Cement augmentation of the navigated iliosacral screw in the treatment of insufficiency fractures of the sacrum. A new method using modified implants

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Abstract

Purpose Pelvis ring fractures of geriatric patients are currently a serious problem in orthopedic and trauma surgery. One controversy that remains is the insufficiency fracture of the sacrum with treatment options ranging from conservative to operative. We modified standard 7.3-mm screws with additional perforations at the tip to allow cement injection through the screw to improve implant anchorage.

Method We describe a new method of treatment of sacral insufficiency fractures. We use modified cannulated 7.3-mm screws (Synthes) with additional perforations at the screw tip. This allows the implant augmentation after proper implant positioning and contrast medium instillation for leakage detection.

Results All patients (12 female) treated this way, are allowed to weight bear as tolerated immediately after surgery. The pain level (measured by the visual analog scale—VAS) was significantly reduced due to surgery (mean 8.2 pre-operatively, mean 2.6 postoperatively), the pain medication could be reduced rapidly.

Conclusion The described procedure for the treatment of sacral insufficiency fractures has the potential to increase the safety of cement injection into the sacrum because of the possibility of contrast agent instillation prior to cement injection. Furthermore, the amount of cement can be reduced and additional stability can be attained due to iliosacral screw osteosynthesis compared to sacroplasty.

Introduction

Pelvic ring fractures are, with an incidence of 0.3 to 8 %, a rare entity compared with all fractures [1]. Nevertheless, current literature and clinical experience shows that the number of pelvic fractures—especially in the elderly patient—continues to rise. Morris et al. found the incidence of pelvic fractures to increase 12-fold in the group of over-85-year-old women compared to the overall incidence [2]. A retrospective investigation at 23 trauma centres in Germany showed 68 % of pelvic fractures were found in people older than 65 years, with the peak at 85 years, predominantly in females (57 %) [3]. Fracture types also depend on age: in the elderly AO Type-A fractures occur in 57 %, AO Type-B in 31 % and AO Type-C in 11 %, respectively. Additionally, the injury mechanism differs significantly between young and elderly patients. Most geriatric patients suffer from low-energy trauma and in 71 % isolated pelvic injuries were found [2, 3].

Lourie et al. first described an insufficiency fracture of the sacrum 1982 [4]. Already weakened bones are particularly vulnerable for insufficiency fractures—one main factor seems to be overstressing [5]. Patients present with persistent and immobilizing pain in the lower back and dorsal pelvic ring [6].

We want to describe a new modified method for the treatment of these insufficiency fractures of the sacrum. The novelty of our technique is the possibility of low amount cement injection after the final placement of an modified iliosacral screw.

Actual treatment options of geriatric pelvic fractures include conservative and operative techniques. Conservative treatment is suitable for stable (AO Type-A) fractures involving mainly pubic fractures and is still

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the therapy of choice for sacral insufficiency fractures. Therefore, more severe fractures have to be excluded using computer tomography. Stabilization of the anterior pelvic ring can be performed by the application of a supra-acetabular external fixator in a minimally invasive manner. The dorsal pelvic ring can be fixed minimally invasive by the 3D navigated percutaneous iliosacral screw osteosynthesis [6, 7]. In the last years the sacroplasty, a method which fills the sacrum percutaneously with bone cement, was introduced especially for the treatment of insufficiency fractures of the sacrum [5]. Additionally, all open reconstruction and internal fixation techniques can be performed [6].

This report presents a new method in treating insufficiency fractures of the sacrum. The described method is minimally invasive and based on three-dimensional (3D) navigated percutaneous iliosacral screw placement. We use cannulated and perforated 7.3-mm screws which allow cement augmentation after screw placement. This method ensures pain reduction and postoperative early mobilization with full weight bearing.

Methods

The operation follows the standard of 3D navigated percutaneous iliosacral screw osteosynthesis described by Fuchs et al. [6].

The patient is placed on a radiolucent carbon table in supine position and in general anesthesia (Fig. 1b). After sterile draping the first surgical step is the placement of the reference pin in the pelvis. Afterwards a 3D scan is performed to visualize the pelvis and the fracture pattern (Orbic Arcadis, Fa. Siemens, Heimstetten, Germany). With the use of a 3D navigation system (Vector Vision, Fa. BrainLab, Feldkirchen, Germany) a threaded K-wire is placed over the iliosacral joint into the first sacral vertebral body. After correct K-wire positioning, the three cortices are over-drilled using the 5.0-mm drill bit after doing a small skin incision and blunt preparation down to the ilium. The screw length can be measured using the measuring device for the K-wire. The appropriate screw is placed over the K-wire; to increase bearing area a washer should be used. In sacral insufficiency fractures the bone quality usually is very bad, thus only very few compression of the fracture gap can be achieved due to the bad implant anchorage [8]. Therefore, a fully threaded screw is used as a positioning screw.

We use a modified 7.3-mm cannulated, self-drilling, fully threaded screw made of titanium alloy (TAN, Synthes, Solothurn, Switzerland). Modification includes 1.6-mm perforations over the first 1/5 of the screw (Fig. 1a).

These perforations allow cement emersion around the screw tip.

After successful screw placement the K-wire is removed and an 8-gauge side-opening cannula (Vertebroplasty needle kit, Synthes, Solothurn, Switzerland) is placed into the screw. A suspension of contrast agent (Ultravist, Bayer Healthcare, Leverkusen, Germany) and ringer solution is injected and visualized using the image intensifier to check for leakage e.g. into the fracture gap (Fig. 1c). Only if there is no leakage we proceed with the augmentation procedure. Therefore, 10 ml of Traumacem V + (Synthes, Solothurn, Switzerland) is prepared following the manufacturer guidelines. The cement is injected through the side opening cannula, which is rotated during injection. The augmentation process is closely monitored using the image intensifier (Fig. 1d).

Surgery ends with closure of the skin incision and a sterile wound dressing.

All patients are mobilized one day after surgery with a physiotherapist. Full weight bearing is allowed directly postoperative. Analgesic medication is quickly reduced adapted to patient requirements.

Results

These results are preliminary and no statistical analyses have been performed.

Up to now, 12 females have been treated with the described method. Operation was performed after five to seven days of conservative treatment (immobilization, analgesic, physiotherapy) without medical improvement.

Intra-operative no complications, especially no cement leakage has been observed.

Postoperative pain reduction was obvious; the mean pain determined using the VAS was 2.6 postoperatively compared to 8.2 preoperatively. We were able to reduce pain medication within three to five days. All patients could be mobilized to their preoperative status without complaining of pain at the fracture site.

Discussion

The present report presents a new method in the treatment of insufficiency fractures of the sacrum. A combination of screw osteosynthesis and augmentation is presented. A modified, cannulated and perforated screw is used to allow implant augmentation after screw placement and contrast agent instillation before cement injection. The reported technique represents a safe technique which allows additional implant reinforcement by cement augmentation. Thus the patients can immediately

Fig. 1 **a** Modified 7.3-mm screw, cannulated and perforated at the tip. **b** Patient positioning on a radiolucent table to allow 3D navigation. **c** Distribution of contrast agent around the screw and in the presacral veins, no leakage is observed. **d** Result after augmentation using 2 ml of cement

weight bear with obviously reduced pain. Further advantage: secondary complications may be reduced.

The number of geriatric trauma patients is increasing and consequently pelvic fractures, too [1–3]. Therefore, it is necessary to develop new diagnostic and treatment algorithms tailored to fit patient's needs.

Mears et al. found no significant difference in complications and mortality of 181 geriatric pelvic fractures comparing displaced and nondisplaced rami pubic fractures as well as sacral insufficiency fractures treated conservatively. The 30 day mortality was 7 %, 23 % after one year and 47 % at three years, respectively. All fracture types showed a decrease in ability to walk and live independently [9]. New standardized treatment options may improve the outcome of elderly patients with these fractures.

Even today conservative treatment of sacral insufficiency fractures is often used. It includes bed rest, analgesic medication and physiotherapy. This management can lead to prolonged pain up to one year and is associated with several complications due to immobilization [10–12].

Therefore, the sacroplasty has been introduced in the treatment of insufficiency fractures of the sacrum. Presently there are many techniques of sacroplasty differing in surgical approach, with or without balloon and different cement volumes. A review of Bayley et al. showed the significant pain reduction after sacroplasty, this was also seen in our first results immediately post-operatively [13]. A biomechanical study of Richards et al. showed that this technique does not restore the strength or stiffness of the sacrum regardless of the volume or location of cement [14]. Additionally, this procedure has its risks and possible complications. Bastian et al. retrospectively investigated 63 sacroplasty

procedures and found cement leakage in 32 %, mostly into the fracture gap [15].

As a further development Tjardes et al. and Fuchs et al. reported a technique of cement injection before iliosacral screw placement into the drill hole [6, 7]. Both of these studies described the technique (cement injection before screw placement) and also showed one clinical case with good results in pain reduction and the recurrence of mobility [6, 7]. Our method represents an advancement of this procedure. With the presented technique it is possible to place the screw first and radiographically check screw placement. In a second step contrast agent can be installed over the screw to check for any leakage. And finally the surgeon can decide to augment or not. There are only small amounts of cement necessary to improve implant anchorage [16, 17]. We install one to two milliliter of cement.

But even the iliosacral screw placement has its risks and potential complications especially in osteoporotic bone. The quality of fluoroscopic imaging is significantly reduced due to the reduced bone quality. Additionally, the surgeon must understand the variability of sacral anatomy. Thus, Routt et al. found the complications occurred due to inadequate imaging, surgeon error, and fixation failure [18].

Further biomechanical and clinical investigations have to confirm the superiority of this procedure.

Conclusion

The described procedure for the treatment of sacral insufficiency fractures has the potential to increase the safety of cement injection into the sacrum due to the possibility of contrast agent instillation prior to cement injection. Compared

to the conventional sacroplasty our method can additionally reduce the amount of cement and increase stability due to iliosacral screw osteosynthesis and thus may reduce complications.

The described procedure reported in this paper is based on a single center experience and for this reason cannot be recommended for general application in the current stage of development.

Conflict of interest The authors declare that they have no conflict of interest.

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