Chapter Eight

Fluoroscopic Positioning of Sacroiliac Screws in 88 Patients

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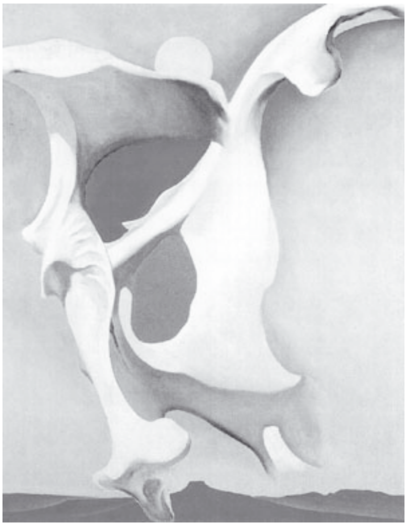


SUMMARY

Introduction.

Fluoroscopic placement of guided sacroiliac screws is a well-established method of fixation of the posterior pelvic ring, leading to biomechanical results similar to an intact pelvic ring. The main problem still remains the risk of neurological injury due to the penetration of the intervertebral root or the vertebral canal.

Material and Methods.

88 patients, in whom the posterior pelvic ring was stabilized for several indications, were reviewed retrospectively. On peroperative and direct postoperative radiographs and postoperative C.T. scan positioning was scored for 285 screws and compared to clinical results.

Results.

Depending on the type of imaging (X-ray or C.T. scan) only 2.1% to 6.8% of the screws showed malpositioning. In several cases the malpositioned screws did not cause any complaints. Postoperative radiographs did not show to have any additional value above peroperative radiographs, in predicting malpositioning.

7 out of 88 patients had neurological complaints and were re-operated. All complaints resolved completely, and no permanent neurological damage occurred. Positioning both sacroiliac screws in the first vertebral body had a significantly lower rate of neurological complaints compared to the lower screw in the second vertebral body. C.T. scan was able to predict neurological complaints most accurately.

Discussion.

Percutaneous sacroiliac screws can be positioned safely, in experienced hands, using peroperative fluoroscopic techniques. A position in the first vertebral body had a significantly lower incidence of neurological injury compared to a position in the second. In case of postoperative neurological deficit only C.T. scan can predict the clinical outcome. Further research towards improving the peroperative imaging technique must be undertaken.

INTRODUCTION

Nonoperative treatment of unstable pelvic ring fractures has a significant long-term morbidity, including pain, leg length difference, difficulty walking and sexual impairment. Internal fixation has shown to reduce mortality, morbidity and hospital stay[1-3]. Better anatomical reduction of the posterior dislocation can also be achieved which leads to a lower rate of malunion[4]. The biomechanical stability of internal fixation through sacroiliac screws approaches that of an intact pelvic ring and the period of nonweight bearing can therefore be minimized[5,6].

Open reduction and internal fixation of the posterior pelvic ring is traditionally associated with a high complication rate of which peroperative hemorrhage and postoperative infection are the most common. Neurological deficit is the most feared because of its severely disabling effects. Although it seems technically easier to position sacroiliac screws correctly through an open procedure, advantages of percutaneously placed screws include a minimal invasion of usually severely compromised soft tissue, limited blood loss and a decreased number of postoperative infections[7-9]. The disadvantage might be a possibly higher percentage of neurological injury.

Computed tomography guided fixation of the posterior pelvic ring is a new technique on which several small studies have been published[10-14]. Despite the advantage of a very precise imaging of the osseous structures of the pelvis, malpositioning is still possible[15]. Fluoroscopy, on the other hand, allows real-time imaging during positioning. Fluoroscopic placement of percutaneous sacroiliac screws requires a high degree of “three-dimensional thinking” and thorough knowledge of pelvic anatomy by the surgeon. The advantage of using a canulated screw technique is that a guide wire is drilled, which allows the surgeon to determine the position of the screw prior to definitive placement minimizing the risk of nerve injury.

In most patients the procedure was started by stabilization of the anterior pelvic ring through a Pfannenstiel incision using one or two plates or, in lateral pubic fractures, screw fixation. After the anterior approach the patient was turned over to prone position for the posterior surgical approach. In some unilateral cases the supine position was retained during the positioning of sacroiliac screws. Intraoperatively the posterior pelvic ring is evaluated through both inlet and outlet view by C-arm fluoroscopic radiographs. After peroperative marking with ink a small incision is made. Through this incision a 3-millimeter guide-wire is inserted. Using in- and outlet views and since 1999 the true lateral view for direction the guidewire is inserted in the first or second vertebral body, aiming towards the center part of the body. After correct positioning has been confirmed by inlet, outlet and later lateral radiographs the canulated screw is positioned over the guide-wire. Most patients are mobilized several days postoperatively, depending on the indication for stabilization and, in trauma patients, the fracture type and concomitant injuries.

In this study we present the results of 88 patients in whom the posterior pelvic ring has been stabilized using fluoroscopically positioned sacroiliac canulated screws.

Material and Methods

Retrospectively the charts and radiographs were reviewed of all patients in which the posterior pelvic ring was stabilized using canulated sacroiliac screw fixation between January 1st 1994 and June 1st 1999. From 1994 to January 1998 the lower screw was most frequently positioned in the second vertebral body parallel to the first screw. From 1998 onwards upper and lower screws were both positioned convergingly with their tip into the first vertebral body. The technique of positioning of the lower screws was changed because on inlet radiographs it was not always possible to determine the exact contour of the second sacral body and it therefore resulted in misplacement of the lower screw in some patients.

The indications for fixation were trauma patients with unstable pelvic ring fractures, Tile B or C type[16]. Other indications related to permanent disabilities were patients with posttraumatic nonunion or posttraumatic pain syndrome and post partum pelvic pain. These patients were included in a study of which the long-term results are submitted for publication[17].

All available radiographs were scored by the investigators separately. 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 outlet view was used to score screw placement in craniocaudal direction i.e. the relation to the sacral foramina . (Figure 1a+b). On both per- and postoperative outlet views the position of the screw in relationship to the sacral foramina was scored. Because of the variation in angle at which these views can be made no attempt was made to measure the distance exactly, only whether it was “adequately positioned”, defined as no indication of protrusion into the sacral canal or into the sacral foramina, or “malpositioned” defined as clearly showing intrusion into either the sacral canal or the sacral foramina or a position extra-osseous ventrally (figure 1+2). If either inlet or outlet view showed signs of malpositioning the screw was scored as malpositioned. An additional C.T. scan was made routinely starting June 1st 1998. Prior to this date C.T. scan was only made if there was suspicion of malpositioning, either clinically or on postoperative radiographs. On C.T. scan the relationship with both vertebral body and sacral foramina was scored using the same categories (figure 2). All data were analyzed with SPSS using Student t-test and Chi square test.

RESULTS

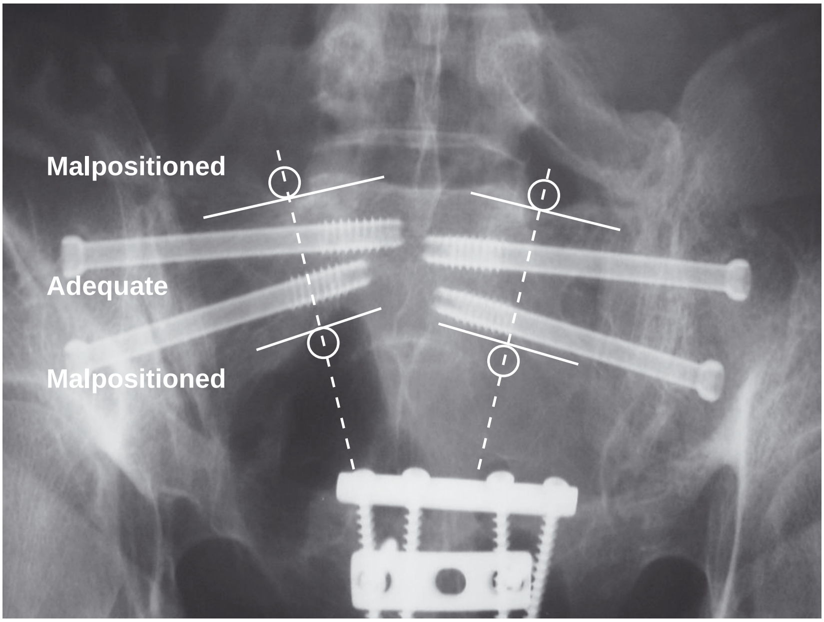
In 88 patients (65 women and 23 men) the posterior pelvic ring was stabilized using canulated screws. The average age was 38.6 years (16-75). The indications and the technique of the posterior pelvic ring stabilization are shown in table 1. According to Tile classification five patients had a type-B fracture, which was most often stabilized with one sacroiliac screw and 17 patients had a totally unstable type-C fracture, in which case two sacroiliac screws were used. In all but three trauma patients, in whom sufficient reduction could not be acquired through closed reduction, the sacroiliac screws were positioned percutaneously. In patients with post partum pelvic pain the posterior pelvic ring was stabilized with two sacroiliac screws bilaterally in almost all cases.

Average time to weightbearing mobilization was 10.2 days (1-77) for trauma-patients and 1.8 (1-14) days for nontrauma patients. Average hospital stay was 19.2 days for trauma and 5.0 for nontrauma. One patient died after developing a multi organ failure. Average follow-up was 11.6 months (3-45 months).

There were no posterior wound infections or haematomas. Nine patients needed re-operation of the posterior pelvic ring. Two for technical complications (one in which a screw was positioned too deeply protruding the cortex of the os ileum and one in which the screw loosened and worked its way out). Pain and a positive test of Laseque was present in five patients, one patient had pain and sensory deficit of the first sacral root and in the last patient a sensory and motor deficit of the first sacral root was noticed. C.T. showed malpositioning in four out of seven patients. In these seven patients re-intervention was carried out during which the screws were repositioned parallel to the old screws using a guidewire system. All complaints resolved completely and there was no permanent neurological damage.

Type of stabilization	1 unilateral screw	2 unilateral screws	1 screw on each side	2 screws bilaterally	Total (% male)
Tile-B pelvic ring fracture	4	1	0	0	5 (60%)
Tile-C pelvic ring fracture	3	12	1	1	17 (71%)
Nonunion	0	7	0	8	15 (53%)
Post partum pelvic pain	0	2	0	49	51 (0%)
Total	7	22	1	58	88 (26%)

Table 1. Indications for and type of stabilization (number of patients)



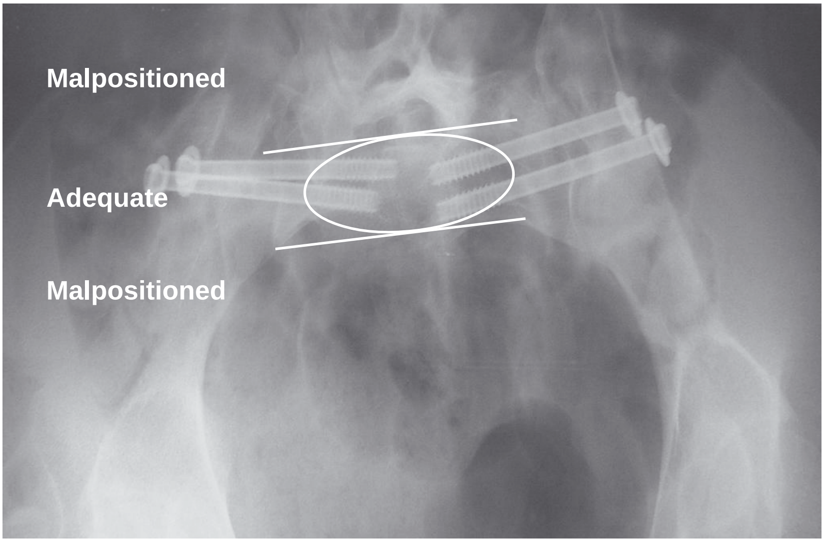


Figure 1a+b. Outlet and inlet views. The position of the intervertebral foramina and the body of the sacrum are highlighted.

A significantly higher number of patients (6 out of 31) with the lower screw positioned in the second vertebral body had neurological complaints when compared to patients with both screws in the first vertebral body (1 out of 49, $p < 0.01$, using Chi-square test (eight patients with only one screw were excluded)). In retrospect, our change of technique to positioning both screws in the first vertebral body seems therefore justified. There was no significant effect of the addition of the lateral view to peroperative fluoroscopy.

Overall 285 sacroiliac screws were positioned in 88 patients. For 188 screws (53 patients) both per- and postoperative radiographs and postoperative C.T. scan were available. Peroperative radiographs were not retrieved in 12 patients because no hard copies were made peroperatively, direct postoperative were not available for 10 patients, most often because no adequate inlet and outlet views were made, and in the early period no routine C.T. was made in 21 patients.

On the inlet view radiological scoring showed 72% of the screws in the center of the vertebral body on peroperative and 83% on postoperative radiographs. The remaining screws were positioned more ventral or more dorsal in about equal percentages (respectively, 11% and 17% peroperatively and 8% and 9% postoperative). On C.T. only 58% scored in the center while 32% of the cases showed a more ventral position and only 10% a more dorsal positioning. When the peroperative positioning was thought to be exactly in the center, the C.T. scan confirmed this positioning in only 66.6% of the cases, in total 3.5% (5 cases) severe malpositioning either into the sacral canal or extra-osseus ventrally was seen.

On the outlet view the relationship between screw and sacral root canal was scored. Peroperatively 99.2% (242 screws) scored adequate, while in 0.8% (2 screws) the screw seemed to penetrate the foramen. Postoperative percentages were similar. On C.T. scans 99.0% (218 screws) was positioned safely in relationship to the sacral root canal and in 1% (2 screws) there was definite intrusion of the sacral canal.

The relationship between radiological scoring and clinical outcome is shown in table 2. In about 2.0% to 6.8% of cases the overall positioning was inadequate. Despite the fact that the 94% of the screws (176 screws of 188 screws) scored similar on peroperative views and postoperative C.T., there was a significantly higher risk of neurological complaints in patients in which the C.T. showed a malpositioned screw ($P<0.01$, using Chi-square test). Eleven screws were malpositioned on C.T. scan, but did not cause any neurological symptoms in these patients.

No correlation was found for neurological symptoms and score on per- or postoperative radiographs ($p>0.1$). Although the quality of peroperative fluoroscopic images might be poorer than postoperative radiographs there was no additional value of postoperative conventional radiographs in this series. No additional malpositioned screws were discovered on postoperative radiographs in patients with neurological complaints who had scored optimal peroperatively.

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 7.7%[3,7,8,10,12,15]. In this study we tried to evaluate not only the clinical results but also the radiological results by scoring peroperative and postoperative inlet and outlet views and C.T. results. Clinically we followed 88 patients, 22 after acute trauma and 66 with chronic pain or nonunion, for an average follow-up of almost 12 months. There were no posterior infections or haematomas, in one patient a screw was positioned too far into the os ilium and in one patient the screw loosened and worked its way out, both requiring re-operation.

Complications due to sacroiliac screw malpositioning were seen in seven patients with neuralgia. In two patients neuralgia was combined with motor or sensor deficit. All complaints resolved completely after re-operation and no permanent neurological damage was seen.

Although there might be a bias from the learning curve, we believe that there is a significantly lower risk of neurological complaints in patients with both sacroiliac screws in the first vertebral body compared to the earlier technique with the lower screw in the second vertebral body.

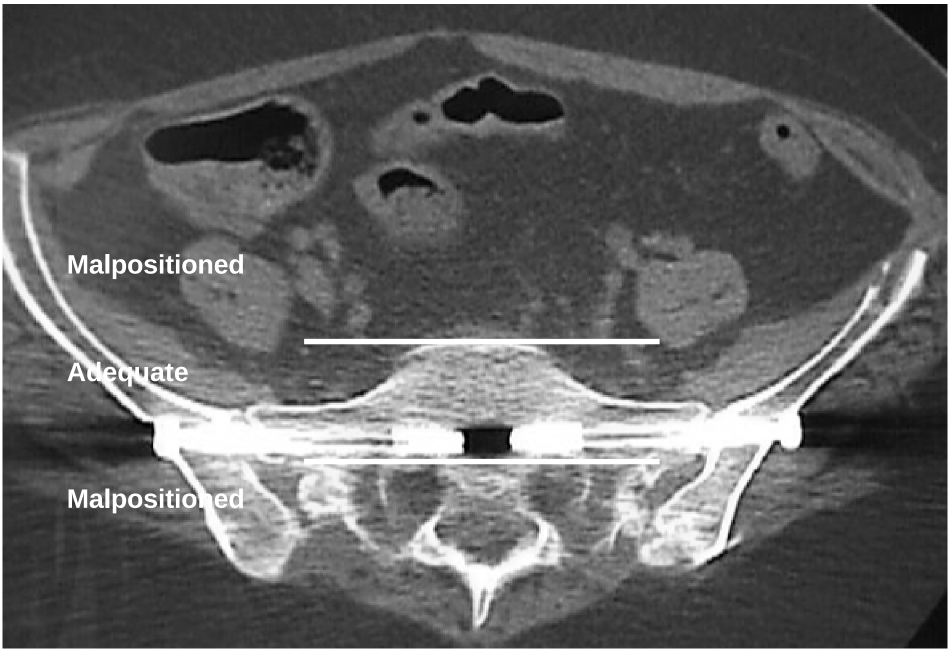


Figure 2. Relationships, such as those between the tip of the screw with the vertebral body, were scored on C.T. scan.

Using the criteria for accurate screw positioning used in this article it seems possible to position sacroiliac screws quite safely fluoroscopically with less than 7% malpositioned screws on both peroperative radiographs and postoperative C.T.. Although C.T. shows some variation of the exact position of the screw in the vertebral body compared to peroperative fluoroscopy, the overall positioning is similar in 94% of the cases. Despite this high number of similar results between peroperative radiographs and C.T. scan, C.T. scan is able to predict the clinical outcome more accurately with a significantly higher chance of neurological complaints when a screw is malpositioned on C.T.. Since the additional value of postoperative conventional radiographs is absent, we recommend that a C.T. is made to determine the exact position more precisely.

To prevent neurological injuries we changed our technique from only bidirectional views (inlet and outlet) to tridirectional fluoroscopy as described by Matta and Routt[10,18]. We hope that the addition of a true lateral radiograph can determine the antero-posterior positioning of the distal part of the screw in the vertebral body more precisely. Research into the added value of this radiograph, especially combined with peroperative computer guidance systems, is currently undertaken.

Despite the fact that computed tomography guided placement of sacroiliac screws seems to offer the advantage of more precise information of the position of the screw due to the greater accuracy of C.T. above conventional radiographs, there are several disadvantages to C.T.. Besides the logistical demands of a C.T. suite with sufficient space for the required monitoring equipment for trauma-patients, it is also necessary to have an operating room located quite close to the C.T. in case the reduction requires operative intervention or when surgical debridement of the wound is necessary. In non-trauma patients, when the patient is seldom in a critical condition and therefore requires less intensive monitoring computed tomography guided placement could become the option of first choice.

However, currently, sacroiliac screw positioning can be carried out with a high degree of safety using conventional fluoroscopy. More research whether C.T. guided positioning can improve this fluoroscopic technique, with such a low frequency of permanent neurological complications, requires further investigation into the accuracy and practicality of C.T. guided positioning versus fluoroscopic guided positioning of sacroiliac screws.

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