscopic guidance is a difficult procedure because of the risk of damage to sacral nerves. Several studies have investigated the risk of neurological injury after sacroiliac screw positioning, the percentage neurological injury is between 0.5% and 13%[6,7,9-13]. In this study we evaluated the correlation between the peroperative fluoroscopy and postoperative C.T. scan and, especially, if the lateral view contributed to the overall safety of the procedure. Peroperatively, the lateral view is more difficult to obtain because of the necessary rotation of the C-arm, thus possibly compromising the sterility of the procedure. However, despite the fact that the lateral view is recommended by surgeons experienced in the fluoroscopy and the positioning of sacroiliac screws, no exact data is known whether this view decreases malpositioning of the sacroiliac screws.

In 74 patients, who were operated for several indications and followed for 12.6 months, a total of 222 sacroiliac screws were evaluated. Overall complications of sacroiliac screw positioning were few without any haematomas or wound infections. Three patients had neuralgia, in one patient hypaesthesia was seen. On C.T. the lower screw was positioned too posterior on the ilium in two cases, in the third case malpositioning was not so clear however removal of the screw resolved his complaints. In the other patients the complaints also resolved completely after removal. No permanent neurological deficit was seen.

The lateral view played an important role in predicting the accurate position as seen on C.T. scan. Both anteroposterior as well as craniocaudal position of the screw in the vertebral body correlated significantly better than on either the inlet or outlet view. Also an additional correlation between the position on the lateral view and the C.T. was seen after correction for the position on either the inlet or outlet view.

Intrusion into the sacral foramina was suspected peroperatively in 4.9% (11 screws) and on C.T. 2.3% (5 screws) penetrated the foramen. However none of these patients had any complaints. A position ventral to the sacral ala was suspect peroperatively in two screws. C.T. scan showed an additional nine screws to be positioned to anterior in respect with the sacral ala.

Three patients suffered from neuralgia, which was combined with sensory deficit in 2 patients. The lower screws which were positioned in the second vertebral body once and twice in the first vertebral body, caused these complaints due to intrusion into the sacral canal due to positioning too posterior on the ilium. In all cases the complaints resolved after removal.

Overall, safe positioning using fluoroscopy seems to be possible without permanent neurological deficit. In 4% of the patients removal of the screws was necessary because of neuralgia or sensory deficit. Besides the fact that our overall complication rate decreased compared to a previous study[6] since the introduction of the lateral view, the position of the screw in the vertebral body on the lateral view seems to correlate significantly better with C.T. scan than the inlet or outlet view.

The lateral view remains a difficult view because the repositioning of the C-arm in order to verify the correct position of the screw or the K-wire has several disadvantages. Besides the increased fluoroscopy time and possible compromise of the sterility, it takes additional time in usually severely injured patients. We hope that computer navigated fluoroscopy facilitates this procedure. But even with this technique we have shown in this study the additional value of the lateral view and the increased safety which may be obtained from it in the prevention of malpositioning of sacroiliac screw.

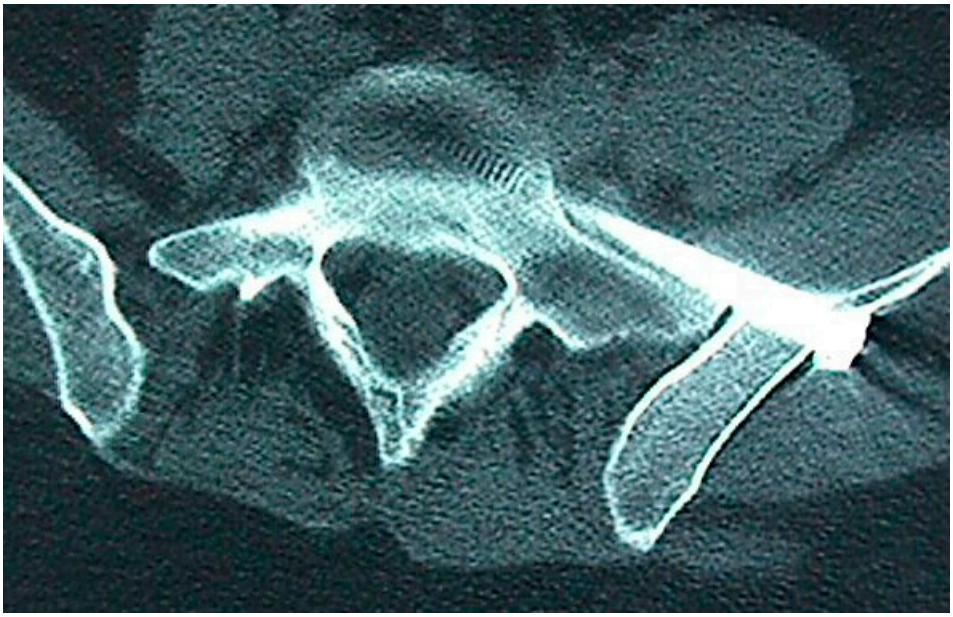

Figure 2. Although the head of the screw is positioned in the vertebral corpus part of the screw is positioned anterior to the sacral ala. The patient did not have any complaints.

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