# Aesculap Spine
## MACS TL

Modular Anterior Construct System
for the Thoracic and Lumbar spine

Operating technique

B|BRAUN
SHARING EXPERTISE

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# Introduction

From the perspective of biomechanics, reconstructing the load-bearing ventral spine is indispensable in cases of instable spine traumas. Still, in the past, the concept of ventral provision was chosen rather reluctantly, given the higher morbidity entailed by the conventional open access. Only the arrival of minimally invasive alternatives within the last decade led to a significant change in this restrictive attitude. The endoscopic technique, in particular, quickly revealed the limited suitability of implants that were originally designed for the open-access technique. Consequently, a new generation of implants had to be developed to meet more exacting requirements. Apart from the option of endoscopic assembly, the main focus of such developments was on achieving sufficient stability, given a suitable trauma pattern, with exclusively ventral provision for the spine.

The ventral stabilization system MACS TL is the result of collaborative development work by BG Trauma Center Murnau and Aesculap. MACS TL is a modular system and can be implanted using either the open technique, the minimally invasive technique (mini TTA, mini ALIF), or the endoscopic technique (MIASPAS TL).

In this operating manual, the procedure of a MACS implantation using the thoracoscopic access technique is demonstrated as an example. The endoscopic technique is subject to a longer learning curve before it can be applied safely. Therefore, switching to the endoscopic technique is not recommended before the open technique is safely mastered.

Experience shows the thoracolumbar transition region is also accessible to the gasless thoracoscopic treatment technique after opening the diaphragm.

Finally, the endoscopic ventral decompression of the spinal canal also proved to be highly efficient, thanks to the excellent visualization. Therefore, both diagphragm splitting and endoscopic decompression will be described in this manual.

Surgical interventions at the spine are challenging in every respect, the prevention of bad results with potentially negative effects being of the highest priority. Based on our own experience, we decided for a combined description of the thoracoscopic access method and the MACS TL implantation technique, which also includes some practical notes.

In this sense, the present manual is meant to be an aid for achieving a successful intervention.

Dr. Potulski, BGU Murnau    Prof. Dr. Beisse, BGU Murnau

# Implants

## MACS TL-System „Twin Screw“

The fixed-angle MACS TL System “Twin Screw” is intended for orthopedic/traumatological application in cases of instability-related defects of the thoracolumbar spine. In its basic version, it comprises the following components:

- 2 posterior polyaxial screws
- 2 ventral stabilization screws
- 2 clamping elements
- 1 stabilization plate
- 2 fixation nuts
- 2 locking screws

In the standard mounting procedure, the stabilization plate is fixated on the spine by means of two screw-bearing clamping elements. As the clamping elements can be freely positioned against the plate, a posteriorly imbedded implant (internal fixator) can be taken into consideration.

The cannulated posterior polyaxial screws allow exact screw positioning through temporary application of Kirschner wires. In this way the limited possibility of fixation in a partly resected vertebral body are taken into account, especially for monosegmental treatments.

Due to the polyaxiality between the clamping element and the posterior polyaxial screw, an optimal fit of the implant with the individual spinal anatomy is ensured at a maximum angulation of ±15°. This, together with the low overall height of the implant, ensures that any soft tissue irritation is kept to a minimum.

The self-locking anterior stabilization screws are introduced through temporarily mounted guiding sleeve, which guarantees precise screw positioning.

Angular stability is achieved by the four-point fixation of the implant after the final clamping of the polyaxial mechanism.

In addition to the standard components, MACS TL also offers the following for atypical situations:

- Thoracic clamping element
- Polyaxial screw XL
- Double rod
- Bone graft clamp

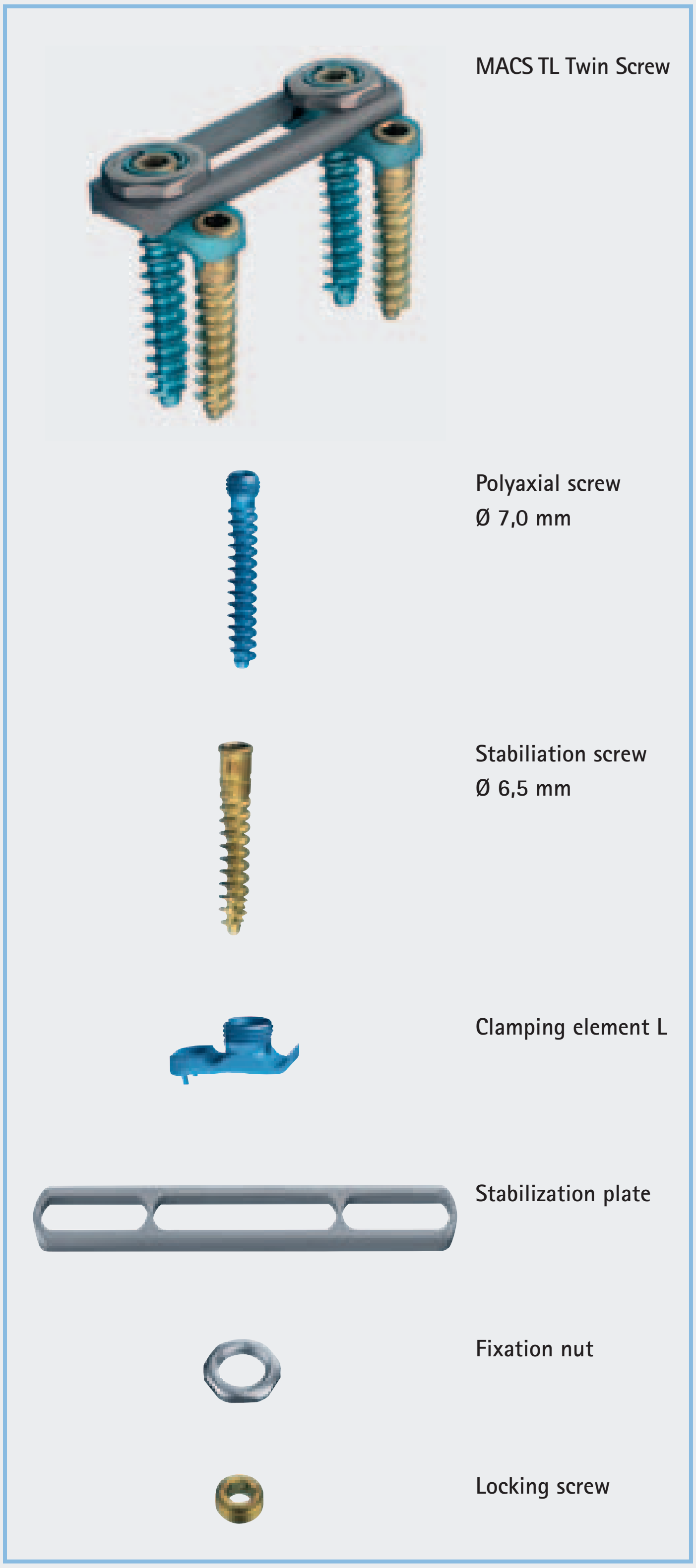



*Fig. 1: MACS TL components*

The thoracic clamping element has been designed to fit the smaller thoracic vertebral body. In contrast to the standard clamping element with its anterior stabilization screw situated in front of the plate, the anterior stabilization screw of the thoracic clamping element is implanted within the plate. Consequently, the width of the plate equals the overall width of the implant, while still maintaining the principle of four-point fixation.

Due to its larger diameter, the polyaxial screw XL can be seated firmly even in cases of reduced bone density. There is also the option of cementing the screw through its cannulated and slotted shaft.

In cases for multi segmental fusion of the spine, the application of non-bendable plates is limited by the spinal anatomy. Bendable rods, which have to be used in such cases, can be adapted to the anatomic spinal lordosis.

For exceptional cases where the bone chip cannot be fitted optimally, the chip can be fixated separately with a special bone graft clamp component.

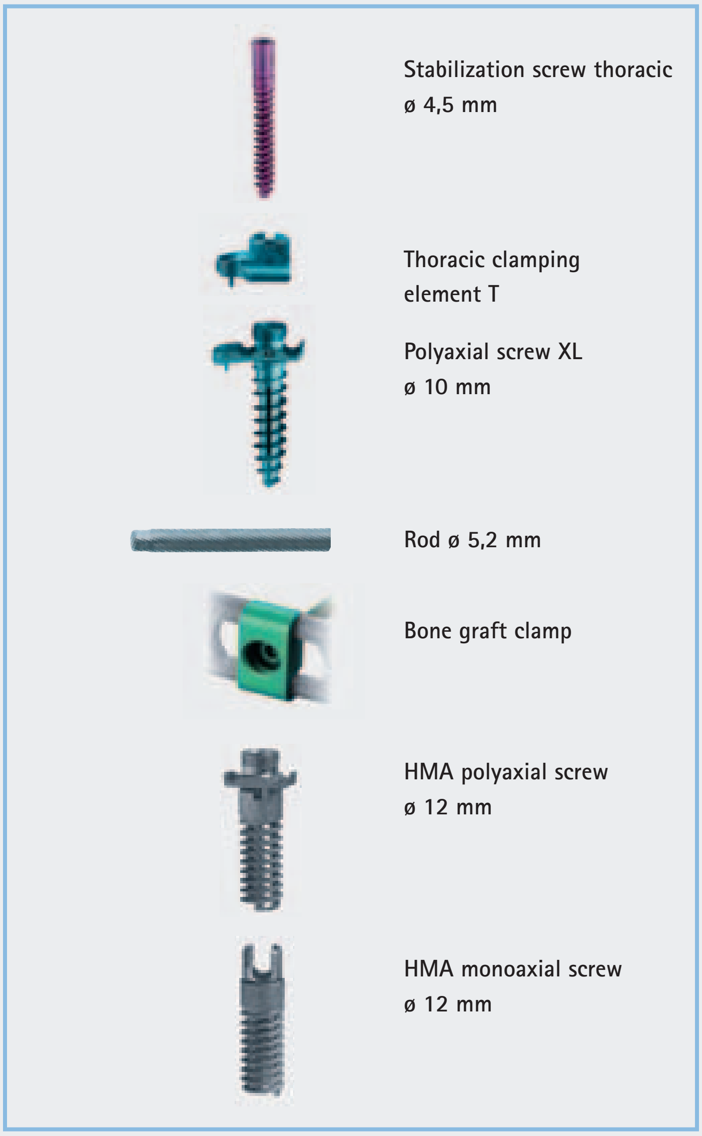



*Fig. 2: MACS TL components*

## MACS TL System „HMA“

The MACS TL System "HMA" is used preferably in the surgical treatment of scolioses. For such corrections, which usually extend over longer segments of the spine, large HMA screws are implanted into each vertebral body of the fusion segment. The application as a single-rod system with monoaxial HMA screws requires a basic stability of the deformity to be corrected, because rotational stability, at least in relative terms, can only be achieved through a multisegmental construction.

The support elements, fixation nut and locking screw are identical to those of the Twin Screw system. Combined mounting with the polyaxial HMA screw and a Twin Screw tensioning element is also possible.

## Indications – Contraindications

Anterior spine stabilization with MACS TL may be suitable for the following indications:

- Unstable fractures of the thoracic and lumbar spine, from T3 to L4
  - as the singular treatment for type A2 and A3 fractures (AO classification)
  - as an additive treatment for posteriorly reposed and stabilized type B + type C fractures (AO classification)
- Discoligamentous instabilities
- Correction of posttraumatic and congenital axial misalignment (combined with posterior intervention)
- Instabilities in cases of infection or tumor
- Degenerative instabilities
- Deformities

The following conditions are considered as contraindications:

- Severe osteoporosis
- Infection
- Pregnancy
- Foreign body sensitivity to implant materials

## Mounting options

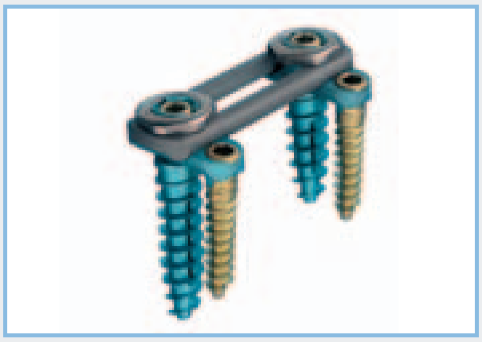
The modular concept allows combining the various elements and bone screws, depending on the indication. The following basic concepts are available:

Twin Screw Standard

Standard version for anterior stabilization from T8 to L4 with fixed-angle four-point fixation.

Twin Screw XL

Equivalent to standard version, but with a cementable screw, for fusion in conditions of reduced bone density.



Twin Screw thoracic

Thoracic extension of the standard version, for fixed-angle four-point fixation in “small” vertebrae (T3 to T8).

HMA polyaxial screw

Special design, preferably for anterior stabilization of tumors and multisegmental axis correction (scoliosis).

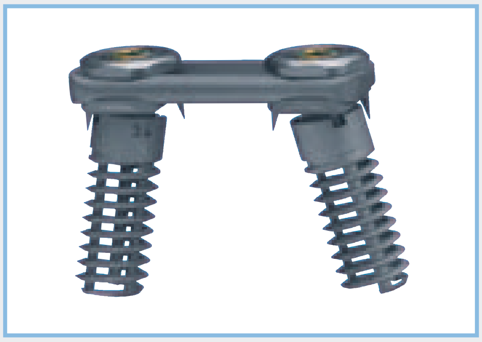


*Fig. 3: MACS TL concepts*

# The thoracoscopic technique of spinal treatment

## General

The gold standard for anterior stabilization of the thoracolumbar spine has been open access surgery.

The drawback of that technique is the access morbidity of the incision, which has to be relatively wide because of anatomic conditions. The drive towards a reduction of access morbidity is characterized by two steps of development. The introduction of long shaft instruments eliminated the necessity for the surgeon's hand having direct access to the operating site. However, such mini-open access impairs the visualization of the site. This problem was overcome, in turn, by using an endoscope. The next step was then, following comparable developments for operations in other regions of the body, the adaptation of a completely endoscopic technique to the requirements of spine surgery.

In principle, the endoscopic access to the lumbar and thoracic spine must be considered as an alternative to the open access technique. The endoscopic access to the thoracic spine offers the convincing advantage that, once a pneumothorax has been applied, the surgeon can perform a gasless operation on the spine in the thoracic cavity. Fenestration of the diaphragm allows access to the thoracolumbar transition region through the retroperitoneal access canal, making the majority of all fracture provisions accessible to this alternative technique.

The thoracoscopic technique of provision is guided by the conventional open procedure. Accordingly, the patient is put into a stable lateral position. For the surgeon, this position facilitates the change to the thoracoscopic technique, and if any complication cannot be managed thoracoscopically, the problem can be approached immediately by widening the access. The alternative ventral position entails a significantly longer reaction time due to the necessary emergency repositioning of the patient, in the case of a hemorrhage of a large blood vessels.

The safety of endoscopic interventions at the spine primarily depends on the existence of fixed orientation marks. MACS TL takes account of this requirement, in the way that the posterior polyaxial screws are inserted at the beginning of the intervention, and serve as landmarks for the length of the procedure. The following operating steps largely follow the conventional open procedure.

## Advantages and drawbacks of the thoracoscopic technique

The following advantages arise from the thoracoscopic technique:

- Intercostal mini access without rib retraction or resection
- Excellent intraoperative view of the target area through 30° optics combined with a modern video transmission system
- Efficient and safe anterior decompression of the spinal canal
- Tissue-preserving provision for multisegmental and multilevel pathologies through additional mini access openings
- Reduced blood loss
- Low pre- and postoperative morbidity thanks to earlier extubation,
- Less pain and faster rehabilitation

The drawbacks are:

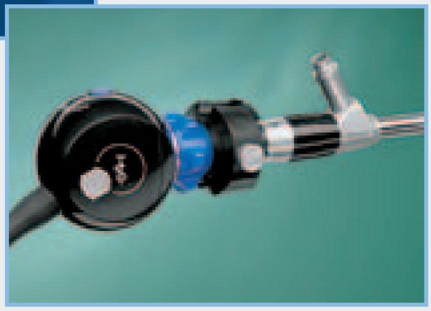
- Increased complexity of anesthesia (e.g. double-lumen intubation)
- Longer learning curve for the endoscopic operating technique

## Indications and contraindications for thoracoscopic treatments

The indication for a thoracoscopic treatment is the same as the indications for the open technique.

Contraindications against the thoracoscopic technique are:
- Significantly restricted cardiopulmonary function
- Acute post-traumatic pulmonary function disorder
- Significant blood coagulation disorder

# Operating Technique



In this operating manual, the thoracoscopic bisegmental standard treatment with access from the left side, corporectomy, bone graft bridging and MACS TL instrumentation is described using the example of a lower thoracic spine stabilization. The special techniques of diaphragm splitting and endoscopic decompression are treated separately in "Special cases" section starting on page 28.

## Instrumentation

*Fig. 4: Miaspas TL Instruments, extra configuered set for the thoracoscopic approach available at Aesculap.*

The following devices and instruments are required for the thoracoscopic anterior access:

- Video transmission chain with a 3-chip camera, a rigid endoscope with 30° optics, Xenon light source and two monitors for the operating surgeon and assistant
- Suction/irrigation unit
- Lung and diaphragm retractor
- Instruments for the trocar accesses
- MACS TL instrument and implant sets
- Long shaft instruments for the thoracoscopic preparation of the vertebral structures and for the resection of intervertebral disc and bone material (e.g. MIASPAS TL for MACS TL, a specialized instrument set for endoscopic access surgery, offered by Aesculap, Fig. 4).
- Instruments for bone grafting from the iliac crest
- Emergency set for thoracotomy / thoracophrenolumbotomy

## Patient position

The intervention is executed with the patient in an exact lateral position. As in the open technique, the right-side access (patient in left lateral position) is recommended for the provision area T3 to T8, and the left-side access (patient in right lateral position) for the provision area T9 to L4.

Note:

If the spine segment to be instrumented is covered by the aorta, you must access from the opposite side!

The exact lateral position must be ensured through support at the scapula, the arm, the sacrum, and the symphysis. To avoid any obstruction to the freedom of movement of the instruments, the arm that rests on top of the body should not be positioned above the level of the lateral thorax wall.

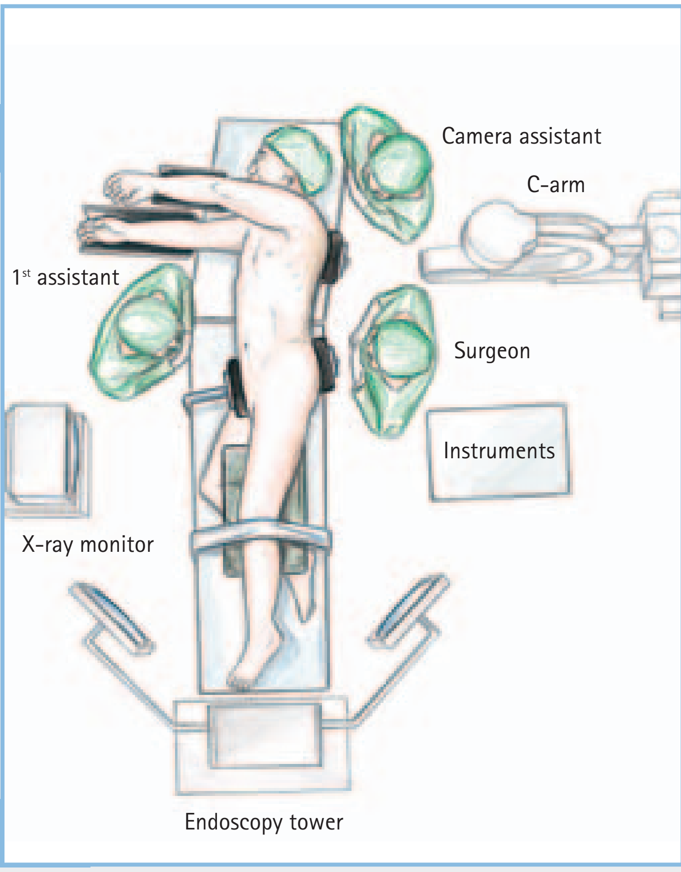



*Fig. 5: Operating room setup*

## Operating team, monitor, X-ray C-arm

The surgeon and the camera assistant stand behind the patient. The 1st assistant stands on the opposite side.

Each member of the operating team must be able, at all times, to control the intervention via the monitors. Therefore, the endoscopy tower with the two monitors is set up at the bottom end of the operating table.

The X-ray C-arm is positioned between the surgeon and the camera assistant. The X-ray monitor is placed on the opposite side. Check that the C-arm is freely movable before applying sterile cover to the patient.

## Access

The thoracoscopic standard provision is carried out through four mini-access portals, which are kept open by tissue-protecting plastic trocars. Through three of these trocars, the optical system, the lung retractor and the suction/irrigation tube are introduced; the fourth trocar serves as the working channel.

As thoracoscopic surgery requires triangulating operation of the instruments, the portals must be positioned in such a way that the target area is accessible through any one of the portals. Also, the working channel should be approximately orthograde in relation to the target area, so that the corporectomy and the introduction of the implant will not be made more difficult by the need to handle the instruments aslant. For multisegmental treatments, the obvious option would be an exchange of roles between the working channel and the optics portal.

Note:

An incorrectly positioned port can become a considerable hindrance to the surgical procedure when the thorax is rigid. Therefore, portals should be planned and applied with foresight and diligence. If the trocar position is suboptimal, the surgeon can try reaching the adjacent, more favorable intercostal space by subcutaneous tunneling from the same skin incision.

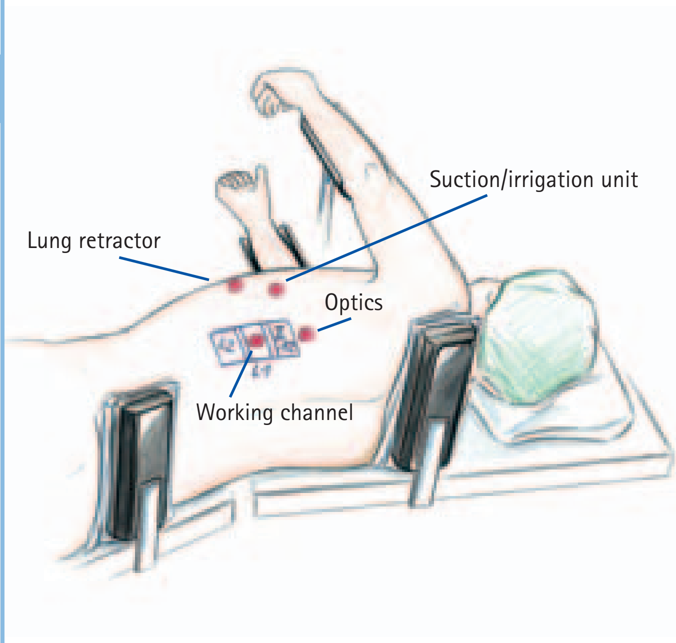



*Fig. 6: Access positions*

The outlines of the vertebral bodies to be fused have to be clearly identified under X-ray control, and marked on the skin surface. Diagonal projections should be avoided under all circumstances, due to the distance between the skin and the operating site. A diagonal projection would result in an incorrect trocar position.

The working channel is sited in a perpendicular projection above the target area, usually above the fractured vertebra. The optical channel, too, is positioned perpendicularly above the spine, at a distance of two intercostal spaces towards cranial. For fractures of the middle and upper thoracic spine, the optical channel is sited at a distance of two intercostal spaces from the working channel, towards caudal. The trocars for the suction/irrigation tube and the retractor are applied approx. six inches ventral (roughly along the anterior axillary line) from the working channel and the optical channel.

Note:

To avoid mutual obstruction of the instruments, the distance between the accesses must not be too close.

The first channel to be opened is the optical channel. To avoid damage to the parenchyma of the lungs, single-lung aspiration is applied and the thorax is opened through an approx. 1.5 cm long mini-thoracotomy incision. The first trocar (Ø10 mm) is inserted with the collapsed lung displayed. The remaining trocars are sited under videoscopic control.

# Site setup

The camera assistant must maintain steady camera handling. Ideally the operating site should be displayed on the monitor in a manner the surgeon is familiar to. With the camera aligned accordingly, the spine should be displayed parallel to the bottom edge of the monitor screen. The structures situated ventral from the spine are displayed in the upper part of the screen. In accordance with the working direction of the surgeon, the right/left edges of the screen represent the cranial/caudal boundaries of the site.

Unobstructed view of the operating area, which is essential, must be maintained by the first assistant. As the camera setup has been adjusted to the needs of the operating surgeon, the first assistant will see a laterally reversed image of the site, which will make it more difficult for the assistant to maintain visual control of his or her instrument handling. This problem can be overcome either by relying on the assistant's experience or electronically, through inverse image display on the assistant's monitor (only applicable if two monitors are used).

Slight parenchymal adhesions can often be easily loosened with the blunt shaft swab. In cases of extended scarring, the risk of damaging the parenchyma necessitates a decision whether a switch-over to the conventional method is indicated.

The diaphragm and the collapsed lung are carefully pushed towards medial, using the retractor, until the spine becomes visible. The height of the fractured vertebral body is often marked by a hematoma. Lesions below the diaphragm are accessible through diaphragm splitting (see page 30, "Special cases" for a description of thoracoscopic diaphragm splitting).

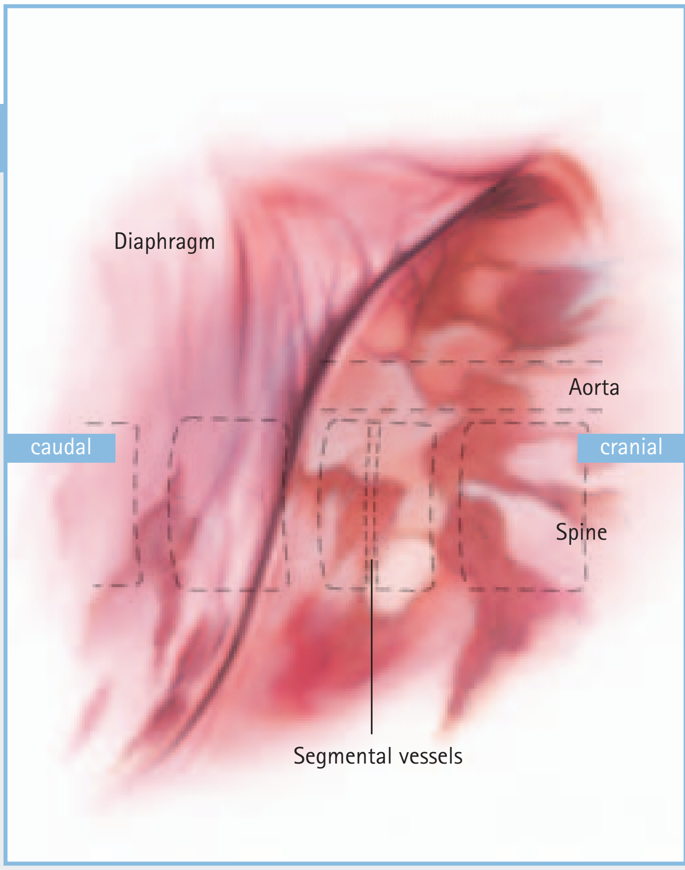



*Fig. 7: View of the site*

■ ■ ■ Note:

Even with rounded retractor blades, organ (spleen, liver) or vascular lesions cannot be excluded if excessive pressure is applied to the tissue!

# Screw position

While the thoracoscopic operating method provides excellent visibility of all details in the target area, the general overview is hampered by the lack of a three-dimensional impression. This deficit can be compensated by using orientation marks, which, ideally, are applied at the beginning of the operation. The implantation sequence with MACS TL allows for this fact, in the way that the posterior polyaxial screws including the clamping elements are applied prior to the preparation and corporectomy. Monitored via the imaging system, the screw insertion points are marked with Kirschner wires without prior opening of the pleura.

Because of the higher bone strength in the region of the vertebral end plates, the screws are preferably inserted in the cranial or caudal third of the vertebral bodies. Where pedicle screws are already imbedded, the procedure must be adapted to the situation. If the bone strength is normal, monocortical screw fixation is sufficient. The necessary screw length is determined from the CT scan.

■ ■ ■ Note:

When the plate or rod is fixed to both the clamping elements, the latter are forced into a position perpendicular to the implant axis. This also determines the position of the ventral stabilizing screw. To avoid the risk of mispositioning the ventral screw in the intervertebral disc space, any axial divergence between the spine and the implant must be avoided under all circumstances. This risk exists, especially, if the posterior screws are positioned very close to an end plate, and for longer constructs.

The location of the screw insertion point depends on the selected screw type:

## MACS TL Twin Screw Standard and XL (Fig. 8)

The posterior polyaxial screw is positioned approx. 10-13 mm from the dorsal edge and 10-13 mm from the cranial or caudal end plate. Since the aim is to achieve a parallel implant position, the location of the screw insertion points should be identical in all vertebral bodies to be instrumented.

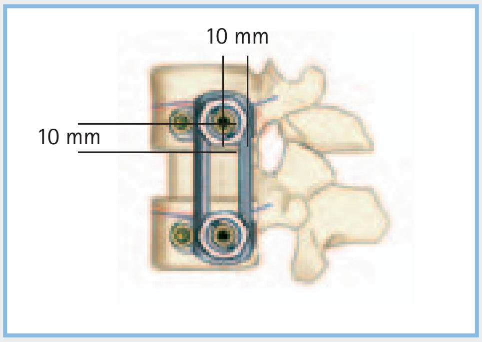



*Fig. 8: Standard*

## MACS TL Twin Screw Thoracic (Fig. 9)

The polyaxial screws of the thoracic clamping element are inserted centrally into the vertebral body, in such a way that the clamping elements too will be positioned centrally.

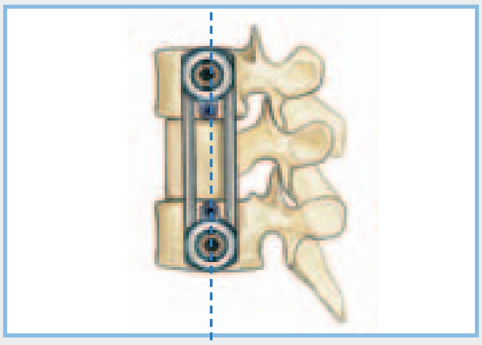


*Fig. 9: Thoracic*

## MACS TL Twin Screw Thoracic + Standard Combined (Fig. 10)

For a combination mounting, the standard clamping element is positioned as described above. The thoracic tensioning element is applied in such a way that the plate runs parallel to the spinal axis.

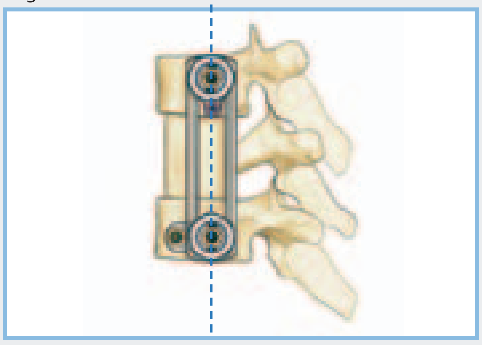


*Fig. 10: Combined: Standard + Thoracic*

## MACS TL HMA (Fig. 11)

Due to their larger diameter, the HMA screws are positioned 20 mm from the dorsal edge and 15 mm from the cranial or caudal end plate.

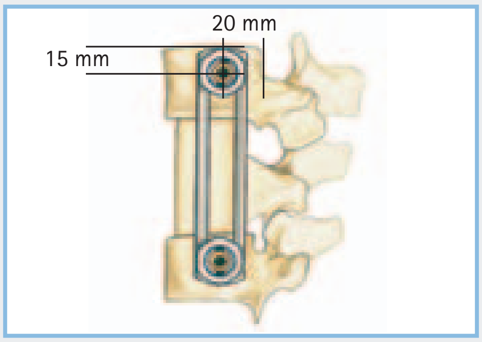



*Fig. 11: HMA polyaxial screws*

# Hemostasis

The effectivity of hemostasis in endoscopic interventions essentially depends on the level of experience of the operating surgeon and team. If blood spraying occurs, the surgeon must immediately decide from the intensity and localization of the hemorrhage, whether hemostasis can be reliably achieved endoscopically or rather openly, following an emergency thoracotomy. There are no general rules of procedure for such cases.

However, according to experience, due to the enlargement effect of the optical system, even minor incidents of blood spraying often appear stronger than they really are. By immediate compression of the source of the hemorrhage, using the suction syringe or the shaft swab, the situation can be defused in most cases, if overview is maintained, so that a targeted hemostasis can be performed. Untargeted, over-rushed hemostasis without visibility should be avoided under all circumstances.

For diffuse hemorrhages we recommend hemostasis with a hemo-stypticum. Minor blood sprays can be reliably treated with monopolar current or with clips.

The segment vessels of the fractured vertebral body require targeted treatment. After mobilization and ligation with double clips, the vessels are severed with endoscopic scissors.

The segment vessels of the vertebral bodies to be instrumented can be preserved in most cases. The hemorrhage from a vessel that was accidentally damaged during positioning of the screw usually stops when the screw is driven into the bone.

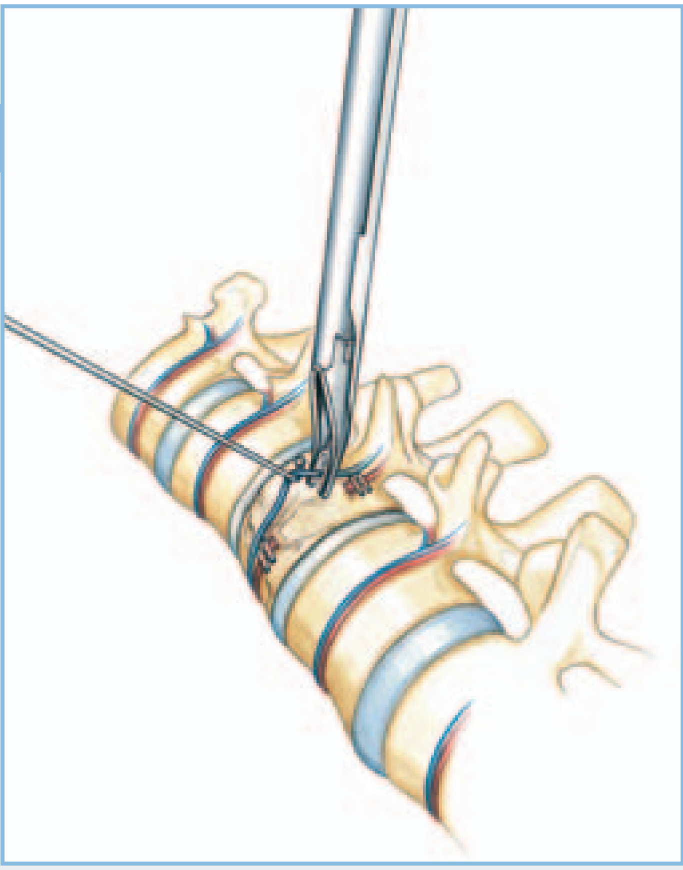


*Fig. 12: Sealing the segment vessels*

## Inserting the K-wires

The K-wire is connected to the insertion instrument and introduced into the X-ray transparent aiming device.

Controlled via the imaging system, the intended screw insertion point is found with the aiming device on the precisely set vertebral body. Then the insertion point is aligned in such a way that the K-wire appears as a point, concentrically within the metal ring that forms part of the aiming device *(Fig. 13a)*.

Using the slotted hammer, tap the insertion instrument until the K-wire, now in an orthograde position, is driven to the maximum possible depth of 20 mm.

The insertion instrument is freed from the K-wire by turning the instrument counter-clockwise. The aiming device is removed. The position of the K-wire is inspected via the imaging system.

The second K-wire is introduced in the same way.

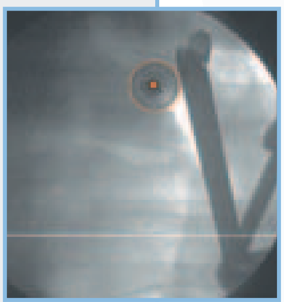


*Fig. 13a*

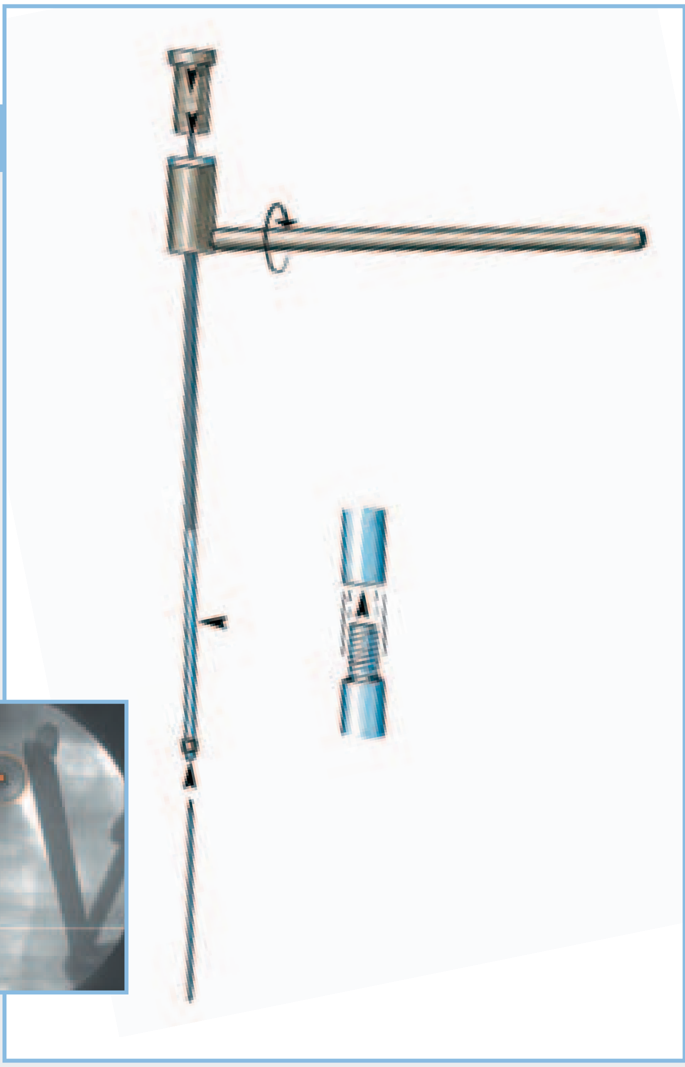


*Fig. 13: Insertion instrument for K-wire FW330R, K-wire set FW343S*

## Preparing the screw insertion point

**A** Twin Screw concept (Fig. 14)
The cortex is opened by revolving movements of a cannulated center punch, down to a maximum penetration depth of 10 mm.

**B** HMA concept (Fig. 15)
The cortex is opened with a cannulated cortex drill.

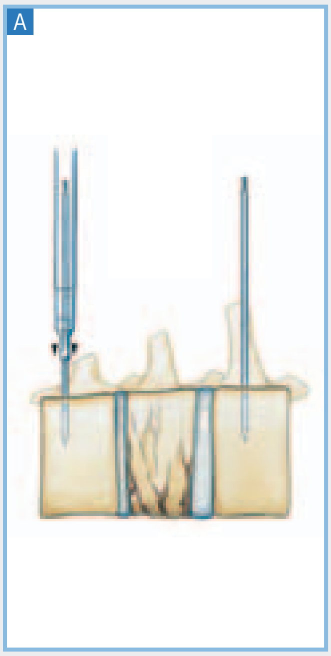


*Fig. 14: Cannulated center punch FW339R*

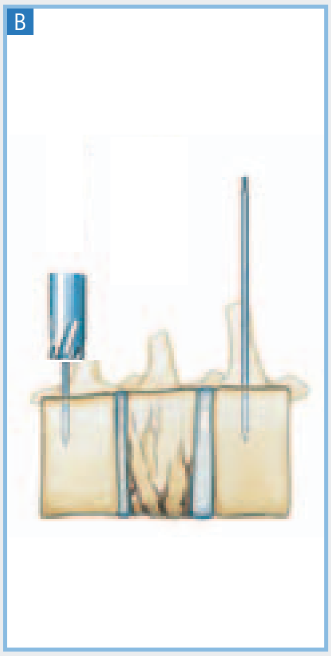


*Fig. 15: Cortex drill FW332R*

Note:

To avoid pulling out the K-wire, the revision instrument (FW336R) can be used for applying a counterforce.

## Inserting the posterior polyaxial screw and the clamping element

MACS TL is implanted using a 2-part insertion system (centralizer and insertion sleeve) that allows targeted mounting of the individual components. Prior to implantation, the posterior polyaxial screw and the clamping element are connected to the sleeve system and the cannulated screwdriver in the following assembly steps:

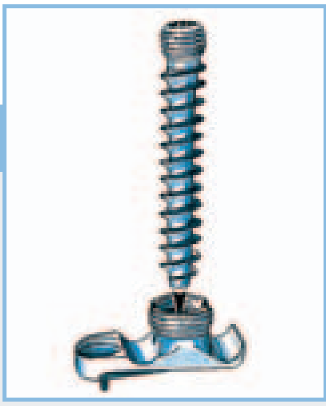


*Fig. 16a: Polyaxial screw, e.g. SX791T + clamping element SX800T*

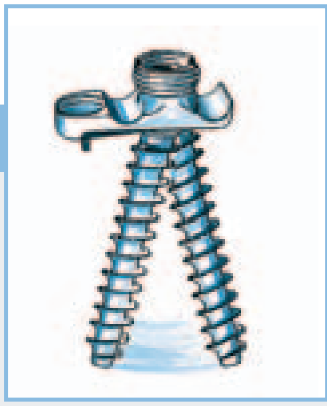


*Fig. 16b: Polyaxial screw, mounted*

- Connecting the posterior polyaxial screw to the clamping element

  **A** Twin Screw concept (Fig. 16a)
  A posterior screw of suitable length is screwed into the clamping element.

  **B** HMA concept (Fig. 16b)
  The HMA screw is supplied pre-assembled with the clamping element.

- Assembling the clamping elements with the centralizer (Fig. 17)

  The centralizer is connected with the clamping element, using the screwdriver marked "For centralizer" (blue handle). When doing this, the pins of the centralizer sleeve must be fitted into the grooves of the clamping element.

*Fig. 17: Centralizer FW317R
Hexagon wrench »For centralizer« FW337R*

- Connecting the centralizer to the insertion sleeve (Fig. 18)

  The insertion sleeve is put on the external hexagon of the centralizer. When doing this, the springs of the insertion sleeve must engage in the groove of the centralizer.

  The handle of the insertion sleeve is put on the proximal external hexagon of the insertion sleeve. With the handle and the clamping element in identical alignment, the position of the clamping element can be controlled through the handle while the screw is driven in.

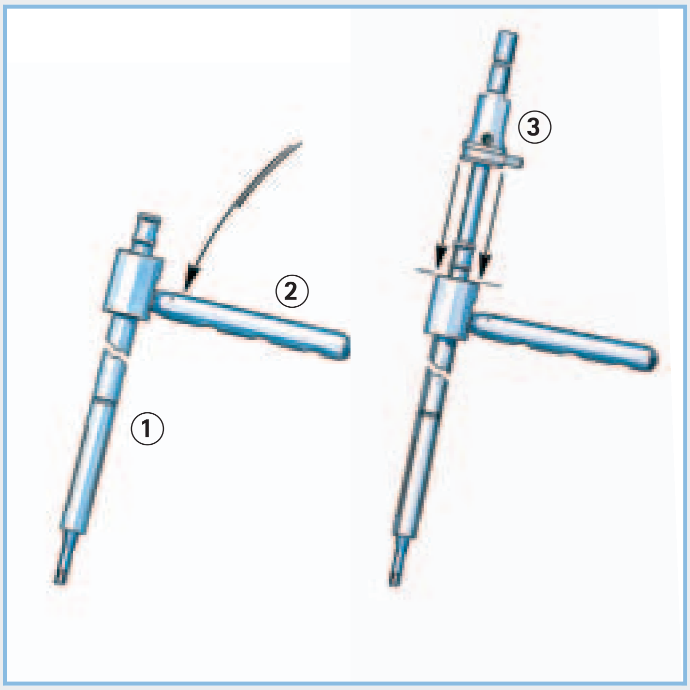



*Fig. 18: **1.** Insertion sleeve FW318R; **2.** Handle for insertion sleeve FW316R; **3.** Cannulated screwdriver FW319R*

# MACS TL operating steps

The black ratchet handle is fitted on the cannulated screwdriver by pulling up the ring of the Harris connector. (Fig. 19)

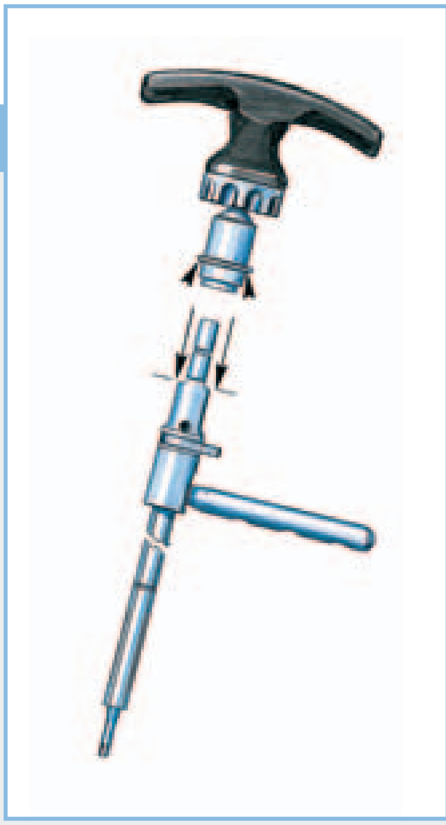


*Fig. 19: Screwdriver with ratchet handle FW400R*

- Inserting the cannulated screwdriver (Fig. 20)

With the screw axially aligned with the insertion sleeve, the cannulated screwdriver is pushed through the insertion sleeve inside the hexagon socket of the screw head until it is securely engaged. The polyaxiality of the screw head is now locked while the screw is implanted.

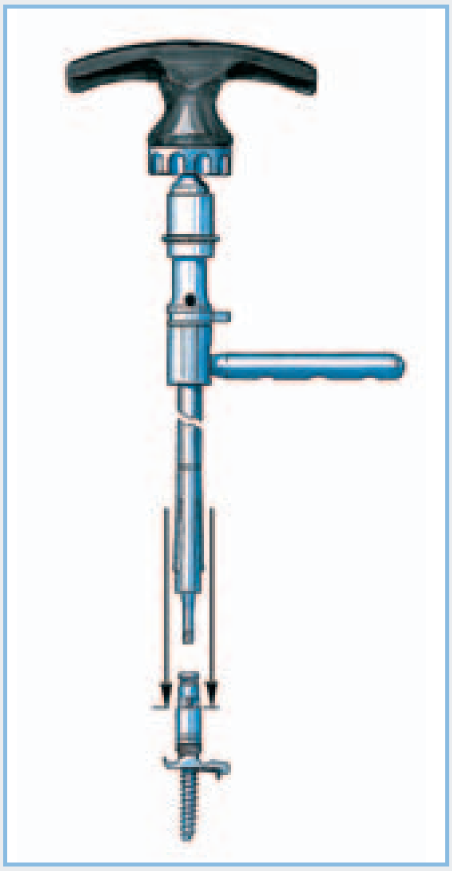


*Fig. 20: Mounting a screw*

## Implanting the posterior polyaxial screw

A Twin Screw concept (Fig. 21)
Because of its size, the screw is inserted through a speculum. The trocar is removed and the speculum is introduced by means of a guide rod.
The posterior screw is driven in via the K-wire, by 2 to 3 turns, until the first turns of the thread have engaged in the vertebral body.

B HMA concept (Fig. 22)
The HMA screw is driven in through the speculum, via the Kirschner wire. To facilitate the positioning of the plate or rods, the head of the polyaxial screw should be aligned in such a way that its arrow points ventrally.

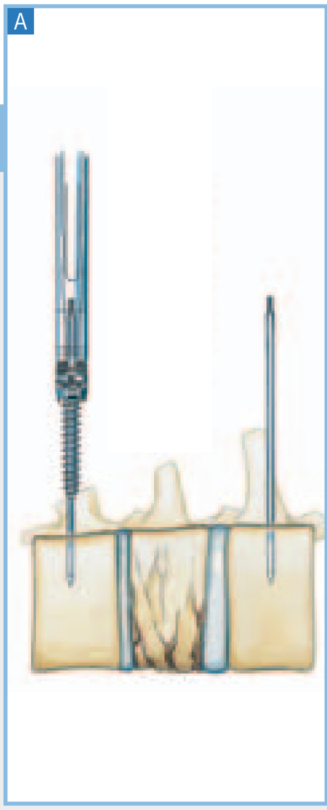



*Fig. 21: Twin screw*

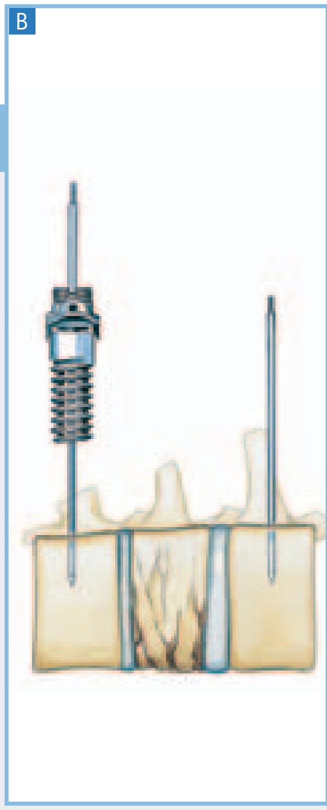



*Fig. 22: HMA screw*

Removing the K-wire:

The removal instrument for the K-wire *(Fig. 24)* is introduced through the black ratchet handle into the cannulated screwdriver and screwed onto the K-wire. The K-wire is then pulled out.


*Fig. 24: Removing a K-wire with a removal instrument*

Note:
The K-wire must be removed at this stage because jamming in the cannulated screw can lead to perforation of the opposite cortex if the screw is driven in any further!

Ideally, the polyaxial screw is now driven parallel to the vertebral end plates and orthograde to the dorsal edge of the vertebral body, but only to a depth at which the polyaxiality between the clamping element and the screw is still fully maintained (Fig. 23). The final tightening will be carried out later.

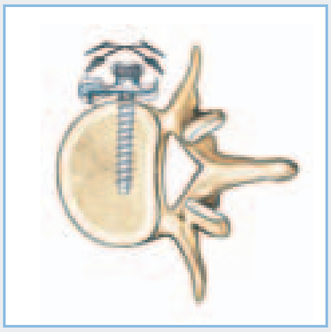


*Fig. 23: Flexible clamping element*

## Removing the screwdriver and the insertion sleeve

### Fig. 25

The locking springs of the insertion sleeve are opened by briefly pressing the unlocking button and gently pulling at the cannulated screwdriver. The screwdriver and the insertion sleeve can now be removed. The centralizer remains mounted on the screw.

The second posterior screw is inserted in the same way.

The position of both screws must be inspected via the imaging system.

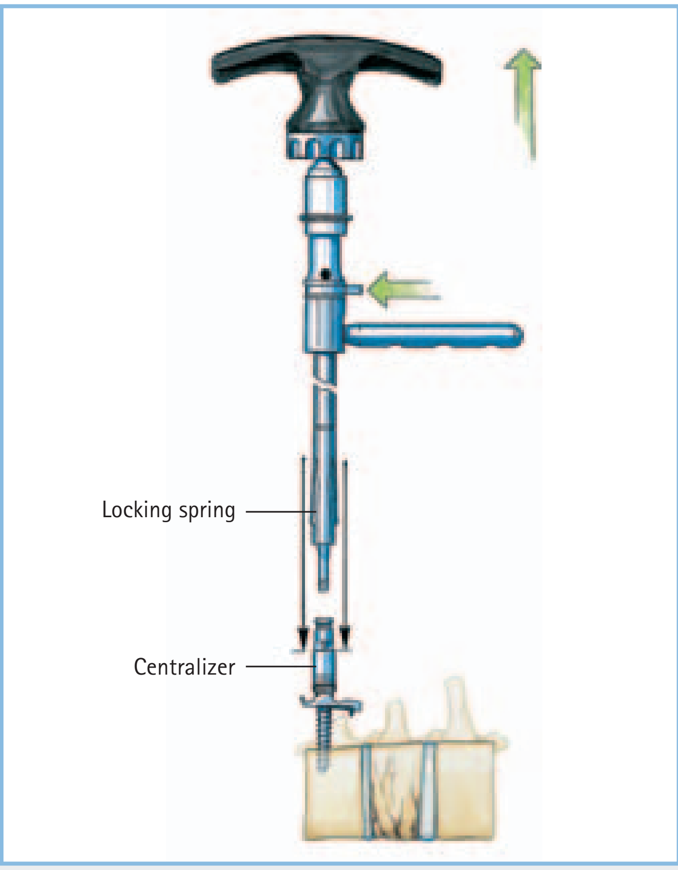



*Fig. 25: Removing the screwdriver*

Both clamping elements now serve as landmarks for the alignment. They mark the "safe working corridor", in which the intervention is continued at a calculated risk, without damaging important adjacent structures.

The corporectomy and discectomy are carried out with long-shaft instruments (e.g. MIASPAS TL). The thoracoscopic technique for anterior decompression, which may become necessary, is described in "Special techniques" on page 28.

Note:

During monosegmental treatments, the centralizer can obstruct the view of the operating area. If that is the case, the centralizer can be screwed off with the instrument marked "for centralizer". The centralizer must be remounted at a later stage.

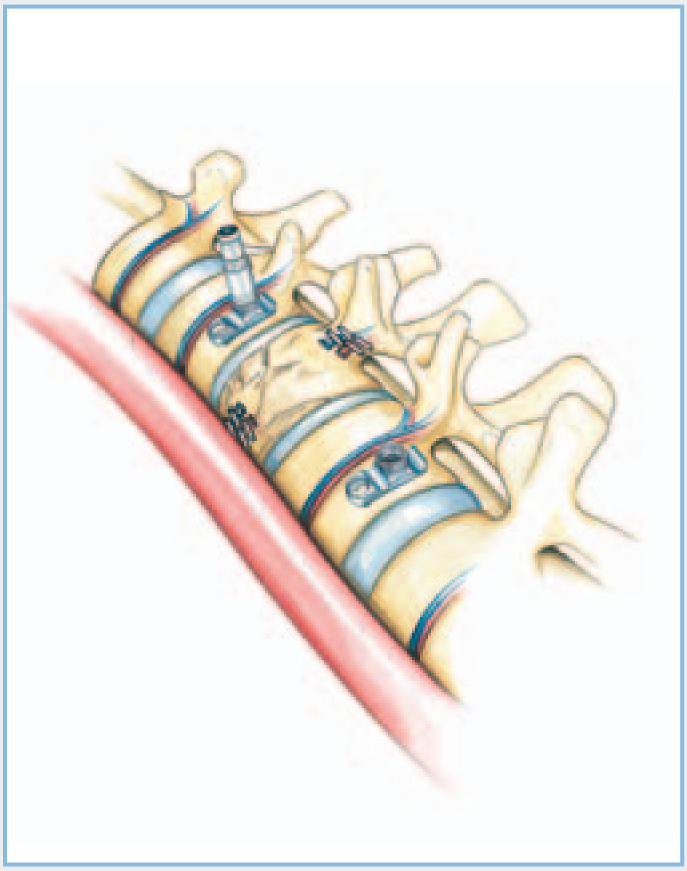


*Fig. 26: Anatomic situation after mounting the screws*

## Corporectomy

The central aim of the operation is the reconstruction of the load-bearing capacity of the ventral spine. To achieve this through the most common technique, a lesion-bridging fusion between the neighboring intact vertebral bodies is created, abandoning the segmental function.

While autologous material is considered the gold standard for pressure-proof support and defect filling, alternative implants such as titanium baskets are also increasingly used. The extent of the corporectomy depends on the degree of spinal dislocation, and how far the vertebral body has disintegrated, as well as on the space required by the vertebral body replacement. The size of the bone graft bed should be appropriate for the bone graft size so that there is as much contact area as possible between the blood-rich bone graft bed and the chip.

The thoracoscopic corporectomy requires long-shaft resection instruments (e.g. MIASPAS TL). The instrument set includes chisels, rongeurs, punches and curettes with graduated working shafts. The scale allows continuous control of the working depth and thus compensates for the missing 3-dimensional view of the endoscopic operation. For reasons of safety, these instruments should be controlled with both hands.

Note:

Using a long-shaft milling cutter is possible, in principle, although it entails a considerable risk of damaging the adjacent vascular and soft-tissue structures if the cutting head gets jammed.

The procedure of thoracoscopic resection is in line with the open technique of corporectomy. The thoracoscopic technique of dorsal edge resection, which can become necessary, is described in the "Special techniques" chapter.

The resection starts with the discectomy of the intervertebral discs next to the defect. A disc knife (Fig. 27) is introduced through the working trocar under optical control. The anulus fibrosus is incised at a sufficient distance from anterior and posterior boundaries of the vertebral body, along the end plates. The disk is resected with a rongeur.

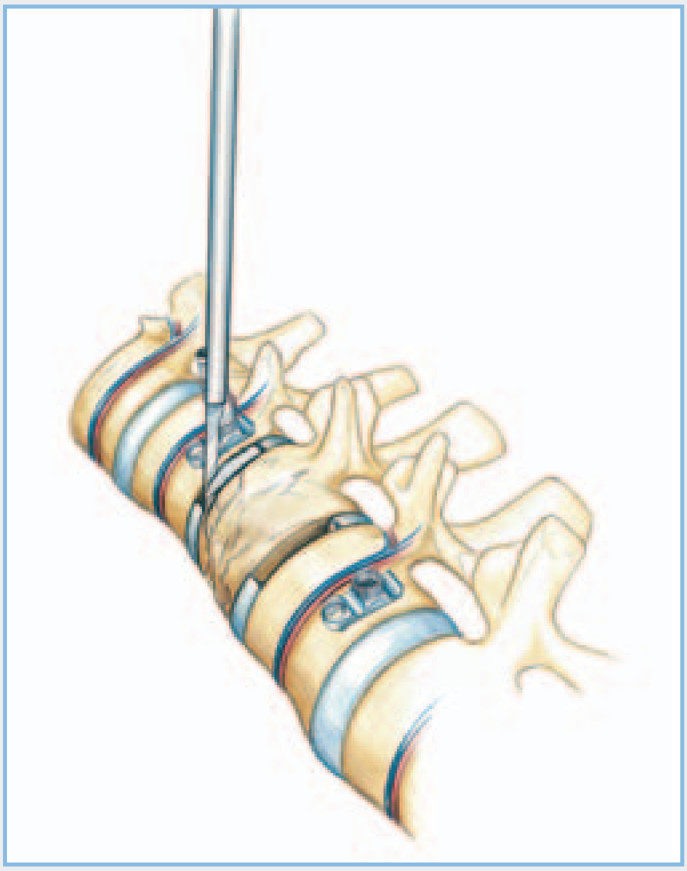


*Fig. 27: Discectomy*

The boundaries of the planned bone graft bed, parallel to the anterior and posterior walls of the vertebral body, are marked with an osteotome (Fig. 28). Within these markings, the bone material is ablated with the rongeur and punch. The operative lateral wall as well as the anterior wall of the vertebral body can be left untouched in most cases.

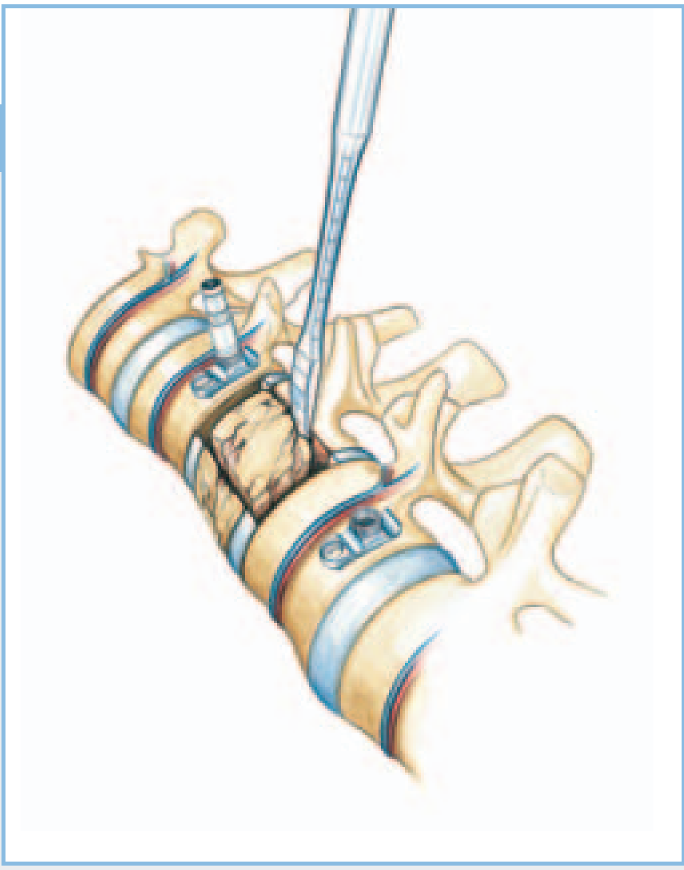


*Fig. 28: Corporectomy*

To create better conditions for bone graft ingrowth, the end plates of the adjacent vertebral bodies have to be roughened with a curette or scoop (Fig. 29). Any perforation of the end plates must be avoided in this process, since the bone graft could sink into soft spongiosa of the vertebral bodies.

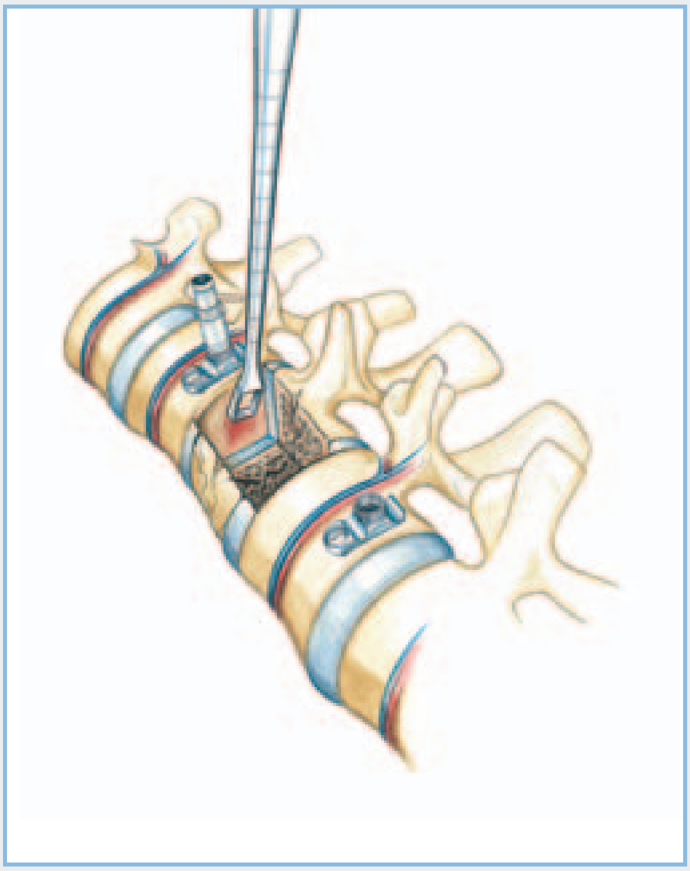


*Fig. 29: Roughening the end plates*

The size of the bone graft is determined with the length measuring instrument (Fig. 30). For an optimum fit, the bone graft should have an over-length of 1 to 2 mm.

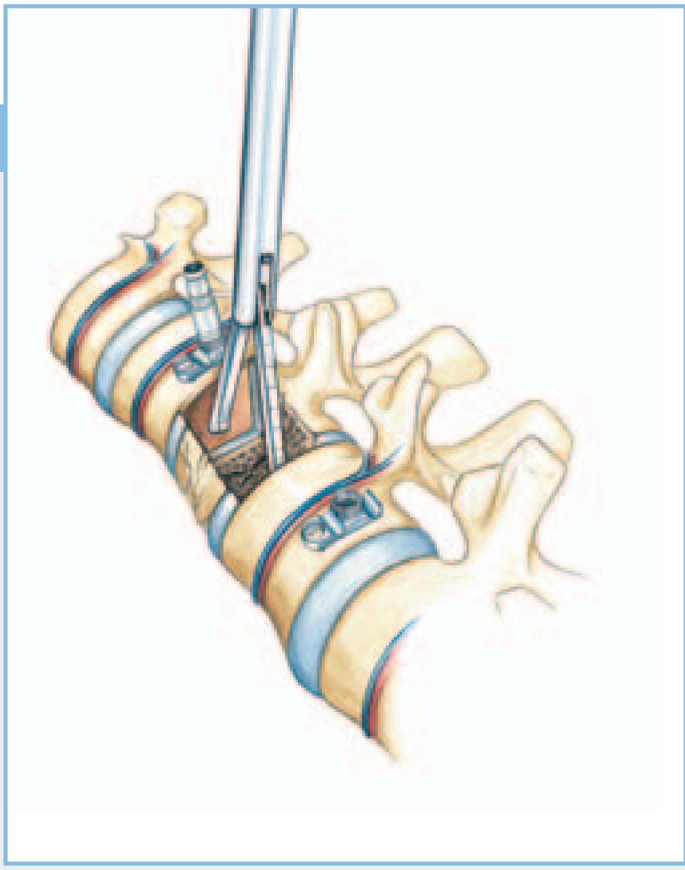


*Fig. 30: Endoscopic measuring instrument FG045R*

## Distraction

For optimal results, the bone graft should be placed in an axial position with an exact fit.

The marginal bulge of the depressed end plates often complicates the placement in of the bone graft. It is much easier to precisely position the transplant while distracting the adjacent vertebral bodies. As the distraction forceps generally available are applied to the end plates of the vertebral bodies, thus making the placement in even more difficult, the MACS TL range of instruments offers a distraction instrument that is mounted on the centralizer sleeves and allows, thanks to its special design, unobstructed access to the bone graft bed.

Distraction of the adjacent vertebral bodies serves to reconstruct the anatomic height of the fractured vertebra. Furthermore, slight temporary overdistraction helps inserting the slightly oversized bone graft. Thus, when distraction is released, this process ensures not only a precise fit but also a degree of compression. Therefore, there is generally no need for using compression forceps.

The distractor (Fig. 31a) is introduced to the operating site through the speculum. Subsequently, holding forceps are used for installing the distractor with its eyes at both ends on the centralizer sleeves. The actual distraction is performed with distraction forceps, which are applied at the distraction instrument (Fig. 31b).

There is a short version available for monosegmental fusions. For bisegmental fusions, there is a long version of the device.

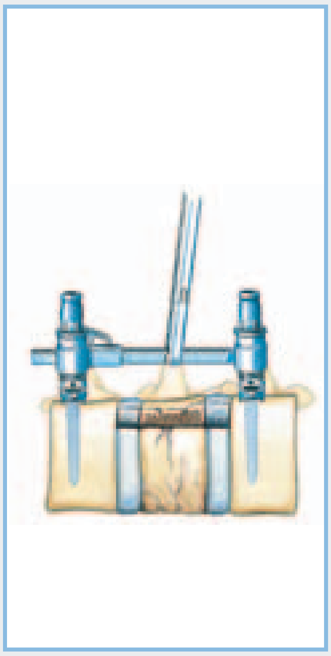


*Fig. 31a: Distraction element FW323R and FW324R*

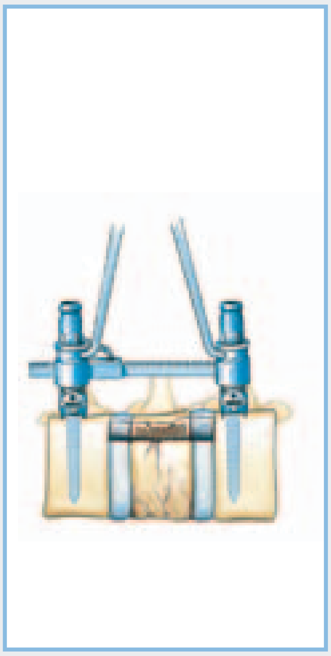


*Fig. 31b: Distraction forceps FW329R*

Inserting the bone graft (Fig. 32)

A hole for the thread of the bone graft holder is drilled into bone graft. Then the bone graft is inserted through a plastic tube into the thorax cavity. To do this, the intercostal space may have to be distracted, temporarily, depending on the transplant size.

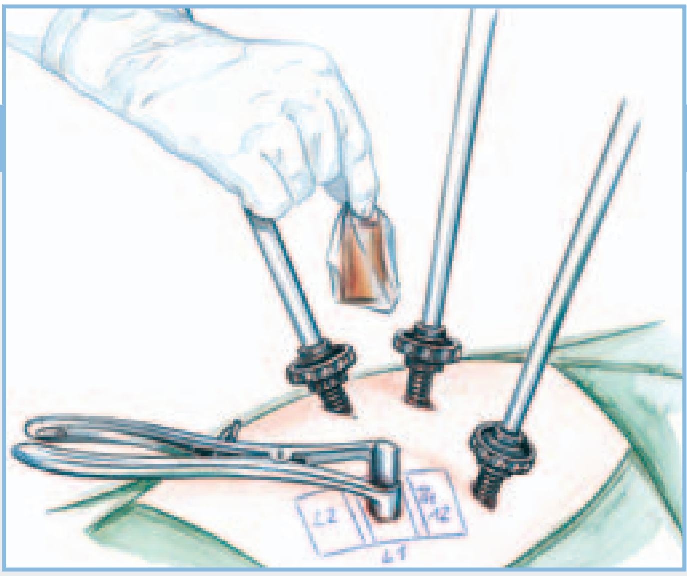


*Fig. 32: Inserting the bone graft through a plastic tube*

At the site, the graft holder is screwed into the prepared hole of the bone graft. Now the graft can be placed in a controlled manner into the distracted defect. Finally, the distractor is deactivated and removed with the holding forceps.

A vertebral body replacement implant is inserted in the same way. The distractor does not need to be used when using a distractible implant.

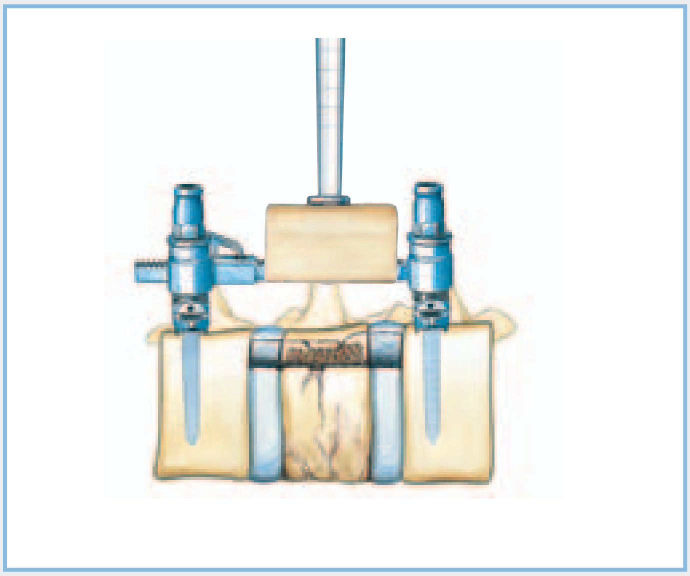


*Fig. 33: Bone graft insertion instrument FG044R*

## Stabilizing plate and rods

Stabilizing plate

The length measuring device (Fig. 34a) is used for measuring the distance between the clamping elements. The correct plate length is calculated as the measured length plus 30 mm.
Through the speculum and via the centralizer, the plate (with the flat, inscribed side facing up!) is put onto the clamping elements (Fig. 34b). The freely movable clamping elements will align themselves with the plate.

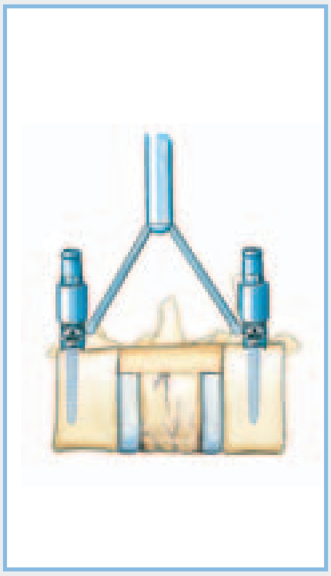


*Fig. 34a: Measuring the plate size FG045R*

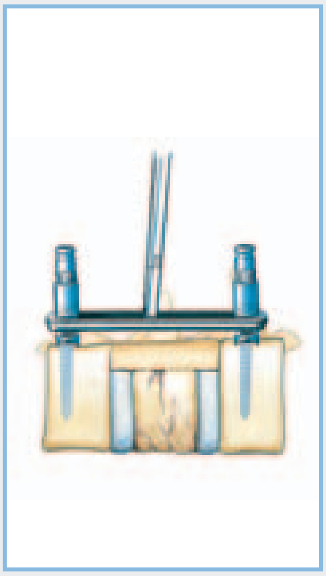


*Fig. 34b: Inserting the plate FW326R*

The plate is fastened to the clamping elements, using the fixation nuts. To do this, the insertion sleeve is installed on the centralizer (Fig. 35a, Fig. 35b).

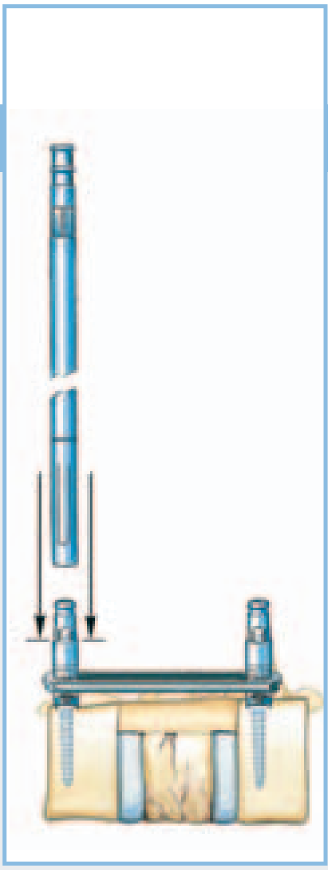


Fig. 35a: Insertion sleeve FW318R


Fig. 35b: Nut driver FW320R (1) with handle FW312R (2)

The nut driver, with the fixation nut inserted in its socket, is guided through the insertion sleeve, to the thread of the clamping element. The nut is then screwed on (Fig. 36).

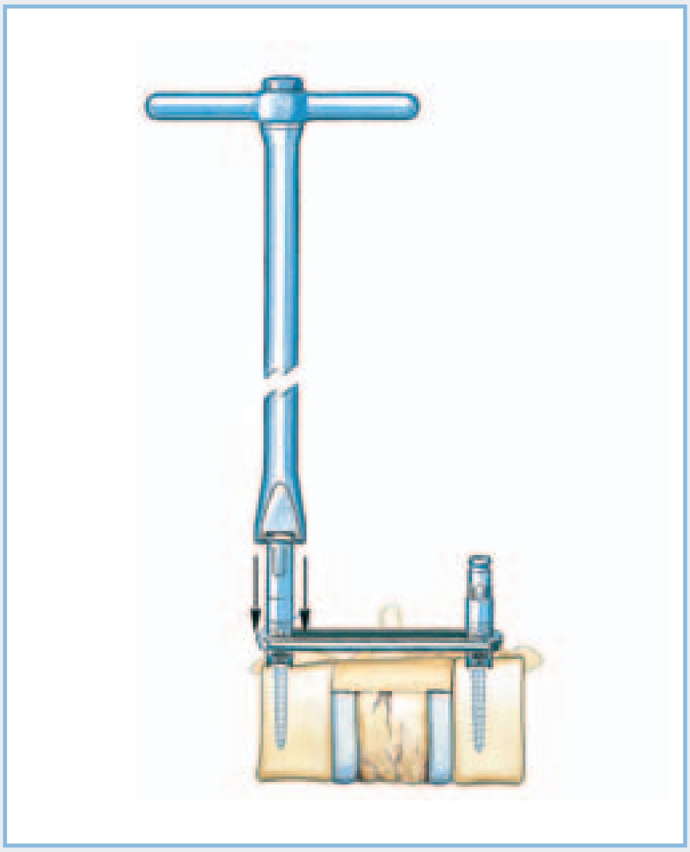


Fig. 36: Mounting the nut SX802T

# MACS TL operating steps

Under all circumstances, the torque applied in this process must be countered through the insertion sleeve handle (Fig. 37a, Fig. 37b) in order to prevent any loosening of the bone screws, especially when the bone is osteoporotic.

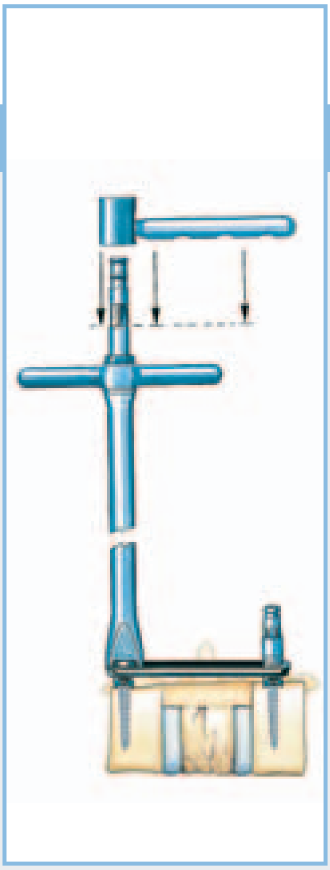


Fig. 37a: Handle FW316R

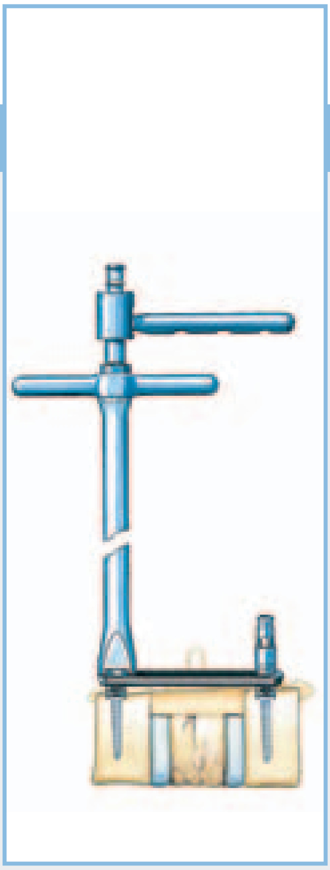


Fig. 37b: Tightening the nut, applying counter torque

The nut is tightened with a torque wrench set to 15 Nm before the nut driver is removed. (Fig. 38)

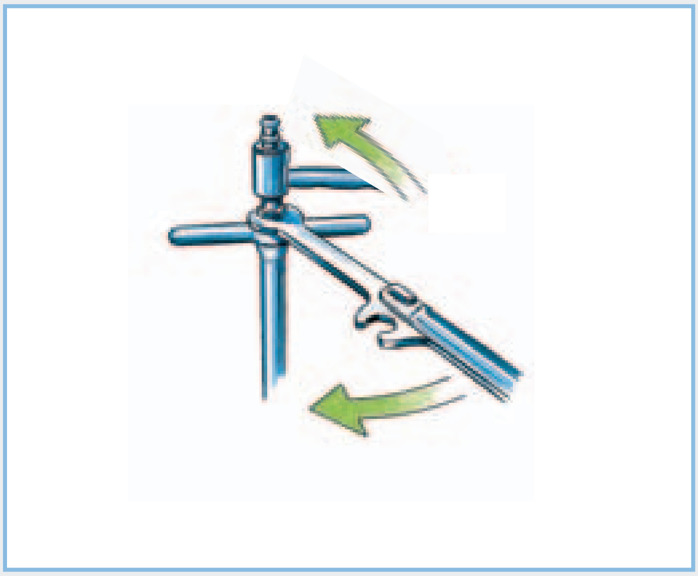


Fig. 38: Tightening the nut with 15 Nm FW331R

The insertion sleeve and the centralizer are freed from the clamping element by turning the screwdriver marked "for centralizer" counter-clockwise.

The second fixation nut is tightened in the same way.

Rods

For multisegmental treatments (longer than 100 mm) rods are used.

Both rods must be pre-bent identically, according to the patient´s anatomy. Since the anterior depression of the clamping element is shaped slightly shallower than the posterior depression, the posterior rod (Fig. 40), which is to be inserted first, can be secured by slightly tightening the nut. After that, the anterior rod can still be easily inserted. Both rods are fixated with the fixation nuts, in same way as described for the plate.

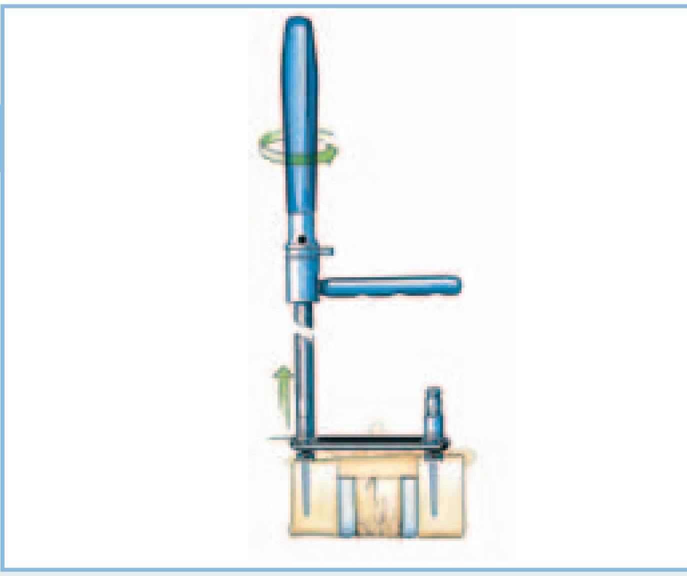


*Fig. 39: Dismounting, using the instrument »for centralizer«*

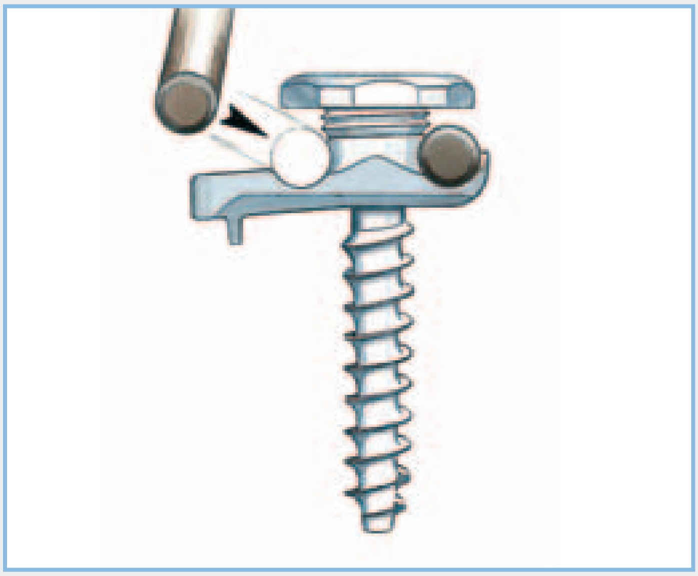


*Fig. 40: Inserting the second rod*

Note:

As the external thread of the clamping elements is very short, due to the overall flatness of the construct, care must be taken that the clamping elements move freely when inserting the plate or rods. Otherwise the fixation nuts cannot be easily grasped. If the screws were driven in too deeply in the first place, surrounding soft tissue may be in the way of achieving correct plate positioning in the depressions of the clamping element, and thus of achieving correct fixation. If that is the case, the polyaxial screw should be slightly removed.

The nuts must be tightened smoothly and easily otherwise the external thread of the clamping element can be damaged, making it impossible to achieve safe clamping between the plate and the clamping element. If this happens, the clamping element must be replaced!

## Final insertion of the polyaxial/HMA screws

The polyaxial screws are now driven in to the final depth (Fig. 41), using the cannulated screwdriver, until the clamping elements are in firm contact with the bone. The polyaxiality of the screws will ensure optimum form fit with the spinal anatomy.

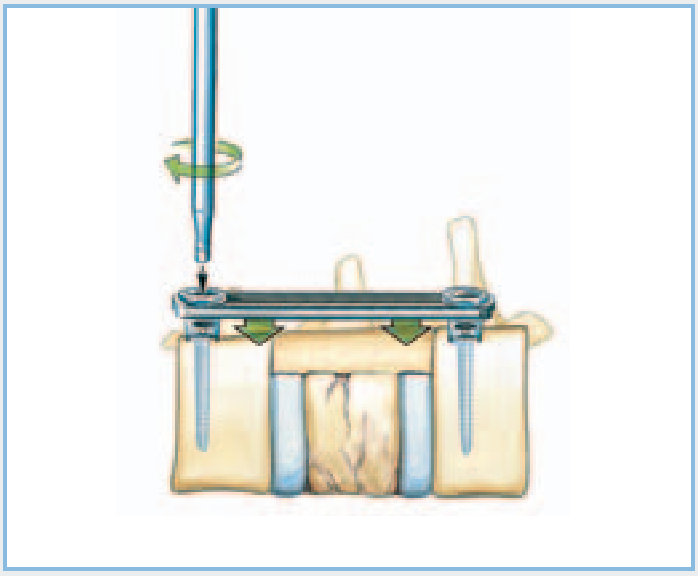


*Fig. 41: Fixating the clamping elements FW319R*

Note:

As the plate/rods are firmly fixed to the clamping elements, any uncontrolled, one-sided screwing down of the implant can lead to overstretching the polyaxiality of the screws. Therefore we recommend intermittent tightening of the screws.

## Inserting the stabilizing screw

Twin Screw concept
Using the "for centralizer" screwdriver, the guiding sleeve (Fig. 42) connected to the insertion sleeve is fastened to the clamping element via the internal thread (identical procedure as for the centralizer).

Note:
The position of the clamping element has changed due to its adaptation to the vertebral body. Consequently, the guiding sleeve must be screwed on at an angle towards anterior.

*Fig. 42: Mounting the aiming sleeve FW335R*

Through the guiding sleeve, the cortex is opened with the center punch. With the yellow-coded screwdriver, a stabilization screw of appropriate length (recommended: 5 mm shorter than the polyaxial screw) is inserted in the direction given by the guiding sleeve (Fig. 43a). Since polyaxiality is still maintained, the frontal area of the clamping element is pulled even tighter to the bone surface. The screw is of the self-locking type. The guiding sleeve is dismounted (Fig. 43b).

Note:
When titanium screws are driven in, such screws tend to take with them the surrounding soft parts. In this way, the wall of the aorta can be damaged, too, if it is in the immediate vicinity. Therefore, we strongly recommend moistening the screws prior to insertion, and to protect the soft parts by applying firm pressure against the vertebral body, (e.g. using the tip of the suction device).

*Fig. 43a: Mounting the stabilization screw SX784T*

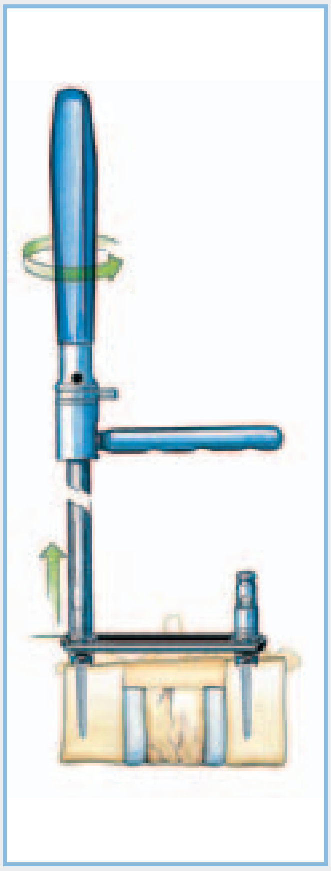


*Fig. 43b: Dismounting the guiding sleeve*

## Locking the polyaxiality

With the implant now in its final position, the final step is to inactivate the polyaxiality. To this end, the yellow locking screw is firmly screwed, in an perpendicular direction, into the interior thread of the clamping element, using the yellow-coded screwdriver (Fig. 44).

The same procedure is applied to the second clamping element

This step is followed by final X-ray confirmation.

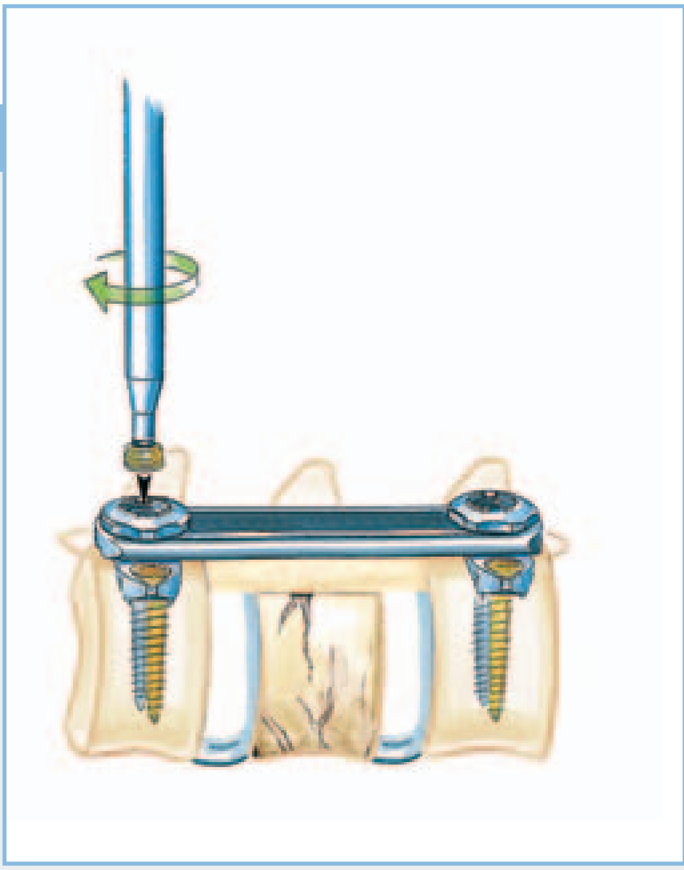


*Fig. 44: Polyaxiality locking with locking screw SX803R*

## Completing the intervention

If desired, spongiosa can be placed on around the bone transplant/ vertebral body replacement implant, through the stabilization plate/rods. Later migration of bone graft into the thorax cavity can be prevented by covering the construct with a hemostypticum.

The thorax cavity is irrigated and thorax drainage achieved through the channel for the suction/irrigation unit.

To prevent atelectases, the expansion of the lung can be monitored by thoracoscopic means. The small skin incisions are closed.

## Final position of the implant

A Twin screw standard (Fig. 45a)

B HMA polyaxial screw (Fig. 45b)

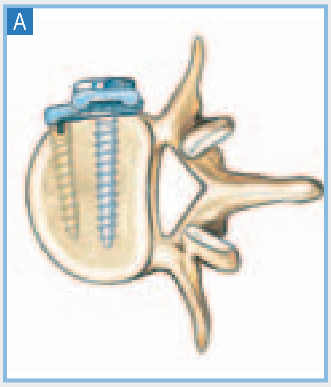



*Fig. 45a: MACS TL Twin Screw standard*

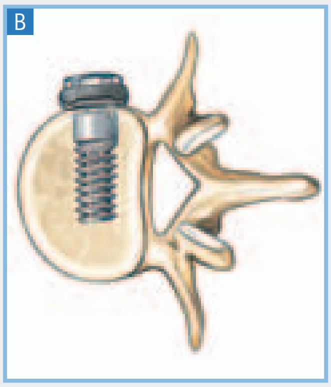



*Fig. 45b: MACS TL HMA polyaxial screw*

## Diaphragm splitting with access into the retroperitoneal cavity

If the anatomy is regular, the central attachment of the diaphragm is located approx. at the height of T12. (Fig. 46) Consequently, fusions in the region T12/L2 cannot be done by performing only a lumbotomy or only a thoracotomy. Instead, such fusions require a traumatizing dual-cavity intervention involving an extended ablation of the diaphragm.

However, using the thoracoscopic technique, the sinus phrenicocostalis, which reaches down to the L2 level, can be used for reaching fractures at the thoracolumbar transition. With access positioned exactly cranial from the lateral onset of the diaphragm, the diaphragm dome pushed aside, and an incision applied at the central attachment of the diaphragm, the required retroperitoneal access to the spine is achieved. The option of thoracoscopic provision can only succeed if an orthograde access can be found.

As the patient is in a lateral position, the intra-abdominal pressure is usually lower on the access side. Nevertheless, the patient should be sufficiently relaxed to prevent excessive retractor pressure.

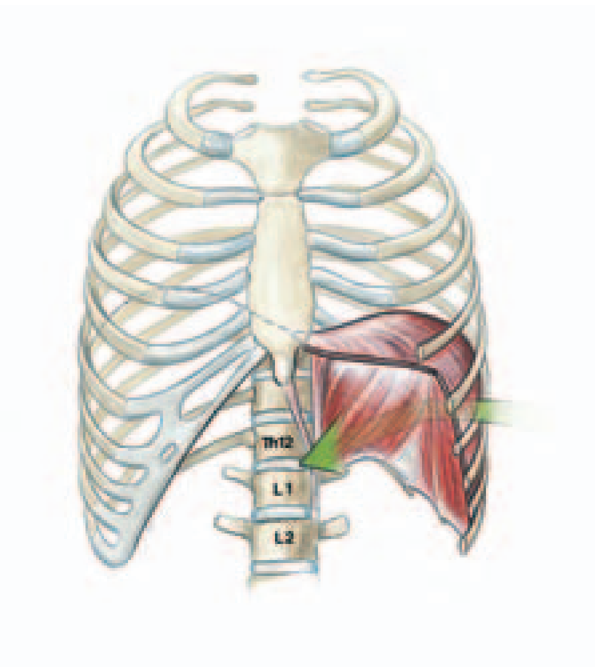



*Fig. 46: Position of the diaphragm*

### Technique

The following is a description of the thoracoscopic technique of diaphragm splitting with left-side access (Fig. 47).

With the operating site set up, the onset of the diaphragm at the spine is identified. With an ultrasound knife (alternatively: a monopolar preparation hook) the course of the incision is marked parallel to the onset, leaving a margin of about 1 cm width and keeping sufficient distance to the aorta. When doing this, the diaphragm should be slightly tensioned, using the retractor. The length of the incision depends on which caudal vertebral body requires instrumentation.

Following the marking, the parietal pleura and the diaphragmatic muscles are severed, layer by layer, until the retroperitoneum lies open. Looking at the fascia of the psoas muscle, the incision is gently opened to the required width, using the preparation swab, and kept open with the repositioned retractor. With the retroperitoneal fat tissue carefully pushed aside, the psoas muscles are mobilized, beginning at the anterior vertebral edge, and the target vertebra is prepared. Depending on the muscle volume, it is also possible that a muscle gap must be prepared by bluntly forcing apart along the direction of the muscle fibers. Any muscular hemorrhage occurring at this stage must be coagulated immediately.

With the site prepared in this way, the further steps of the operation are as described under MACS TL operating steps.

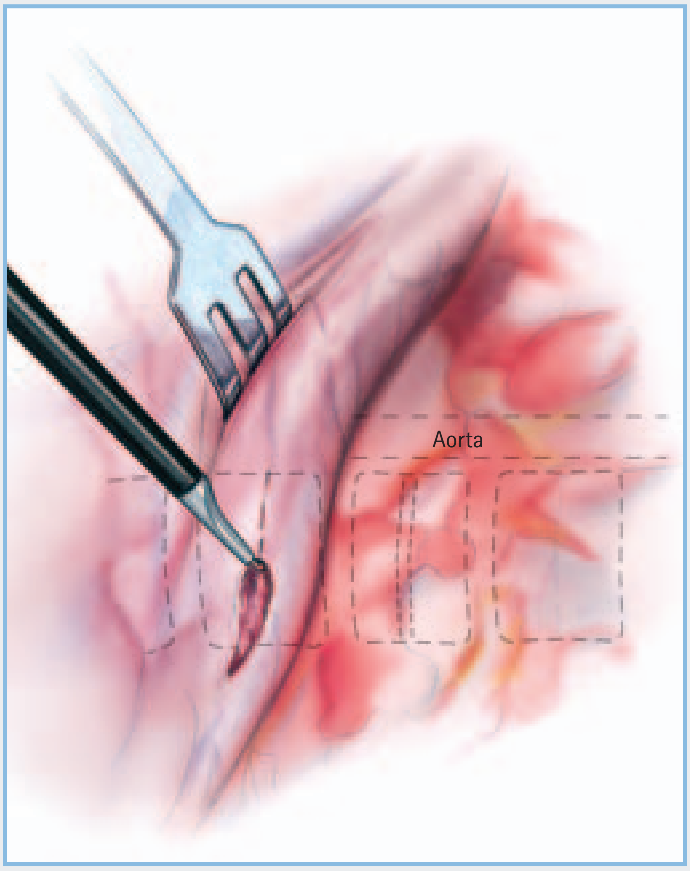



*Fig. 47: Incision of the diaphragm*

Once the fusion has been completed, the diaphragm is closed by adapted single-head sutures or by means of an endo-stapler (Fig. 48). Experience shows, thanks to the incision close to the onset of diaphragm, there is no reason to expect hernia formation, even if the suture is not "watertight".

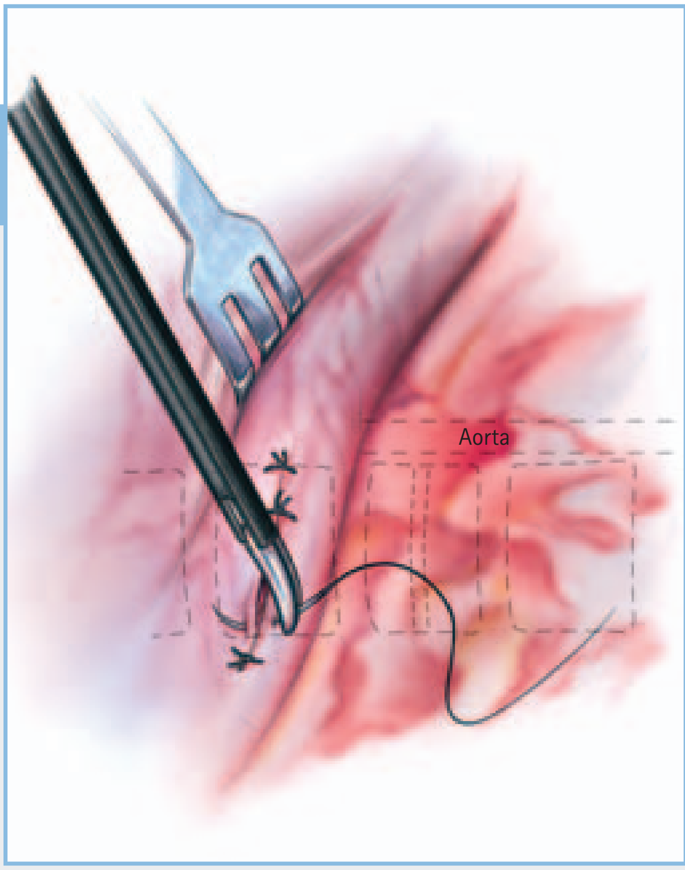



*Fig. 48: Suturing the diaphragm*

# Spinal decompression of the dorsal rim

The indication for clearing the osseous spinal canal (Fig. 49) is undoubtedly given when there are neurological symptoms. If the posterior wall has been dislocated without giving rise to neurological failures, there is a relative indication for a posterior wall resection, mainly depending on the extent of the stenosis. However, to reduce the risk of a later myelopathy, decompression should be considered. According to experience, thora-coscopic posterior wall resection is very effective, due to an imaging system that is very similar to those used in microscopic surgery. In the following we describe the technique of anterior spinal decompression.

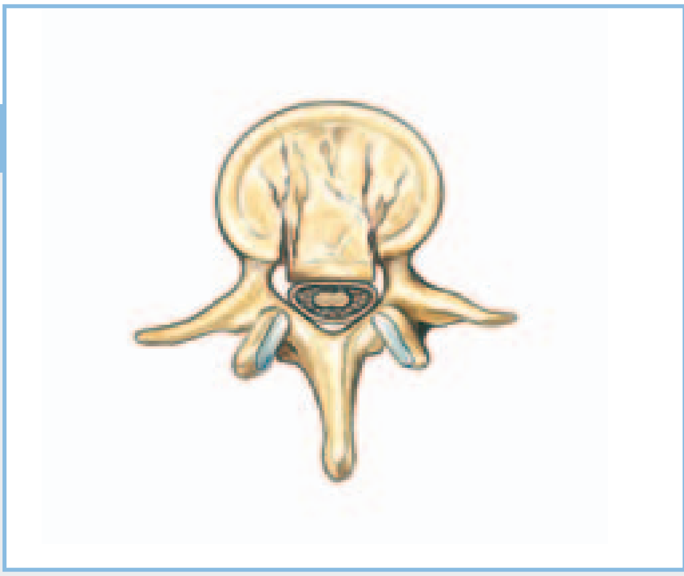


*Fig. 49: Dislocation of the posterior wall*

## Initial situation

As described under MACS TL operating steps, the working corridor is marked by the embedded MACS TL clamping elements. In cases of an unstable posterior wall, the partial corporectomy should initially be carried out with a safety zone of approx. 5 mm to the posterior edge. This measure generally prevents any undetected further dislocation of the posterior wall into the spinal canal while the anterior resection is performed. (Fig. 50)
With the pedicle of the vertebral arch resected and the dura in view, the aim is now to mobilize the dislocated posterior edge into the previously prepared vertebral defect, where it is to be removed. The anterior direction of the resection with view of the dura should be maintained!

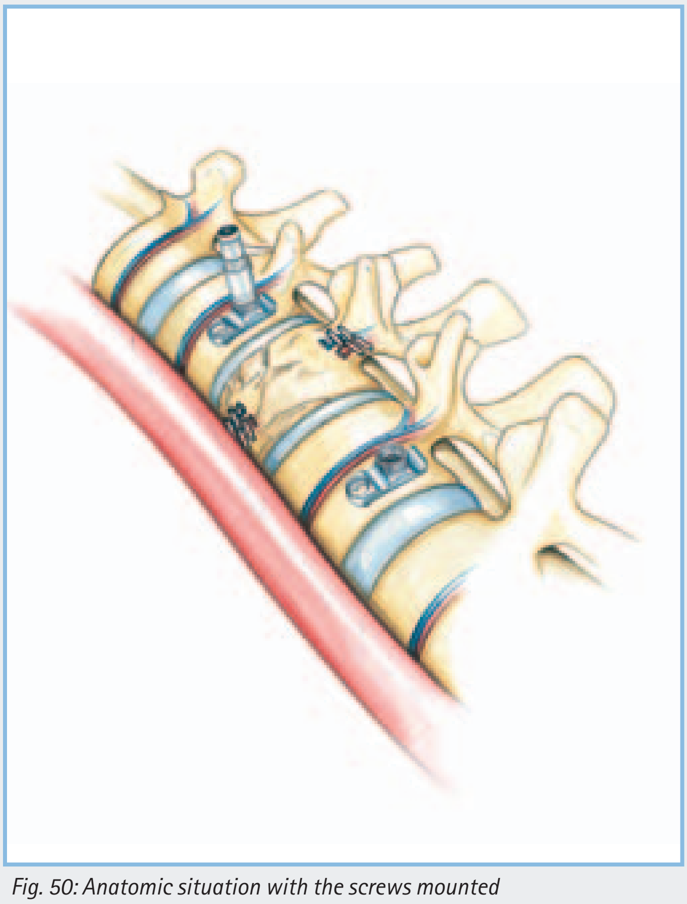


*Fig. 50: Anatomic situation with the screws mounted*

## Technique

The raspatory is used for displaying the pedicle facing the surgeon (Fig. 51).

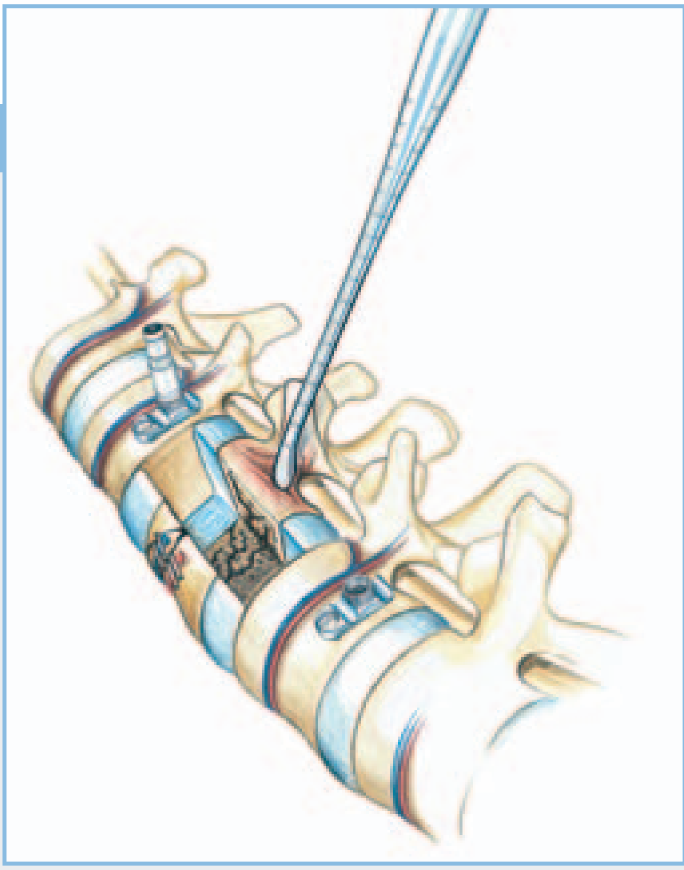


*Fig. 51: Raspatory FK392R*

The lower boundary of the pedicle is probed with the nerve hook. Beginning from there, the pedicle is ablated step by step in a cranial direction, using a punch.

To prevent a lesion of the nerve roots or the dura, the progress of this procedure must be checked repeatedly, using the nerve hook and the dissector (Fig. 52).

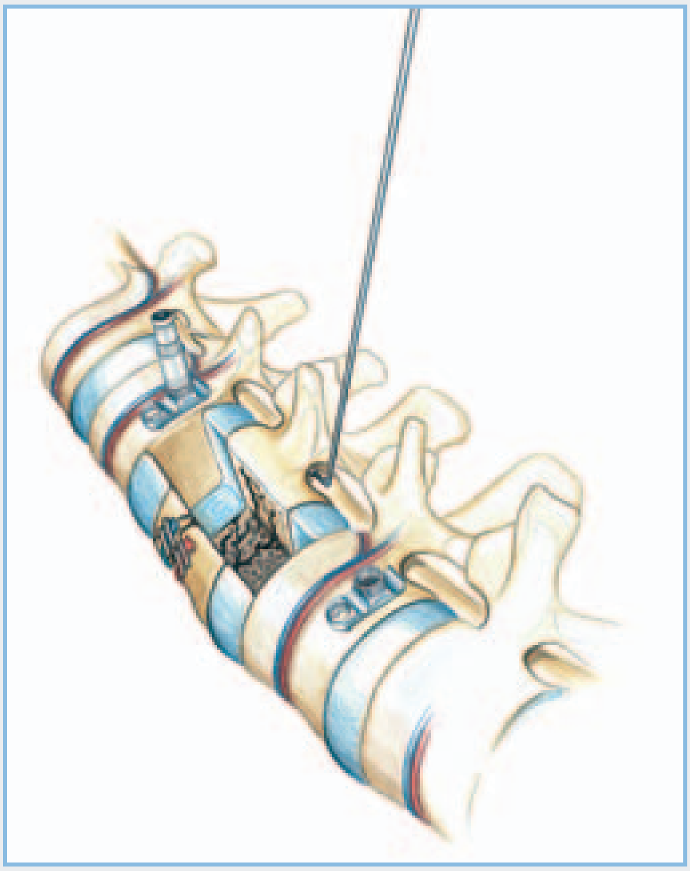


*Fig. 52: Nerve hook BT070R*

If the pedicle is of a larger diameter, the effective lift of the punches may not be sufficient. In such cases the pedicle must first be narrowed from lateral (Fig. 53). Appropriate caution must be applied if the pedicle is fractured, since the neurogenic structures may be adhered or jammed, or could be contused by fragments.

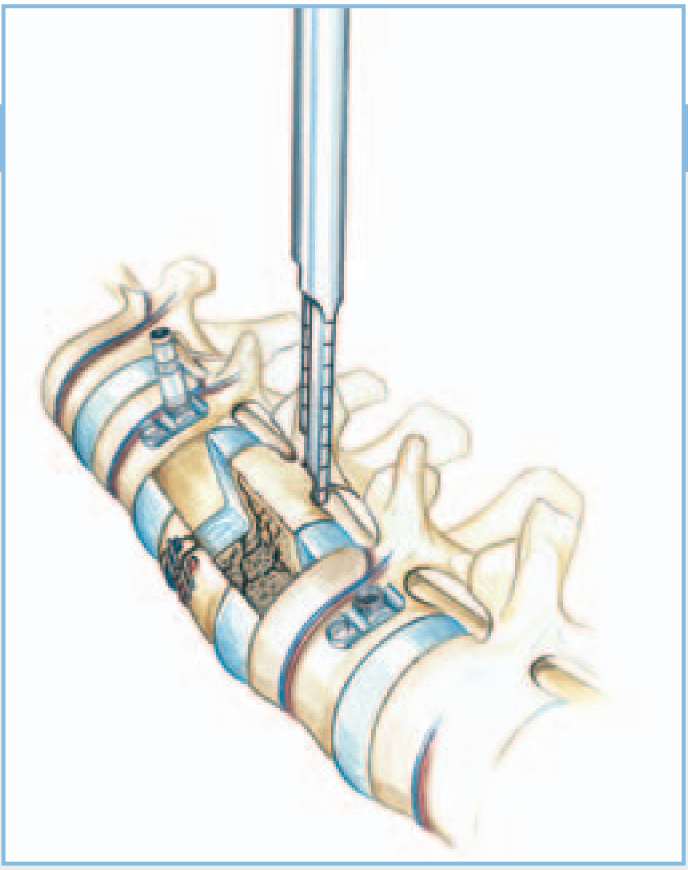


*Fig. 53: Bone punch FG84R*

The fragment is removed with a rongeur (Fig. 54).

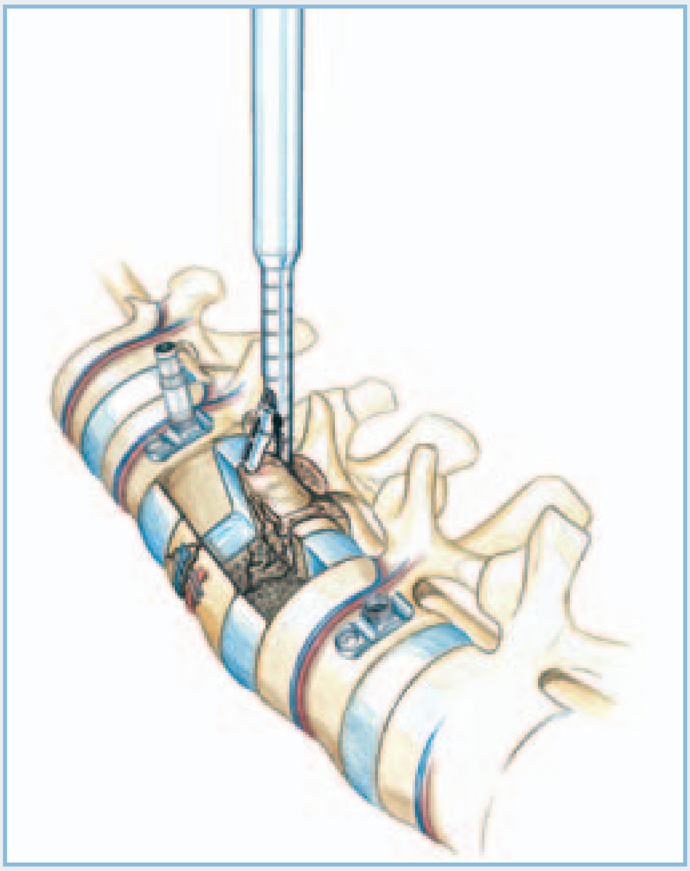


*Fig. 54: Rongeur FF840R*

With the pedicle resected, the dura becomes visible. Now the dislocated posterior edge can be mobilized ventrally, using a scoop (Fig. 55), under visual control. Fragments fixed to the anulus fibrosus are too elastic, in most cases, and must be removed directly. The same procedure is necessary if fragments of the intervertebral disc are found

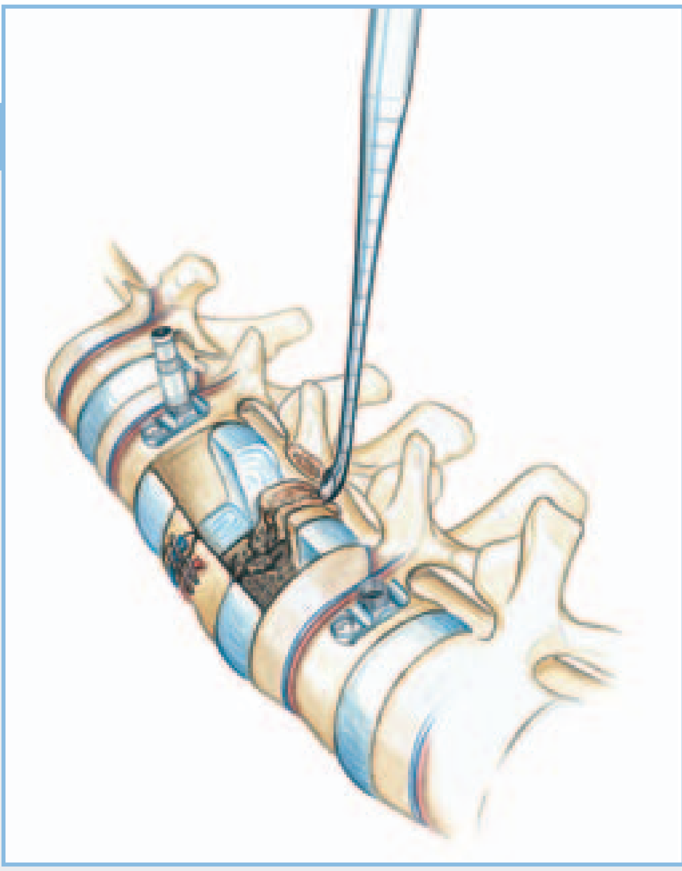


*Fig. 55: Sharp scoop FK780R*

Usually, venous hemorrhages or minor dura leakage can be sufficiently covered by a hemostypticum (Fig. 56). Major dura leakage must be treated with a suture.

Once the anatomic width of the spinal canal has been restored, the dura is protected by a single-layer cover of hemostyptic dressing. If a bone transplant/vertebral body replacement implant is put into place at a later stage, care must be taken that sufficient distance to the myelon is maintained. The same applies when spongiosa is attached.

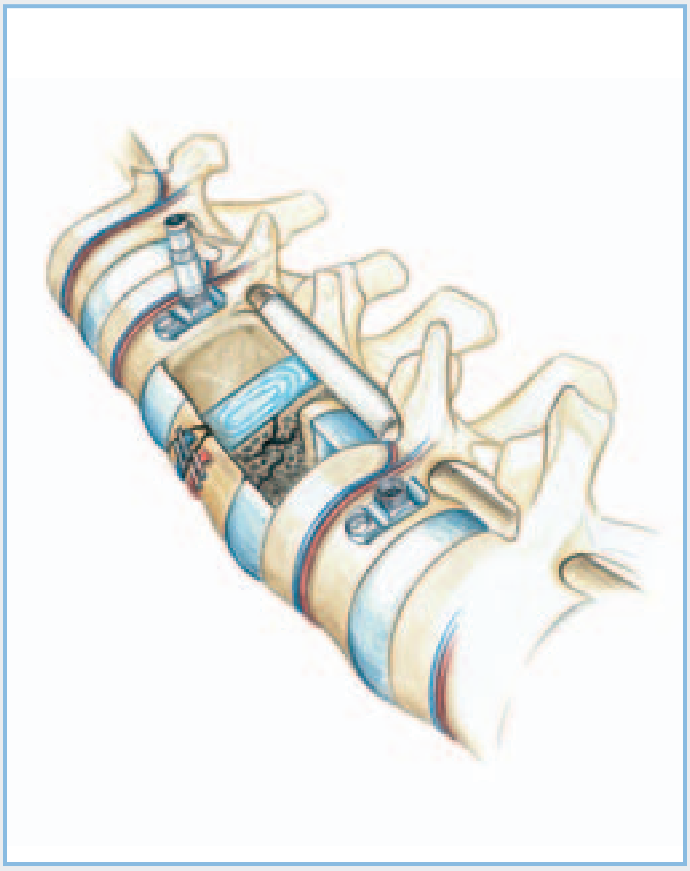


*Fig. 56: Covering the dura with a hemostypticum*

# Implants

## Twin Screw standard

Polyaxial screw ø 7,0 mm

| Art. no. | Lenght |
|---|---|
| SX793T | 30 mm |
| SX794T | 35 mm |
| SX795T | 40 mm |
| SX796T | 45 mm |
| SX797T | 50 mm |
| SX798T | 55 mm |

Stabilization screw ø 6,5 mm

| Art. no. | Lenght |
|---|---|
| SX782T | 25 mm |
| SX783T | 30 mm |
| SX784T | 35 mm |
| SX785T | 40 mm |
| SX786T | 45 mm |
| SX787T | 50 mm |

Clamping element TL

| Art. no. | |
|---|---|
| SX800T | one size only |

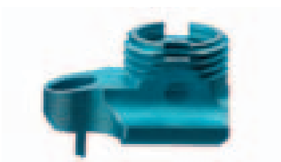
# Twin Screw thoracic

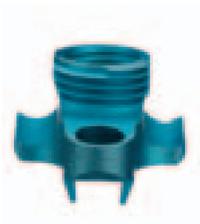
Polyaxial screw ø 7,0 mm

| Art. no. | Lenght |
|---|---|
| SX790T | 15 mm |
| SX791T | 20 mm |
| SX792T | 25 mm |
| SX793T | 30 mm |

Stabilization screw thoracic ø 4,5 mm

| Art. no. | Lenght |
|---|---|
| SX826T | 15 mm |
| SX827T | 20 mm |
| SX828T | 25 mm |
| SX829T | 30 mm |



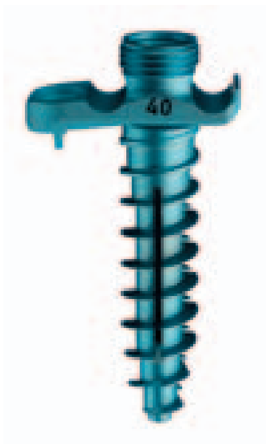


Clamping element T

| Art. no. | |
|---|---|
| SX801T | one size only |

# Implants

## Twin Screw XL

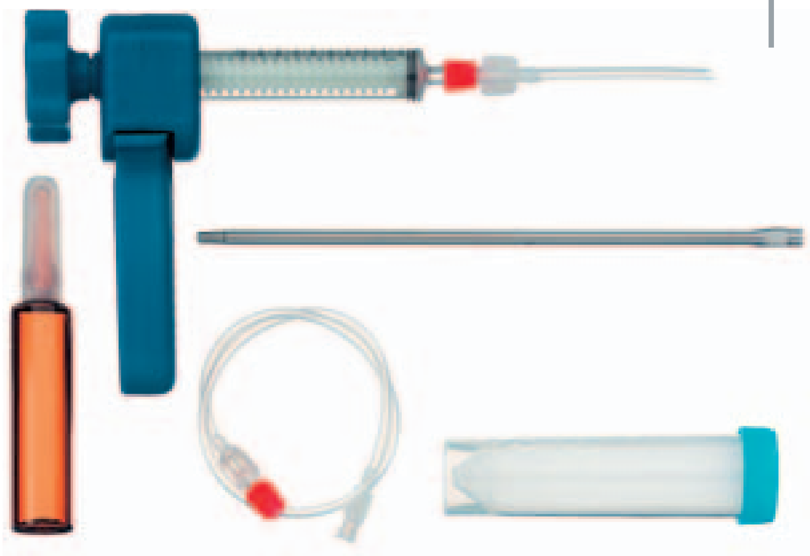



Polyaxial screw XL ø 10 mm

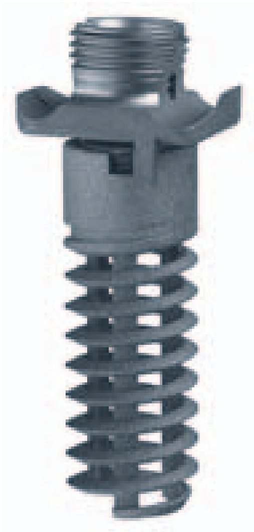
| Art. no. | Lenght |
|---|---|
| SX821T | 30 mm |
| SX823T | 40 mm |

Cimplant: Cement application kit

| Art. no. | Set |
|---|---|
| FJ304 | Applier |
| | Cement |
| | Suction tube |
| | Extension tube |
| | Injection cannula |



## HMA Screw polyaxial



HMA polyaxial screw ø 12 mm

| Art. no. | Lenght |
| --- | --- |
| SX805T | 26 mm |
| SX806T | 30 mm |
| SX807T | 34 mm |
| SX808T | 38 mm |

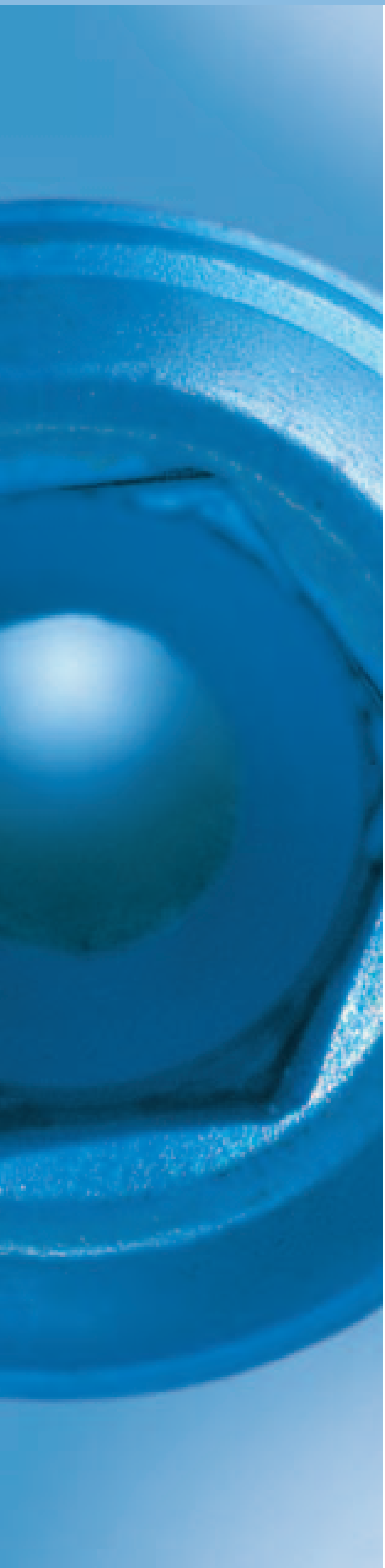
## HMA Screw monoaxial

for multisegmental treatments

HMA monoaxial screw ø 12 mm

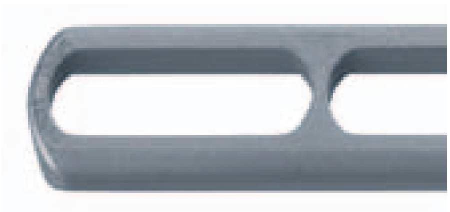
| Art. no. | Lenght |
|---|---|
| SW137T | 26 mm |
| SW138T | 30 mm |
| SW139T | 34 mm |
| SW140T | 38 mm |

# Implant components



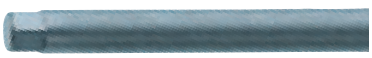
### Stabilization plate

| Art. no. | Lenght |
|---|---|
| SX811T | 45 mm |
| SX812T | 50 mm |
| SX813T | 55 mm |
| SX814T | 60 mm |



### Stabilization plate

| Art. no. | Lenght |
|---|---|
| SX835T | 70 mm |
| SX816T | 80 mm |
| SX817T | 90 mm |
| SX818T | 100 mm |

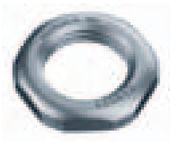


### Rod ø 5.2 mm

| Art. no. | Lenght |
|---|---|
| SX110T | 100 mm |
| SX112T | 120 mm |
| SX115T | 150 mm |
| SX118T | 180 mm |
| SX120T | 200 mm |

# Implants

## Implant components

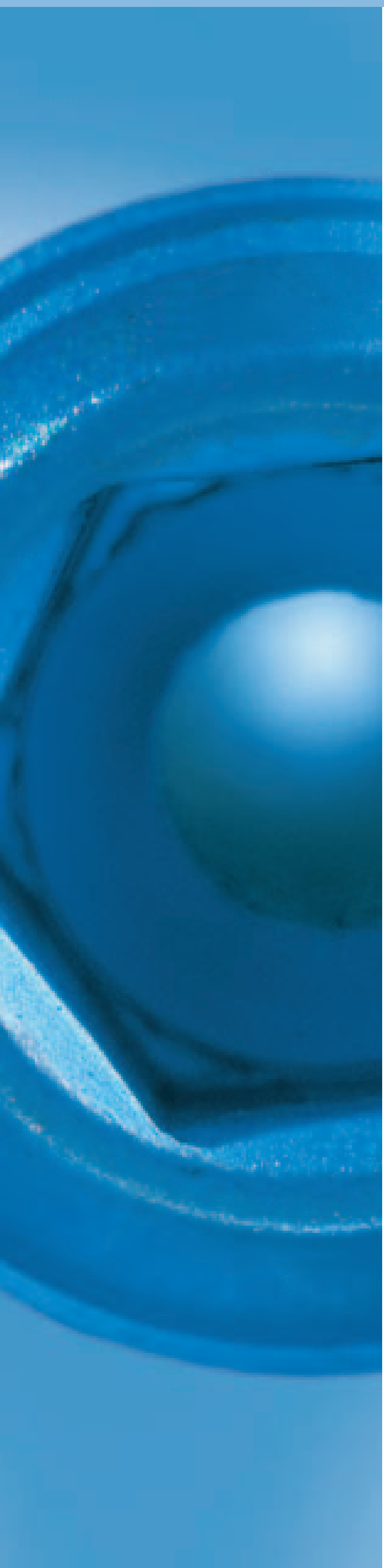


Fixation nut

| Art. no. | Thread |
|---|---|
| SX802T | M 11 |

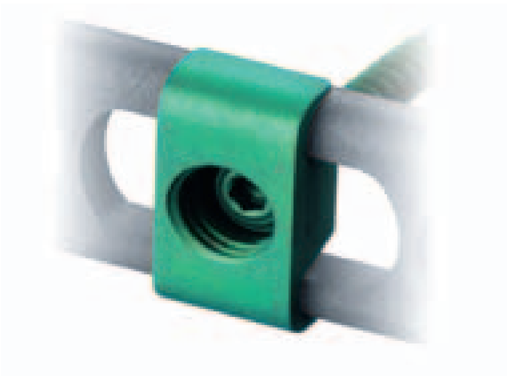
Locking screw

| Art. no. | Thread |
|---|---|
| SX803T | M 8 |



Bone graft screw ø 4,0 mm

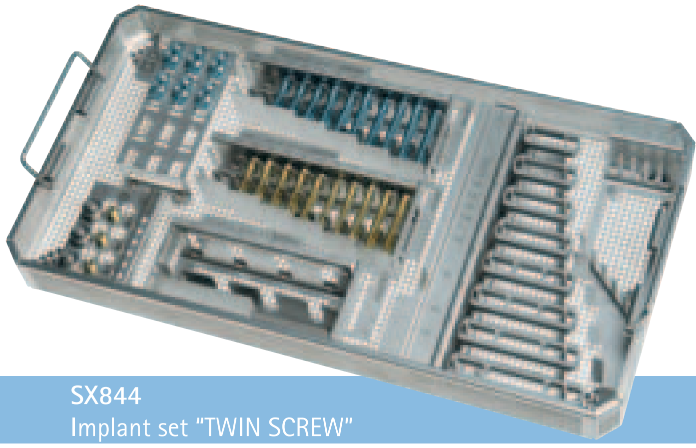
| Art. no. | Lenght |
|---|---|
| SX832T | 32 mm |



Bone graft clamp

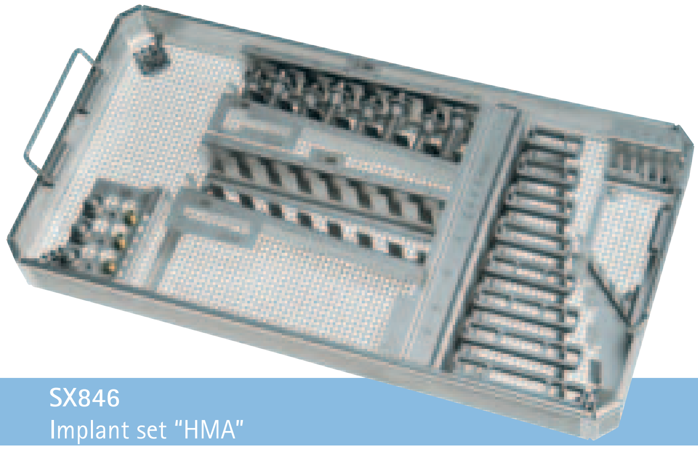
| Art. no. | |
|---|---|
| SX825T | one size |

# Implant sets



SX844
Implant set "TWIN SCREW"

| Art. no. | Description | Dimensions (mm) | Set Twin Screw | Set HMA |
|---|---|---|---|---|
| | Complete set* | 485x253x50 | SX844 | SX846 |
| | Empty basket* | 485x253x50 | SX845R | SX847R |
| | **Set content** | | | |
| SX802T | Fixation nut | M 11 | 8 | 8 |
| SX803T | Locking screw | M 8 | 8 | 8 |
| SX782T | Stabilization screw | ø 6,5x25 | 4 | |
| SX783T | Stabilization screw | ø 6,5x30 | 4 | |
| SX784T | Stabilization screw | ø 6,5x35 | 4 | |
| SX785T | Stabilization screw | ø 6,5x40 | 4 | |
| SX786T | Stabilization screw | ø 6,5x45 | 4 | |
| SX787T | Stabilization screw | ø 6,5x50 | 4 | |
| SX792T | Polyaxial screw | ø 7,0x25 | 2 | |
| SX793T | Polyaxial screw | ø 7,0x30 | 4 | |
| SX794T | Polyaxial screw | ø 7,0x35 | 4 | |
| SX795T | Polyaxial screw | ø 7,0x40 | 4 | |
| SX796T | Polyaxial screw | ø 7,0x45 | 4 | |
| SX797T | Polyaxial screw | ø 7,0x50 | 4 | |
| SX800T | Clamping element TL | one size | 6 | |
| SX805T | HMA Polyaxial screw | ø 12x26 | | 3 |
| SX806T | HMA Polyaxial screw | ø 12x30 | | 3 |
| SX807T | HMA Polyaxial screw | ø 12x34 | | 3 |
| SX808T | HMA Polyaxial screw | ø 12x38 | | 3 |
| SX811T | Stabilization plate | 45 | 2 | 2 |
| SX812T | Stabilization plate | 50 | 2 | 2 |
| SX813T | Stabilization plate | 55 | 2 | 2 |
| SX814T | Stabilization plate | 60 | 2 | 2 |
| SX835T | Stabilization plate | 70 | 2 | 2 |
| SX816T | Stabilization plate | 80 | 2 | 2 |
| SX817T | Stabilization plate | 90 | 2 | 2 |
| SX818T | Stabilization plate | 100 | 2 | 2 |



SX846
Implant set "HMA"

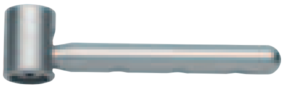
| Art. no. | Description | Dimensions (mm) | Set Twin Screw | Set HMA |
|---|---|---|---|---|
| **Please order separately** (implants can be stored in the basket) | | | | |
| | | | order separately | order |
| **Polyaxial screw XL** | | | | |
| SX821T | Polyaxial screw XL (clamping element pre-mounted) | 30 | 2 | |
| SX823T | Polyaxial screw XL (clamping element pre-mounted) | 40 | 2 | |
| **HMA monoaxial implants** | | | | |
| SW137T | HMA monoaxial screw | ø 12x26 | | 3 |
| SW138T | HMA monoaxial screw | ø 12x30 | | 3 |
| SW139T | HMA monoaxial screw | ø 12x34 | | 3 |
| SW140T | HMA monoaxial screw | ø 12x38 | | 3 |
| **Modular implant components** | | | | |
| SX825T | Bone graft clamp | one size | 1 | 1 |
| SX832T | Bone graft screw | ø 4,0x32 | 1 | 1 |
| SX110T | Titanium rod | ø 5,2x100 | 2 | 2 |
| SX112T | Titanium rod | ø 5,2x120 | 2 | 2 |
| SX115T | Titanium rod | ø 5,2x150 | 2 | 2 |
| SX118T | Titanium rod | ø 5,2x180 | 2 | 2 |
| SX120T | Titanium rod | ø 5,2x200 | 2 | 2 |

Implant material: Ti6Al4V acc. to ISO 5832-3

* Storage unit incl. basket and lid

# Instruments

■ ■ ■ Basic instruments



Handle for insertion sleeve

| Art. no. | pcs. |
|---|---|
| FW316R | 1 |

Centralizer

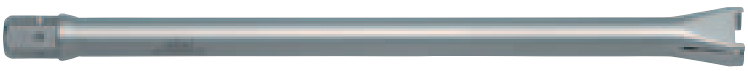
| Art. no. | pcs. |
|---|---|
| FW317R | 1 |

Insertion sleeve

| Art. no. | pcs. |
|---|---|
| FW318R | 1 |

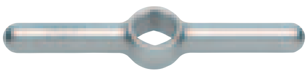
Cannulated screwdriver size* 4

| Art. no. | pcs. |
|---|---|
| FW319R | 1 |



Nut driver for fixation nut, size 16

| Art. no. | pcs. |
|---|---|
| FW320R | 1 |



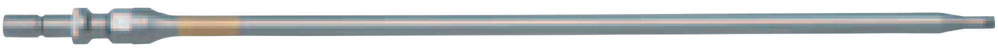
Handle for nut driver

| Art. no. | pcs. |
|---|---|
| FW321R | 1 |

* Tool width in mm

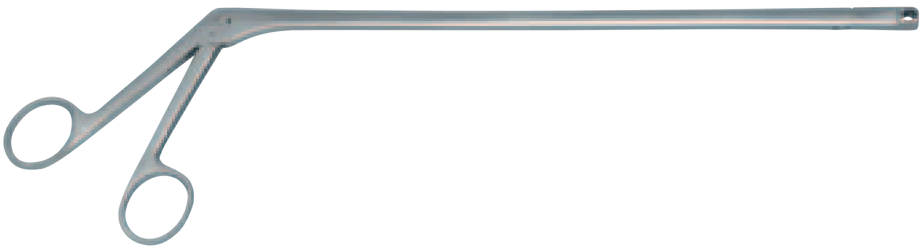
Screwdriver with locking spring, size 4

| Art. no. | pcs. |
| --- | --- |
| FW322R | 1 |



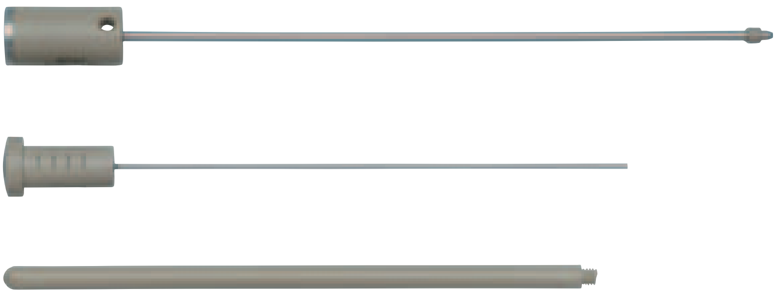
Holding instrument for rod/plate

| Art. no. | pcs. |
| --- | --- |
| FW326R | 1 |



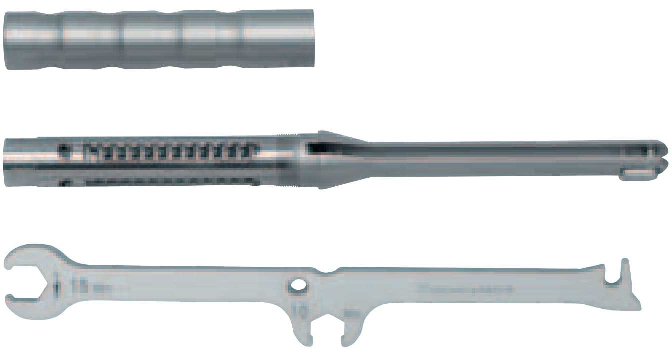
Insertion instrument for K-wire, 3 components

| Art. no. | pcs. |
| --- | --- |
| FW330R | 3 components |



Torque wrench, 3 components

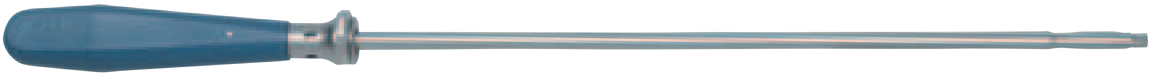
| Art. no. | pcs. |
| --- | --- |
| FW331R | 3 components |



# Instruments

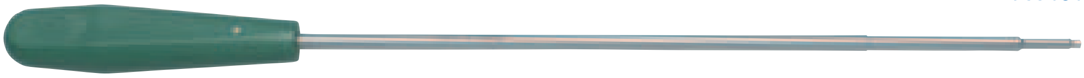
Screwdriver "for centralizer"

| Art. no. | pcs. |
|---|---|
| FW337R | 1 |



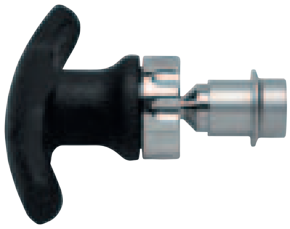
Screwdriver for bone screw

| Art. no. | pcs. |
|---|---|
| FW401R | 1 |



Ratchet handle

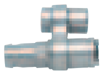
| Art. no. | pcs. |
|---|---|
| FW400R | 1 |



## Twin Screw instruments

Guiding sleeve for stabilization screw

| Art. no. | pcs. |
|---|---|
| FW335R | 2 components |

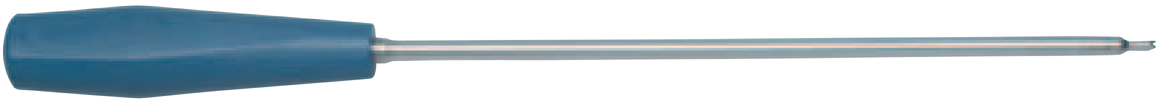


Revision instrument for stabilization screw

| Art. no. | pcs. |
|---|---|
| FW336R | 1 |

Cannulated center punch

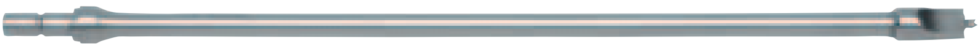
| Art. no. | pcs. |
|---|---|
| FW339R | 1 |



## HMA polyaxial and monoaxial instrument

Cortex drill for HMA, ø 12 mm

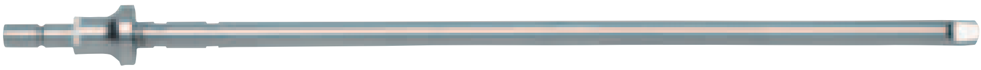
| Art. no. | pcs. |
|---|---|
| FW332R | 1 |



## HMA monoaxial instruments

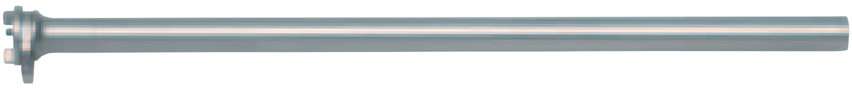
Insertion instrument for
HMA monoaxial screw

| Art. no. | pcs. |
|---|---|
| FW333R | 1 |



Holding sleeve for HMA monoaxial screw

| Art. no. | pcs. |
|---|---|
| FW402R | 1 |

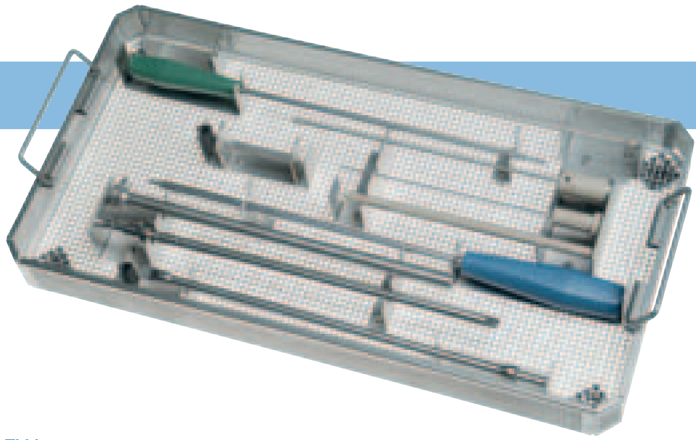


## Single-use products

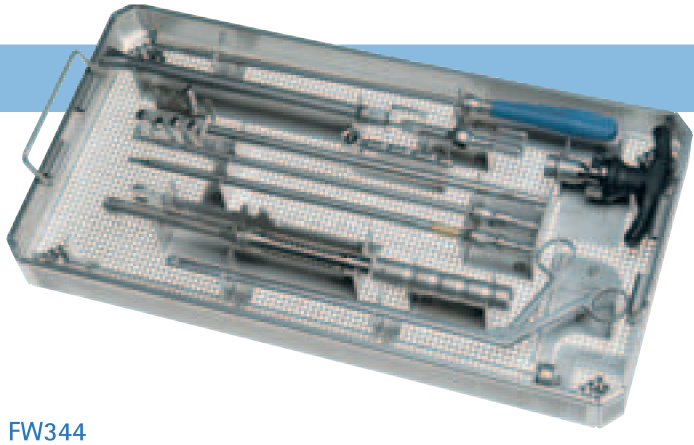
K-wire set, sterile, single-use product
incl. 2 K-wires
1 removal instrument for K-wire

| Art. no. | Set |
|---|---|
| FW343S | 3 components |

# Instrument sets



**FW346**
Instrument set "Preparation"



**FW344**
Instrument set "Implantation"

| Art. no. | Description | Basic Set Preparation | Basic Set Implantation |
|---|---|---|---|
| | Complete set | FW346 | FW344 |
| | Empty basket | FW347R | FW345R |
| **Basic instruments** | | | |
| FW316R | Handle for insertion sleeve | | 1 |
| FW317R | Centralizer | | 3 |
| FW318R | Insertion sleeve | | 1 |
| FW319R | Cannulated screwdriver, size* 41 | | 1 |
| FW320R | Nut driver for fixation nut, size* 16 | | 1 |
| FW321R | Handle for nut driver | | 1 |
| FW322R | Screwdriver with holding spring, size* 4 | | 1 |
| FW326R | Holding instrument for rod/plate | | 1 |
| FW330R | Insertion instrument for K-wire | 1 | |
| FW331R | Torque wrench | | 1 |
| FW337R | Screwdriver "for centralizer", size* 5 | | 1 |
| FW401R | Screwdriver for bone screw, size* 2.5 | 1 | |
| FW400R | Ratchet handle | | 1 |

* Tool width in mm

| Art. no. | Description | Basic Set Preparation | Basic Set Implantation |
|---|---|---|---|
| | **Modular instruments for different screw types** | | |
| | **Please order separately according to requirements**<br>These instruments can be stored in baskets FW344 and FW346 separately | order separately | order separately |
| | Twin Screw instruments | | |
| **FW335R** | Guiding sleeve for stabilizing screw | | 2 |
| **FW336R** | Revision instrument for stabilizing screw | 1 | |
| **FW339R** | Cannulated center punch | 1 | |
| | HMA polyaxial and monoaxial instruments | | |
| **FW332R** | Corticalis drill for HMA, ø 12 mm | 1 | |
| | HMA monoaxial instruments | | |
| **FW333R** | Insertion instrument for HMA monoaxial | 1 | |
| **FW402R** | Holding sleeve for HMA monoaxial | 1 | |
| | Single-use products | | |
| **FW343S** | K-wire set, sterile, incl. 2x K-wire + 1x Removal instruments for K-wire<br>(The sterile packaging cannot be stored in basket FW346) | 2 | |

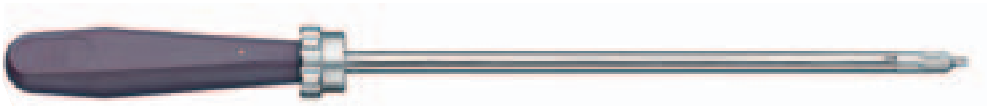
# Twin Screw Thoracic Set

Punch for thoracic stabilization screw

| Art. no. | pcs. |
| --- | --- |
| FW405R | 1 |

Screwdriver for thoracic stabilization screw

| Art. no. | pcs. |
| --- | --- |
| FW342R | 1 |



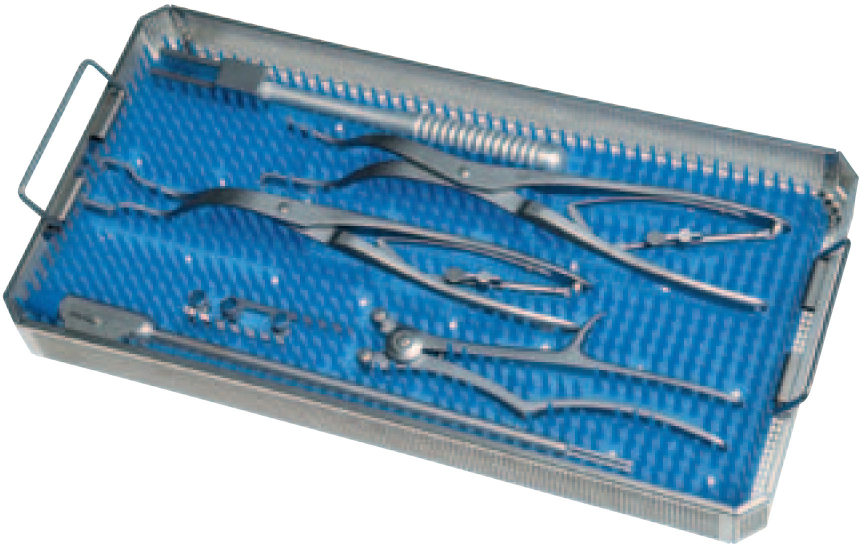
Guiding sleeve for thoracic stabilization screw

| Art. no. | pcs. |
| --- | --- |
| FW341R | 2 |

■ ■ ■ FW348
Twin Screw thoracic

| Art. no. | Description | Dimensions | Set Twin Screw thoracic |
|---|---|---|---|
| | Complete set | 540x250x60 | FW348 |
| | Empty basket | 540x250x60 | FW349P |
| **Instruments** | | | |
| FW341R | Guiding sleeve for thoracic stabilization screw | | 2 |
| FW342R | Screwdriver for thoracic stabilization screw, size 2.5 | | 1 |
| FW405R | Center punch for thoracic stabilization screw | | 1 |
| **Implants** | | | |
| SX790T | Polyaxial screw | ø 7,0x15 | 4 |
| SX791T | Polyaxial screw | ø 7,0x20 | 4 |
| SX792T | Polyaxial screw | ø 7,0x25 | 4 |
| SX793T | Polyaxial screw | ø 7,0x30 | 4 |
| SX801T | Clamping element T | one size | 2 |
| SX826T | Stabilization screw thoracic | ø 4,5x15 | 4 |
| SX827T | Stabilization screw thoracic | ø 4,5x20 | 4 |
| SX828T | Stabilization screw thoracic | ø 4,5x25 | 4 |
| SX829T | Stabilization screw thoracic | ø 4,5x30 | 4 |

# Optional instruments



Basket, empty

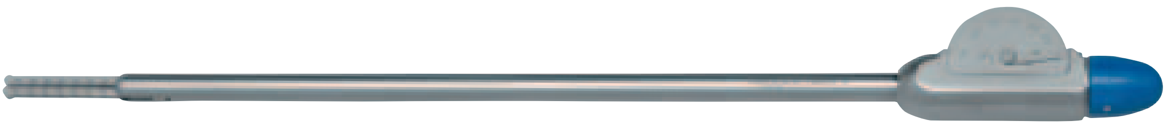
| Art. no. | Dimensions |
| --- | --- |
| JF212R | 485x253x56 |

Silicone storage mat, to be cut to size

| Art. no. | Dimensions |
| --- | --- |
| JF932 | 470x230x56 |

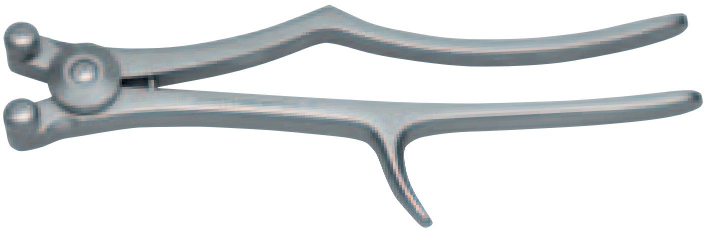
MIASPAS TL bone graft measuring instrument

| Art. no. | pcs. |
| --- | --- |
| FG045R | 1 |



Rod bending forceps

| Art. no. | pcs. |
| --- | --- |
| FW013R | 1 |



## Distraction ratchet

| Art. no. | pcs. |
|---|---|
| FW323R | 1 |

## Distraction rod, short

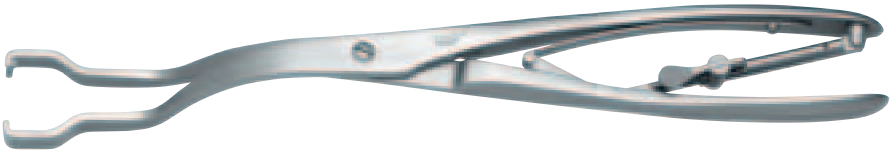
| Art. no. | pcs. |
|---|---|
| FW324R | 1 |

## Distraction rod, long

| Art. no. | pcs. |
|---|---|
| FW325R | 1 |

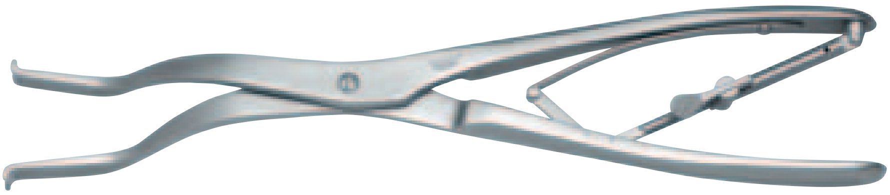
## Compression forceps

| Art. no. | pcs. |
|---|---|
| FW328R | 1 |



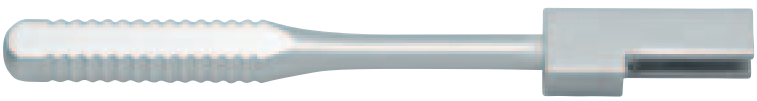
## Distraction forceps

| Art. no. | pcs. |
|---|---|
| FW329R | 1 |



## Slotted hammer

| Art. no. | pcs. |
|---|---|
| FW579R | 1 |



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