

# Balloon Guided Cement Augmentation of Iliosacral Screws in the Treatment of Insufficiency Fractures of the Sacrum – Description of a New Method and Preliminary Results

**“Balloon guided” augmentace iliosakrálních šroubů kostním cementem v léčení insuficientních zlomenin sakra – popis nové metody a předběžné výsledky**

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## ABSTRACT

### PURPOSE OF THE STUDY

Fragility fractures of the pelvic ring in the elderly population are a serious problem in orthopaedics. The treatment options range from conservative treatment to diverse operative options. We present a balloon guided new technique of implanting cement augmented screws aiming at improved implant anchorage and reduced cement leakage.

### MATERIAL AND METHODS

We describe a new technique of balloon-guided cement augmented iliosacral screws. After the balloon has been insufflated and contrast medium has been instilled for leakage detection, iliosacral screws can safely be placed with a relevant cement depot.

### RESULTS

All patients (n = 8) treated in this way were allowed to weight bear on both legs and mobilisation was tolerated the next day after surgery. In the post-operative controls including X-ray and CT scan we noticed no cement leakage. Pain level as measured by the visual analog scale was significantly reduced to pre-surgery (mean 7.6 pre-operatively, mean 2.5 post-operatively). In addition pain medication could be reduced gradually soon after surgery.

### CONCLUSIONS

The described procedure to address fragility fractures of the pelvic ring is a safe and easy to handle method. There are three advantages: First the osteoporotic S1 vertebral body can be stabilised by the amount of cement; second the cement leakage can be prevented by the balloon-compaction of the cancellous bone and the possibility to control the created cavity with contrast medium; third the bone-screw interface is much stronger compared to other procedures and is biomechanically superior against vertical shear stress. In contrast to sacroplasty, the cement application is guided by the previous use of a balloon.

**Key words:** pelvic ring, fragility fracture, osteoporosis, elderly.

## INTRODUCTION

Although pelvic ring fractures account only to 0.3–8% of all fractures, their clinical significance is increasing, especially in the elderly and the aging population (9, 28). In particular, since these fracture pattern comes along with prolonged pain and immobility of the patient. A clinical study published by Morris et al. showed the incidence of pelvic ring fractures to be 12-fold higher in 85-year old women compared to the overall incidence (18). In the elderly there is a predominance of type A fractures and in contrast to pelvic ring fractures of the younger population, they occur in most of the cases as a result of low-energy injuries (20, 27).

Therefore, Lourie et al. described insufficiency fractures of the pelvic ring which occur in osteoporotic altered bone as a result of oversteering without relevant trauma.

(15) Particularly, in elderly females, osteoporosis associated fractures of the hip and the spine are increasing underlining the relevance of osteoporosis as a significant health care problem (12, 14). A new classification for these osteoporosis-associated type of pelvic ring fractures in elderly caused by low-energy trauma- sometimes even not memorable- has been published recently, summarizing them under the term of fragility fractures of the pelvic ring (FFP) (24).

Conservative treatment is the treatment of choice for most of the stable type A fractures (i.e. FFP Type I fractures) mainly affecting the pubic bone and most of the insufficiency fractures of the sacrum. In those cases where conservative treatment failed or operative therapy is required (i.e. FFP Type II- IV), a bunch of operative procedures exists, reaching from iliosacral screws with and without cement augmentation (30) to different open

fixation techniques such as iliosacral bars and others (10,17, 25). In addition, the use of sacroplasty has wide-spread over the last years and lead to promising results (5–7,11,21). Nevertheless, there are three debatable points. First one of the main complications of the latter is cement leakage with potentially affecting neural roots (3, 4), second cement in the fracture line does not allow or at least interferes fracture healing and third the cement is not resistant to vertical shear stress.

All of the recent publications have been lighting out that the underlying pathology of these fracture type is the decreased bone mass in particular of the sacrum and in detail of the massa lateralis. This condition makes it even more challenging for the surgeon if an osteosynthesis is desirable to get a sufficient bone-implant interface (13).

In the following, we want to describe a new technique of cement augmented iliosacral screw implantation by prior use of a balloon.

Comparable to the well known advantage of balloon kyphoplasty in the treatment of osteoporotic spine fractures the prior use of the balloon before augmenting the iliosacral screws has two preferable effects: at first the cancellous bone in S1 is compacted and a cement-filled cavity is created. This leads to increased bone-screw interface with less loosening in the follow up. Second, the cavity can be filled with contrast medium prior to cement application to exclude leakage.

In this context, the described technique combines the effects of iliosacral screw fixation with additional cement augmentation in a safe and reliable manner. Furthermore, it leads to pain reduction and allows early mobilization of the geriatric patients with full weight bearing.

## MATERIAL AND METHODS

After verification of the insufficiency fracture using a CT scan (see Fig. 1a), the operative procedure placing iliosacral screws is performed in the standard way as described before. In short, patients are placed on a radiolucent carbon table in supine or prone position, depending on the general circumstances, as preference of the surgeon, body mass index or treatment of both sides. Visualization is confirmed using lateral view, outlet and inlet X-rays (see Fig. 1b). In a first step a 2.8mm K-wire is placed in the first sacral vertebral body after having created a small skin incision and a blunt preparation to the ilium and correct positioning of the guiding wire is verified by performing an intra-operative CT scan. In a next step, the three cortices are over-drilled by a 5.0mm cannulated drill. The screw length can be measured using the measuring device for the scaled K-wire. Next, a working-sleeve with a diameter of 4 mm is placed over the K-wire. After removing the wire the preferable balloon is placed in the centre of first sacral body. For all



Fig. 1a. Pre-operative CT scan showing a FFP Typ IIc fracture (Pat. 3, Table 1) on the right side with reduced bone quality and an osteolytic lesion.

our cases we used balloons with the maximal volume of 5 ml. After carefully, slowly and stepwise insufflation of the balloon monitored under fluoroscopy with a mean end pressure of 200 PSI, thereby creating a cavity with compaction of cancellous bone, contrast medium (suspension of contrast agent, i.e. Ultravist, Bayer Healthcare, Leverkusen, Germany and ringer solution) is injected and visualized using the image intensifier to exclude any leakage. If no leakage appeared, cement application can be performed using the injection needle (e.g. PFNA cement augmentation or kyphoplasty) inserted through the working sleeve and controlled by fluoroscopy. We used Traumacem V+ cement (DePuy Synthes Inc., Umkirch/ Germany). After successful cement application the kyphoplasty kit is removed except the working sleeve and the guiding K-wire is inserted through the cannula again. Over the K-wire the premeasured cannulated SI-Screw (e.g. 7,3 mm full threaded) is set. The K-wire is removed and a fluoroscopically control in lateral view, outlet and inlet X-rays is made. After curing of the cement, the skin is closed and a sterile dressing is placed.

Patients are allowed for full weight bearing immediately after surgery depending on pain. As control for cement distribution and exclusion of a leakage we recommend post-operative X-rays and additional CT scans (see Fig. 2).

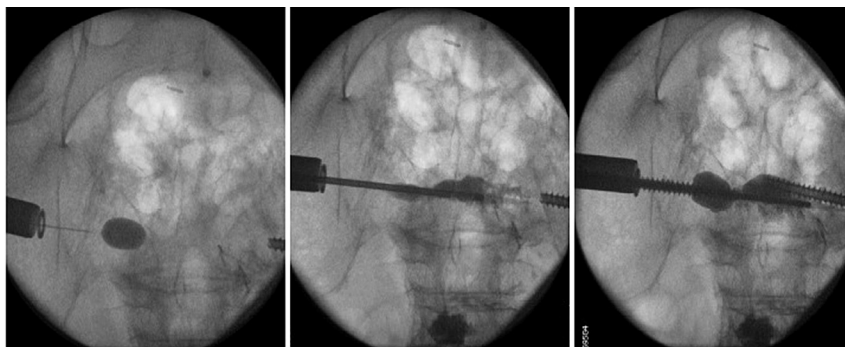


Fig. 1b. Intra-operative X-ray with positioning of the balloon, control with contrast medium and positioning of the screws in the cement depot.



Fig. 2. Post-operative X-ray and CT scan with filling of the osteolytic lesion.

## RESULTS

The results are preliminary and therefore no statistical analyses have been performed. Up to date, 8 women have been operated by use of this technique (two with additional external fixator, see Table 1). Surgery was usually taken into account after failed conservative therapy for one week and no signs of clinical improvement or reduction of pain. In our series, we had no complications related to the surgical technique and did not find any cement leakage. Post-operative pain relief was obvious with a reduction in the VAS and pain medication (mean VAS: 7.6 pre-operatively, mean VAS: 2.5 post-operatively on day 3 after surgery, see Table 1).

## DISCUSSION

The present study describes the preliminary results of a new safe and reliable treatment option in insufficiency fractures of the sacrum and enables to almost exclude cement leakage due to the creation of the cavity with

help of the balloon and the use of contrast agent prior to cement application. The thereby augmented screws have been proven to have a better biomechanical stability with higher pull out forces in the osteoporotic bone and early full weight-bearing can be achieved (16). This simple technique might be a good alternative to other treatment options.

Conservative treatment is still used in insufficiency fractures and includes bed rest, physiotherapy and pain medication. However, this treatment regime is associated with several complications due to immobility, like pulmonary embolism or decubital ulcers (2,15).

To enable an early mobilization the sacroplasty has been introduced in the treatment of sacral insufficiency fractures and has become more and more popular over the last years (5). Despite the good pain reduction of this surgical method, there exist data showing a cement leakage of up to 32% in the frac-

ture gap (4), potentially causing neurological damage. In addition, the applicated cement is not able to restore the necessary biomechanical properties of the sacrum as shown by Richards et al. (22), independently from the amount of bone cement used. Furthermore, the cement application in the sacrum without any screw implantation does not help to stabilize the potential unstable posterior pelvic ring as with axial load the plane of the sacral fractures runs parallel (25) and causes vertical shear stress.

In the last years, the augmentation of screws or blades with cement has been shown to improve the biomechanical stability in osteoporotic fractures (10, 19). There are reports about a cement injection before iliosacral screw placement into the drill hole showing good results in pain relief (10, 29). As an alternative and advancement of the cement augmentation, perforated screws have been introduced with reliable results in a preliminary study (30). Recently, the use of absorbable calcium phosphate cement has been described (8).

The presented new technique has shown in the first applications to be safe and reliable. After creation of the cavity with the balloon, contrast agent can exclude any leakage before application of cement. Due to the created cavity and compaction of the cancellous bone, the pressure needed for application is potentially smaller than in perforated screws and thereby the risk of cement leakage is further diminished.

Despite the improvements in positioning of iliosacral screws, the surgical technique has its own complications and risks itself due to reduced quality of the image intensifier in osteoporotic bone changes or due to intestinal gases. In addition, the surgeon has to be aware of the anatomic variations of sacral anatomy before screw placement (26) and therefore a pre-operative CT scan is mandatory. It is desirable to verify correct screw posi-

Table 1. Patients characteristics

Patient	Age	FFP- Classification	Operating time [min]	VAS (pre-operatively)	VAS (post-operatively)
1	87	IIb	61	6	2
2	81	IIb	56	8	2
3	90	IIb	52	9	3
4	85	IIb	54	7	3
5	74	IIb	53	8	2
6	89	IIc	59	8	3
7	80	IIc	62	7	3
8	79	IIc	59	8	2
				7.6	2.5



tioning by intra-operative CT scan and thereby further reduce complications.

Further studies with a larger number of patients and biomechanical testing is required to confirm the superiority and safety of the described balloon-guided, cement augmented screw placement and compare it to well-established techniques.

## CONCLUSIONS

The prior use of a balloon creating a bone cavity and compacting the cancellous bone has the potential to reduce cement leakage. In addition, there exists the possibility to install contrast agent prior to cement as a further safety factor.

However, the number of patients treated by the described technique is limited and represents the data of a single center, so general application can not be recommended at this stage. Further biomechanical and clinical investigations on a multi-center base are mandatory for general recommendation of this new technique.

Informed consent was obtained from all patients for being included in the study.

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