36 Anterior Surgical Management of Thoracic and Lumbar Fractures

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36.1 Introduction

The posterior stabilisation is the Gold Standard in the operative treatment of spinal fractures. We want to focus on the question which cases might benefit from an additional anterior stabilisation.

A common situation in the clinical practice is, that after a posterior stabilisation the question of an additional anterior operation arises.

Although the scientific evidence for the need of an additional anterior stabilisation is low, we think that in many cases the result of the therapy can be improved with an additional anterior operation.

The following example shows a typical case, in which we would recommend an additional anterior decompression und stabilisation.

Even though in the everyday clinical practice the cases might be not so straightforward, we think that for the demonstration of the principles this case is a prime example.

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36.2 Case Description

A 33 year old man lost control over his car because of unknown reasons. After the initial treatment at the accident site he was transferred with a helicopter to our emergency room. The patient arrived 3 h after the accident.

The clinical examination showed evidence for a spinal cord injury with a paraplegia below T 6 and a residual sensibility corresponding to an ASIA B type lesion.

The X-rays and CT-scan showed fractures of the rips 4–7 on the left side and a bilateral lung contusion.

The reason for the paraplegia was a luxation fracture T 6/7 (AOS C) with a incomplete cranial burst-split of the T 8 (AOS A4).

According to the new AOS-Classification it was a T 6/7 C, T 6/A4, T 7/A 3, T 8/A4, M0, N3 injury (Figs. 36.1 and 36.2).

As an emergency operation we performed an instrumentation T 4,5 on T 8,9,10 with an realignment of the spine and a wide decompression of the spinal canal T 6,7.

As a second step we did an additional anterior thoracoscopic assisted corpectomy T 6,7 and partially T 8 (endplate) with anterior clearance of the spinal canal because there was still a fragment left behind T 5 and the patient showed no neurological improvement after the posterior decompression (Fig. 36.3).

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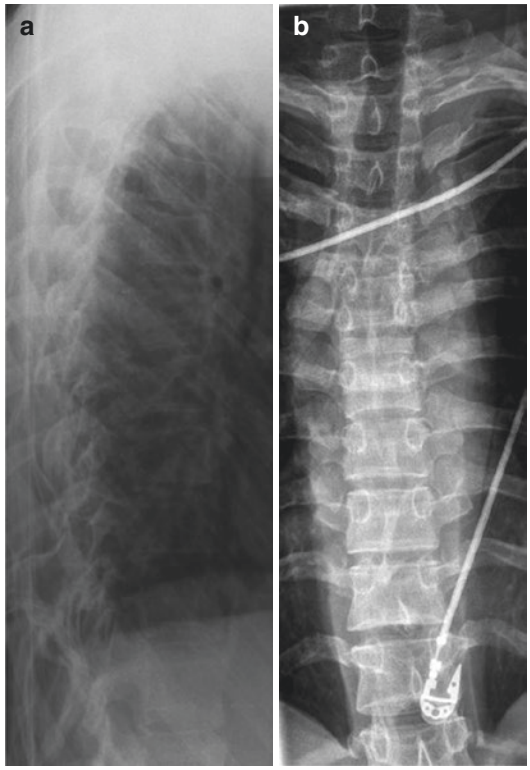

Fig. 36.1 The x-rays from the emergency room in lateral (**a**) and in a.p.-view (**b**) show the fractures of the vertebral bodies T 6,7 and 8 and the anterior displacement of T 6 representing a C-type injury of T 6/7

In the further clinical course we transferred the patient to our paraplegic unit for further rehabilitation.

During his stay in the hospital, which lasted 7 months, the patient learned to walk again.

He is now able to walk for short distances without any help. Unfortunately his is still suffering of an atactic gait and a neurogenic bladder (Figs. 36.4 and 36.5).

36.3 Discussion of the Case

In the upper thoracic spine (T 1–5) we would recommend as an anterior approach a costotransversectomy.

For the vertebral bodies T 5/6 to T 11 a transthoracic approach is used. Most surgeons recommend a left sided approach for the lower thoracic spine because on the right side the liver is difficult to mobilize. For the mid to upper thoracic spine T 5–8 a right-sided approach is preferred.

If it is done in a thoracoscopic or a classic open approach should be chosen by the surgeon depending on his experience and the existing equipment. In our clinic we often use a mini-open approach in combination with thoracoscopy. Especially in cases where the vertebral body has to be replaced, a purely endoscopic operation is not possible because for bringing in the implant an incision of a certain size is unavoidable.

For the vertebral bodies L 2, 3 und 4 we use an XLIF - eXtreme Lateral Interbody Fusion – approach. With this lateral retroperitoneal approach the vertebral bodies can be accessed with a small incision and no large vessels have to be mobilized, which makes it a pretty safe approach.

The vertebral body of L1 can typically be accessed with both approaches. We mostly use the XLIF-approach. Although for the surgeon it is sometimes a bit challenging to mobilize the rib cage, the mayor benefits of the retroperitoneal approach would be that the function of the lung is not compromised and the postoperative pain is much less with no need for a thoracic drainage.

For the replacement of L 5 a classic pararectal retroperitoneal ALIF approach is necessary. Of course L 2–4 can also be reached with an ALIF approach. But in our experience the XLIF approach is causing less bowl irritation and the risk of injuring large vessels is considerably less.

When it is planned from the beginning of the therapy that the patient receives a combined posterior-anterior approach and he suffers of osteoporosis it is advisable to do a posterior cement augmentation of the adjacent vertebral bodies. The anterior implant can rest on the cement filling which will reduce the risk for implant subsidance.

In thoracolumbar fractures we mostly do single level fusions with a resection of the disc and the crushed bony fragments in A3 fractures with at least 2/3 vertebral body height left. There must be a large enough part of bone, where the implant

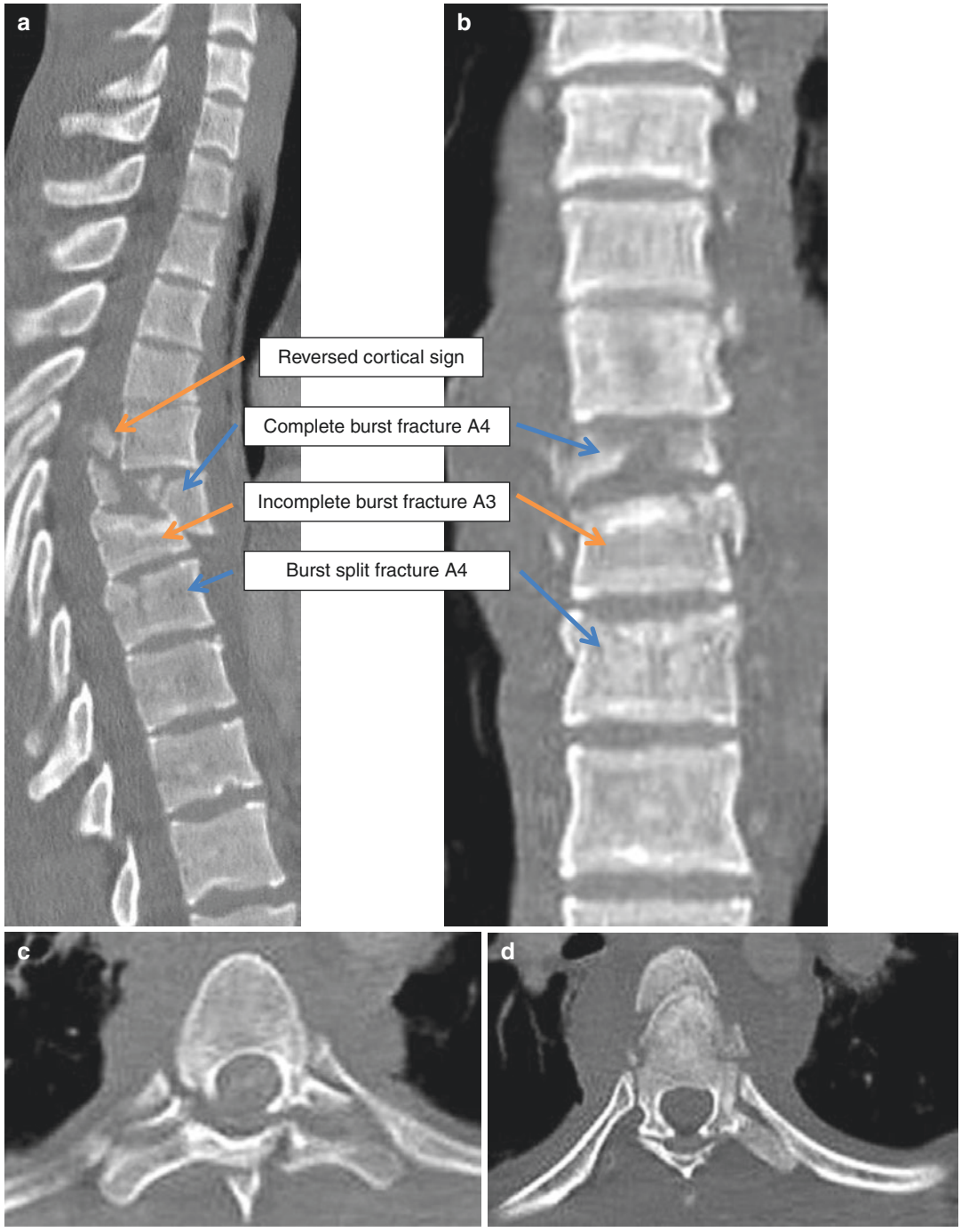

Fig. 36.2 In the CT-Scan further details of the fractures can be seen. Panels (**a**), (**b**), (**c**) and (**d**) show the complete extent of injury in sagittal, coronal and axial cuts

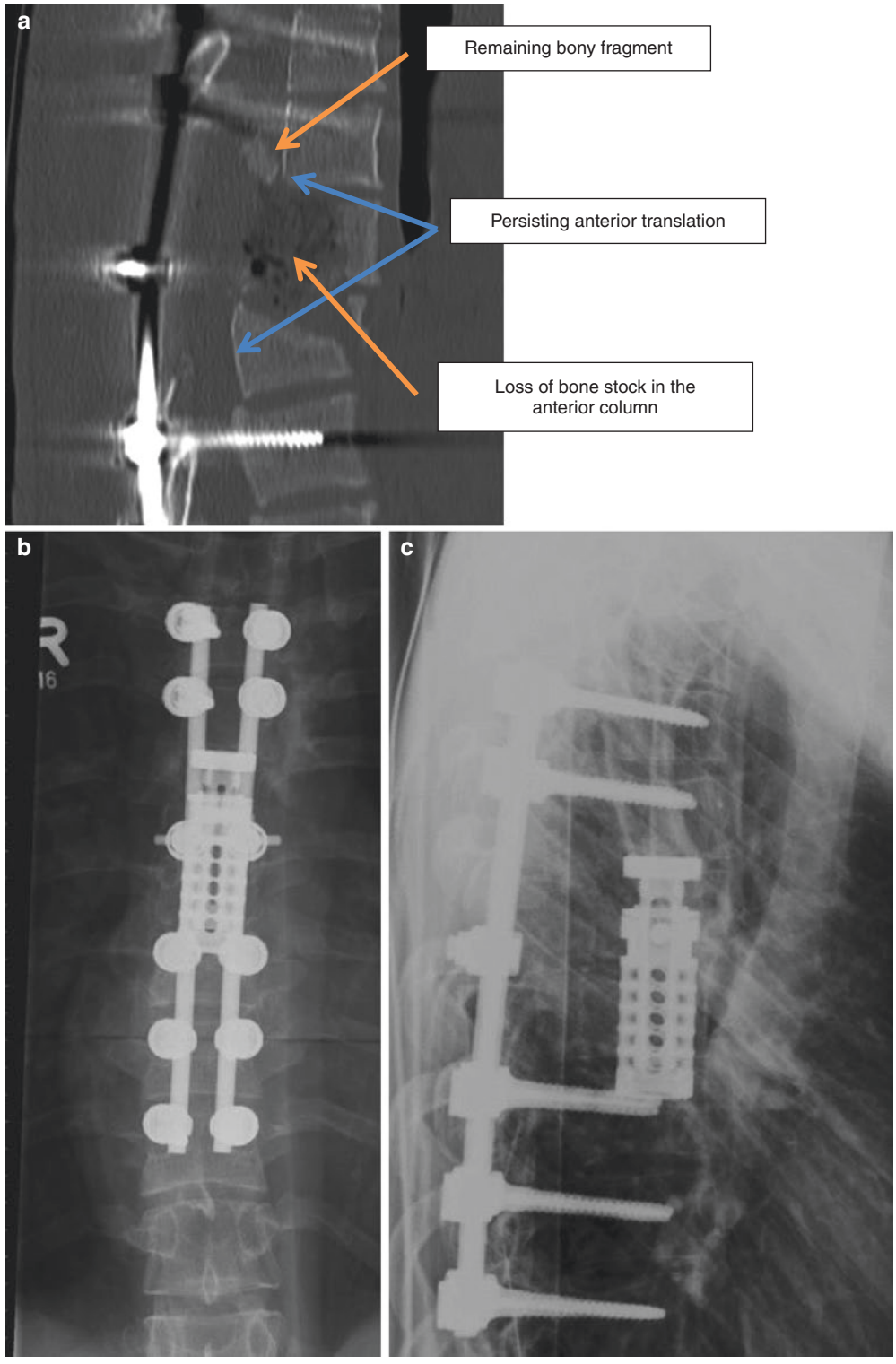

Fig. 36.3 The postoperative CT (**a**) showed a remaining bony fragment which still compromises the dural sac, a significant loss of bone stock in the anterior spinal column and a persisting anterior translation. The postoperative x-rays (**b+c**) showed an excellent positioning of the implants with a good correction of the kyphosis but with a mild residual scoliosis

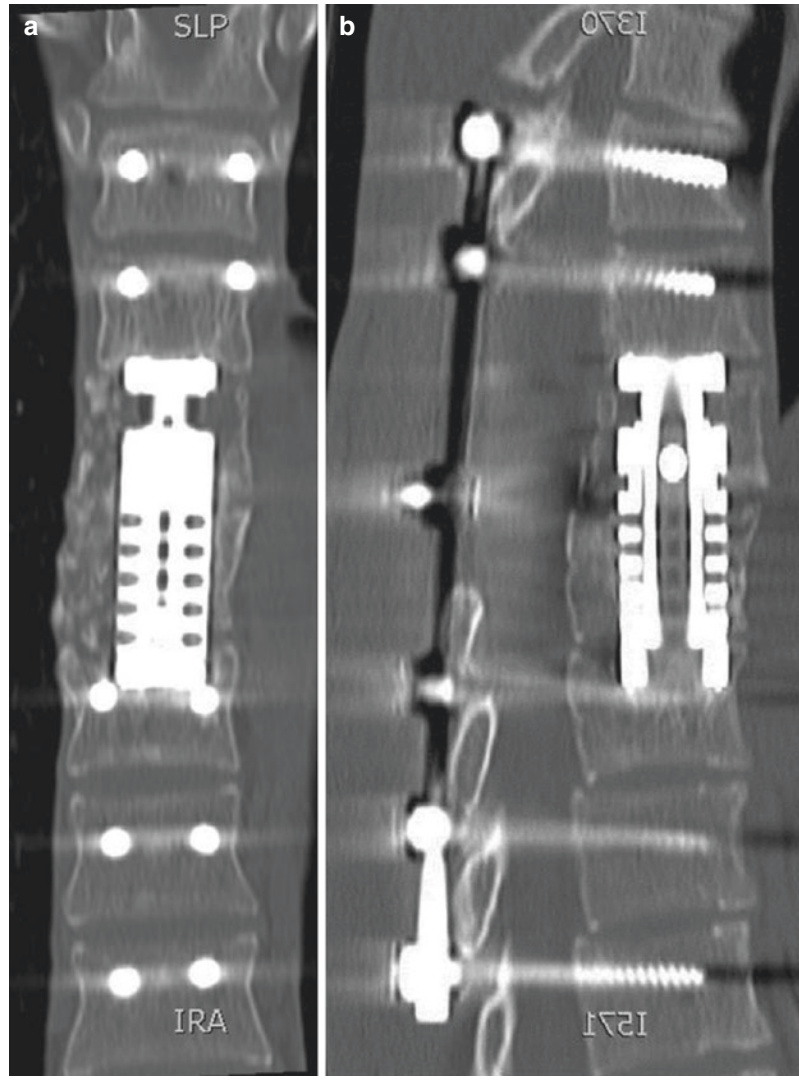

Fig. 36.4 Six months after the trauma the CT-scan showed a good bony integration of the implants with no sign of implant loosening Panels (**a**), (**b**), (**c**) and (**d**) show the complete extent of injury in sagittal, coronal and axial cuts

can be anchored. Depending on the case we use a combination of autologous bone graft and a ventral plate or cage with a screwed design. There is no evidence in the literature for the supremacy of a specific technique.

If the thoracolumbar fracture is a complete burst fracture or an incomplete burst with an impression of the vertebral body of more than 2/3 we would recommend a vertebral body replacement. In these cases we are using expandable titanium cages. Widely used autologous bone grafts as a stand-alone technique are associated with donor site pain, risk of non-union and increased correction loss [1].

Concerning the implants there seems to be a trend that expandable and non-expandable titanium cages have the same fusion rate but expandable cages enable more intraoperative correction [2].

If the fracture is in the lower lumbar or the mid or upper thoracic spine we restrict the indication for an anterior approach.

In incomplete burst fractures of the lower lumbar spine with an impression of the vertebral body not more than 2/3 of the vertebra und a more or less preserved lordosis a loss of correction is unlikely because most of the load in the lumbar spine is carried by the posterior column.

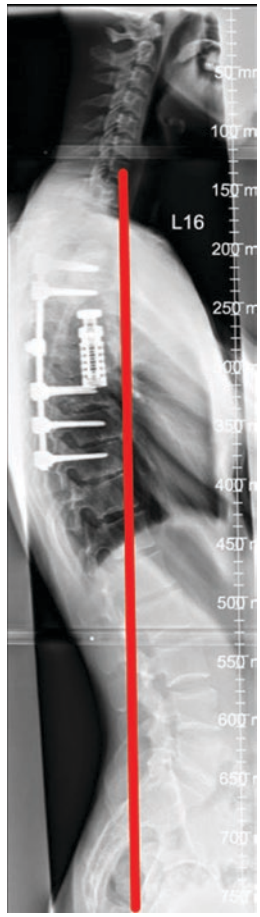

Fig. 36.5 The whole spine x-ray after 6 months in standing position showed a physiological sagittal balance

In our clinic fractures in the upper und mid thoracic spine are operated from posterior including 2 levels above and below the broken vertebra. We think that in these regions it is precarious to do just 1 level above and below because the vertebral bodies are rather small and only small screws can be used. Additional reasons for this concept are that loosing motion segments in these regions is not as critical as in the thoracolumbar or lumbar spine and a loss of correction in these regions is better tolerated by the patients according to Glassman et al. [3]. So in these regions even complete burst fractures are treated only by a posterior approach when the kyphosis is moderate. It is not possible to define a cut off for "moderate kyphosis" but often a whole-spine x-ray helps to see how the patient is affected by the kyphosis and how much he has to compensate.

In former days a long segment posterior stabilization was the common surgical procedure for stabilizing spinal fractures.

The more modern concept is a short segment fixation for saving as much motion segments as possible especially in the thoracolumbar und lumbar spine.

Although posterior stabilization as a stand-alone procedure is a sufficient therapy for many spinal fractures, it has some disadvantages as a stand-alone solution. The most frequent problem is a progressive loss of the initial correction. There seems to be a relation between the destruction of the anterior column and the correction loss after a posterior stand-alone stabilization. Knop et al. for example found a clear correlation between the preoperative wedge angle of the vertebral body and the postoperative loss of reduction [4].

We think that loss of reduction and persisting kyphosis is one of the biggest problems in the treatment of thoracolumbar fractures.

Among others Glassman [3] showed in 2005 that a positive sagittal balance – which means kyphosis – is linear associated with a deterioration in health status measures including the SF-12 an ODI-Scores. Because of the linear association, a cut off angle in terms of a critical degree can't be determined. The deterioration depended on the region of the kyphosis with the thoracolumbar as a critical region only excelled by the lumbar region.

Kyphosis might also accelerate degeneration in the adjacent spinal levels. In an in-vivo animal model (sheep) Oda [5] showed that a fusion L3–5 in kyphosis versus an in-situ fusion lead to significant degenerative changes of the cephalad facet joints.

On the other hand the patients with an additional anterior operation have more blood loss, a longer duration of the operation and the hospital stay and a possible higher rate of complications [6].

So what could help in decision making by taking into consideration that clear evidence for a better *clinical outcome* with an anterior-posterior procedure is still lacking [6]?

A system which can be helpful is the Cormack Load Sharing Classification [7].

Table 36.1 The Cormack load sharing classification system

Amount of comminution	Points	Amount of correction of kyphotic deformity	Points
<30%	1	3° or less	1
30–60%	2	3° to 9°	2
>60%	3	10° or more	3
Displacement of fracture segments			
0–1 mm	1		
At least 2 mm but less than 50% of the cross sectional area of the vertebral body	2		
More than 2 mm but more than 50% of the cross sectional area of the vertebral body	3		

Cormack et al. analysed a series a patients who received short segment instrumentation because of a vertebral fracture. A point system was developed that grades: The amount of damaged vertebral body, the spread of the fragments in the fracture site and the amount of corrected traumatic kyphosis. Table 36.1 shows how the point system works.

Every patient in this series, who had broken screws, had 7 points or more.

The author himself mentions that the classification system has some weaknesses. There were only a small number of patients examined (28 patients) and the system does not contain any assessment of the posterior ligaments. However it remains helpful in evaluating the stability of the anterior column.

Very important for considering an anterior operation is if there are still bony fragments displaced into the spinal canal and causing neural compression. This was the case in our patient. After the initial posterior operation a CT was done, which still showed a fragment compromising the dural sac. Additionally the patient didn't improve in his neurologic function. So these facts encouraged us to indicate an additional anterior operation.

An anterior approach always has the benefit to resect fragments anterior to the dural sac in a save way especially in the thoracic spine where the dural sac should not be mobilized.

Another problem which is recognized since years but still not solved is the role of the intervertebral disc. With increased force on the vertebral body there is an increased force on the intervertebral disc and like any other cartilage tissue the disc has very limited potential for regeneration. An injured disc will not heal and might cause chronic pain. So this might be an argument for additional anterior surgery for the price of sacrificing motion segments.

The crucial point is that although there are some classifications for qualifying the injury of the disc for example from Sander et al. there is no guideline for implementing this into clinical decision making [8].

Also important are the comorbidities of the patient. Especially if the patient has a serious lung disease it might be better to do a longer posterior instrumentation than a short combined anterior-posterior instrumentation. On the other hand residual pulmonary problems due to a persistent hamatothorax might trigger an anterior stabilisation during an pulmonary operation.

In our example case we did an additional anterior operation for 4 reasons:

1. There was a severe destruction of the vertebral bodies (Cormack Classification >7 points)
2. After the initial posterior operation the spinal canal was still compromised and the patient had a persisting neurologic deficit
3. Because of the young age of the patient we wanted to restore a physiological sagittal balance
4. To increase the stability because there was still some anterior translation after the initial posterior operation

36.4 Conclusions and Take Home Message

Clear guidelines for an additional anterior approach can't be derived from the literature.

Evidence Level: C

Although evidence is lacking everyone who is involved in the treatment of spinal fractures should have a clear concept of how to treat these patients.

A summary our concept reduced to a take home message will be described in the following.

According to the recommendations of the Spine Section of the German Orthopaedic and Trauma Society (DGOU/Verheyden et al.) we regularly recommend an additional anterior approach in cases where:

- The vertebral body is more than one third of its height impressed
- There are still bony fragments displaced in the spinal canal and lead to a compression of spinal cord or nerve roots
- The initial kyphotic angle is more than 15–20° or the scoliosis is more than 10°
- The disc is caved in the vertebral body or displaced into the spinal canal

Why?

A widely destruction of the vertebral body predicts postoperative reduction loss after posterior only stabilisation and the more the initial kyphotic angle the more severe the injury is and the more likely a reduction loss will occur [4]. We think that especially in the long term a severe kyphosis at the thoracolumbar junction will matter. At the latest when degeneration of the lumbar spine hinders the compensatory hyperlordosis.

Furthermore a severe damage of the disc will not heal and might cause on going pain.

If there are still bony fragments anterior of the dural sac it might be safer especially in thoracic spine to take them out from an anterior approach.

On the other hand we don't recommend an additional anterior approach in every case.

In A3-type lesions (AOSpine Classification) with only minimal involvement/displacement of the posterior wall, a kyphosis <15° and a good bone quality an additional anterior approach is not necessary.

Also most transosseous B- or C-type lesions (AOSpine-Classification) with only a small bony defect and maybe in a patient with ankylosing spondylitis show good results with long posterior stabilisation only.

And of course severe comorbidities especially of the lung make a long posterior instrumentation more favorable.

In the upper and lower thoracic spine we often restrict the therapy to posterior stabilization two levels above and below even in complete burst fractures considering the kyphosis and degree of destruction of the vertebral body. In these regions sacrificing motion segments is not as critical as in the thoracolumbar or lumbar spine and because of the small vertebral bodies a longer stabilization is needed anyway.

Pearls

- In spite of lacking evidence we recommend an additional anterior approach when the anterior column has a large bony defect (e.g. the vertebral body height is diminished more the 30% or both endplates are broken), which is the case in most A3 type-lesions and all A4-type lesions especially when a short segment stabilisation is planned (According to the recommendations of the Spine Section of the German Orthopaedic and Trauma Society [DGOU/Verheyden et al.]).
- For A3-type lesions an anterior monosegmental fusion is recommend. A4-type lesions should get a vertebral body replacement.

Pitfalls

- In patients with a severe lung illness or a history of complex abdominal operations the need for an additional anterior approach should be questioned critically. These patients might profit from a longer posterior instrumentation without an anterior approach.

Editorial Comment

The authors show according to us a clear-cut case in which an anterior reconstruction should be performed. Despite the fact that there is no high level evidence, the authors provide a very sound line of arguments on when or when not anterior reconstruction is to be considered.

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