Anleitung zur Kalkulation eines geometrischen Mittelpunkts und Programmierung des Roboters

1. Bewegungen auf das Präparat ausüben

- Im ersten Schritt den Roboter starten und das Präparat einspannen. Dann das Programm IF_SFWS öffnen und im Wirbelsäulen-Modus die Bewegungsrichtungen: 4 (Flexion/Extension), 5 (laterale Beugung) und 6 (axiale Rotation) einstellen und der Reihe nach ausführen lassen. Es genügt die Bewegungsaufzeichnung eines Zyklus.
- Im Anschluss die Positions-Daten über IC_SEND an den PC übertragen (ca. 300-400 Datenpunkte). Die Speicherung der Daten erfolgt unter folgender Bezeichnung: SBW*xx*_G1.pos (Flexion/Extension), SBW*xx*_G2.pos (laterale Beugung), SBW*xx*_G3.pos (axiale Rotation).
- Die Daten auf Diskette kopieren und unter dem Pfad: L:\Daten\Hurschler\2008-0011_(Welke,Daentzer,Hurschler)\Specimens\SBW*xx* speichern.

2. Bestimmung des geometrischen Zentrums

- Zunächst das Programm Mathematica 5.1 öffnen und „Calculate Geometric Center 2008-0011 (WS, Welke).nb“ aufrufen. Dieses ist auffindbar in: L:\ Daten\Hurschler\2008-0011_(Welke,Daentzer,Hurschler)\Analysis.
- Unter „Load Analysis Package“ den Pfad überprüfen (**siehe Tabelle G.1 Bild 1**). Allgemein ist darauf zu achten, dass die Bezugspfade eingehalten und nicht verändert werden.
- Im Feld „Then Read and Combine Desired Data, and then Compute Geometric Center…“ unter specname = “sbw*xx*“ die entsprechende Nummer eingeben (**Bild 1**). Abschließend mit Shift+Return die Befehle ausführen.
- Unter „Then Compute new Specimen Coordinates“ erfolgt die Berechnung des neuen Koordinatensystems. Hierfür sollten die Ausgangskoordinaten bekannt sein (alt z. B.: Index 6, neu z. B.: Index 7). In der markierten Zeile „SpecimenWS008 = NewCoor[SpecimenWS007, 8, SpecGC] umbenennen und mit Shift+Return ausführen (**Bild 2**). Den markierten Text kopieren (**Bild 3**) und im gleichen Fenster in die Zeile „New Coordinates“ als „Formatted Text“ einfügen (**Bild 4**).
- Nun unter L:\Daten\Hurschler\2008-011_(Welke,Daentzer,Hurschler)\Analysis\Package das Programm „ThreeDKinematics.nb“ öffnen. Dann eine Kopie vom bisherigen SpecimenWS00*6* :: usage = “Parameter“ erstellen und einfügen (Index z.B. von “6“ auf “7“ ändern) (**Bild 5**).
- Im nächsten Schritt unter „Calculate Geometric Center 2008-0011 (WS, Welke).nb“ im Feld „New Coordinates“ auf die waagerechte Linie klicken und die neuen Koordinaten

hineinkopieren (**Bild 6**). Anschließend den Textwert (**Bild 7**) markieren und kopieren. Diesen unter „ThreeDKinematics.nb“ einfügen (**Bild 8**), den Specimen-Index umbenennen und ein Semikolon setzen. Das neue Koordinatensystem ist nun berechnet.

- Nun unter L:\ Daten\Hurschler\2008-0011_(Welke,Daentzer,Hurschler)\Analysis das Programm „Calculate Coordinates and Center of Gravity 2008-0011 (WS, Welke).nb“ öffnen. Zunächst im Feld „1) The Specimen Coordinates may be rotated…”, in allen drei Zeilen die Indizes (z. B. ”6” durch ”7”) anpassen und mit Shift+Return ausführen (**Bild 9**). Dann Feld „2) Compute Specimen coordinates…“ durch Shift+Return ausführen.
- Zur Übertragung der Daten auf den Kraftaufnehmer wird eine Umwandlung der Koordinaten in „Digit“ benötigt. Dafür die PXX_Vorlage.nb öffnen (L:\ Daten\Hurschler\2008-0011_(Welke,Daentzer,Hurschler)\Specimens), die Überschrift ändern (Präparatname und Index), die neuen Koordinaten reinkopieren, im Ordner des Präparats abspeichern, umbenennen und drucken (**Bild 10**).

3. Umprogrammierung des Sensors

- Die Anwendung pos_tcp nimmt die bestehende Matrix und rotiert die neue Matrix anhand von Verschiebungsdaten.

  Am PC die Eingabe: C:\>doskey
  C:\ROBOTER> cd kms
  C:\ROBOTER\kms> pos_tcp vornehmen.

  Es erscheint am Monitor: Verschiebung und Berechnung einer KMS-Matrix
  Aufruf mit post cp Quelle
  post cp Quelle. mat Ziel. Mat
- Im nächsten Schritt C:\ROBOTER\KMS> pos_tcp s4802sx0.mat s4802w“07“.mat eingeben und den Index entsprechen ändern. Anschließend erfolgt die Abfrage nach den Drehungen. Bei der Drehung um x, y, z: 0 eingeben. Zur Festlegung der Verschiebung, bei der Verschiebung in x-, y-, z-Richtung: Koordinaten aus der zuvor erstellten PXX-Vorlage eingeben.

  Es erscheint am Monitor: Schreiben der Zieldatei: s4802w“07“.mat.

  Zur Kontrolle sollte die Eingabe von C:\ROBOTER\KMS<type s4802w“07“.mat erfolgen.
- Nun den KMS mit dem PC verbinden und C:\ROBOTER\KMS>kms_e eingeben. Das KMS-Messprogramm wird geöffnet, im Feld Matrix kann der neue Matrixname (s4802w“07“) eintragen werden. Anmerkung: Ist dieses Feld geöffnet, niemals “Escape“ betätigen.

- Es erfolgt die Ausführung der Einzelkommandos → Setzen → Matrix → Speichern → Matrix → Hauptmenü.
- Zur Kontrolle das Programm beenden, wieder öffnen und Hauptmenü → Init Datenfeld → Init KMS ausführen. Erneut Programm beenden und wieder öffnen.
- Abschließend den KMS mit der Steuereinheit verbinden.

4. Bestimmung des Massenschwerpunktes

- Den Roboter aus der Homeposition und mit dem Programm LI_FIND (Messung der Sensorrohdaten in unterschiedlichen Positionen) starten. Hierzu die Tastenkombination "5, 1, 3" eingeben. Dabei ist zu beachten, dass das Sensorkabel lang genug aushängt, um eine Quetschung zu verhindern (der Roboter fährt eigenständig große Positionen an).
- Die gemessenen Daten über IC_SEND an den PC mit Taste "2" Positions-Daten (.pos) und Taste "6" Sensor-Daten (.sen) senden.

  Es erfolgt die Eingabe:

  ```
  C:\cd roboter
  C:\ROBOTER>doskey
  C:\ROBOTER>cd roboter
  C:\ROBOTER\ROBOTER>cd "Verzeichnis"
  C:\ROBOTER\ROBOTER\"Verzeichnis"
  >copy daten.dat "name".pos (und .sen)
  ```
- Die Dateinamen lauten: s4802w"07".pos und s4802w"07".sen und werden auf Diskette kopiert. Anschließend den Roboter ausschalten.

5. Umprogrammierung der sens.c und config.dat

- Zunächst werden die pos.- und .sen-Daten eingefügt. Dafür das Programm „Calculate Coordinates and Center of Gravity 2008-0011 (WS, Welke).nb" öffnen.

  Unter „3) Then find Halterung Center of Gravity…" den Matrix-Namen eingeben (SpecHCG = Find CG [filepath, "s4802w07",{0,0,0},1000]) und unter „1) The Specimen Coordinates…" den Specimen-Index überprüfen (… [SBW"03"]\\) (**Bild 11**). Den Vorgang mit Shift+Return ausführen. In Feld „5) Write Data to a File…" wird die Datei mit den Informationen geschrieben, die in die config.dat und den sensortask kopiert werden (**Bild 12**). Den Vorgang mit Shift+Return ausführen.
- Im nächsten Schritt muss die tmp.txt geöffnet werden (L:\Anwendungen\Kuka-Dateien\Wirbelsäule). Diese Datei enthält die Specimen-Koordinaten für die config.dat. Aus der tmp.txt die neuen Specimen-Koordinaten kopieren (**Bild 13**) und in die config.dat einfügen (**Bild 14**). Die config.dat in Ordner des Präparats kopieren und öffnen (**Bild 15**).

- In der geöffneten config.dat auf die initialisierten Parameter achten. In den markierten Zeilen (**Bild 16**) (INT MAX_SPEC="7" und DECL FRAME SPEC_DATA["7"]) die Indizes anpassen.
- Nun die Änderung der Matrix durchführen. Hierzu von der Sensortask sens."330".txt (L:\Daten\Hurschler\Roboter\Schulter-1\Daten/Roboter\c...task) mit dem Notepad++ öffnen. Die markierte Matrix (**Bild 17**) aus der tmp.txt kopieren und im Notepad++ unter dem vorherigen Specimen einfügen (**Bild 18**). Entsprechend der Neuerung einen Kommentar setzen und die geänderte sens."330".txt mit aufsteigender Nr. speichern. Abschließend die bestehende sens.c durch die erneuerte sens.c ersetzen (sens."330".txt wird zu sens.c).
- Zum Kompilieren die senmake.bat ausführen (**Bild 19**). Diese ist im Ordner C_Task zu finden. Zusätzlich befindet sich in diesem Ordner eine Anleitung zur Pfadeinstellung (senmake.bat.Hinweis.txt).
- Nun ist zu überprüfen, ob sich die sensor.o und sens.c im erneuerten Zustand befinden. Anschließend die sensor.o, sens.c und config.dat in den Ordner des Präparats kopieren. Die config.dat und sens.c auf die Diskette kopieren und auf den PC übertragen.
- Den Roboter einschalten und die Diskette einlegen. Zum Schluss an der tragbaren Bedieneinheit die sensor.o-Daten in den Sensor-Ordner übertragen und die config.dat in R1-Ordner.

Tabelle G.1 Auflistung der Screenshots, die als Unterstützung während der Durchführung der oben genannten Anleitung dienen sollen. Die Bilder sind fortlaufend nummeriert.

Bild 1

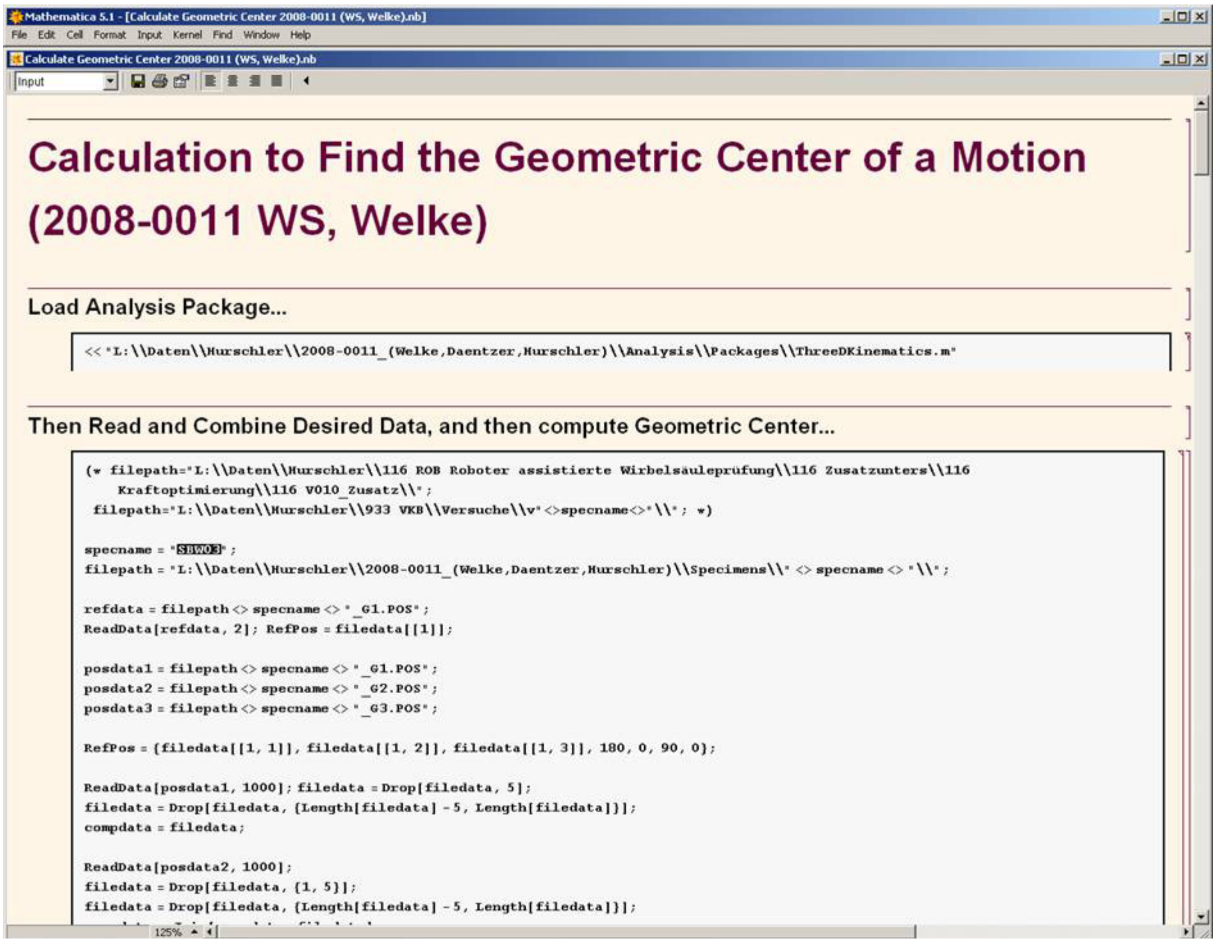


Bild 2

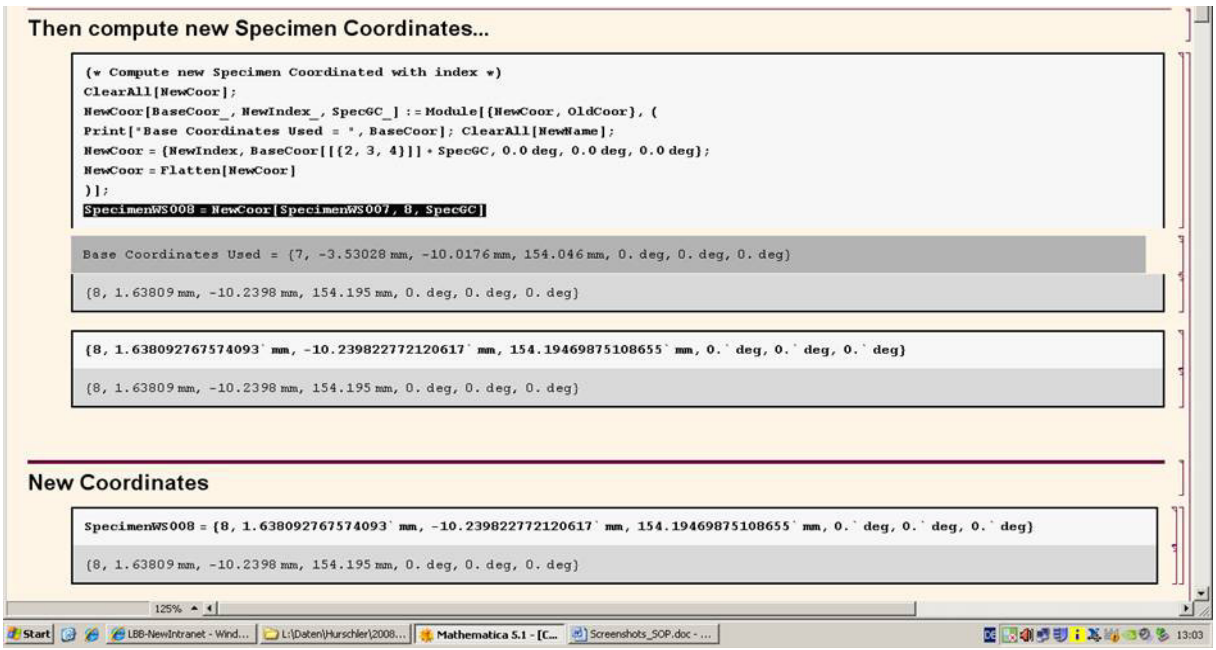


Bild 3

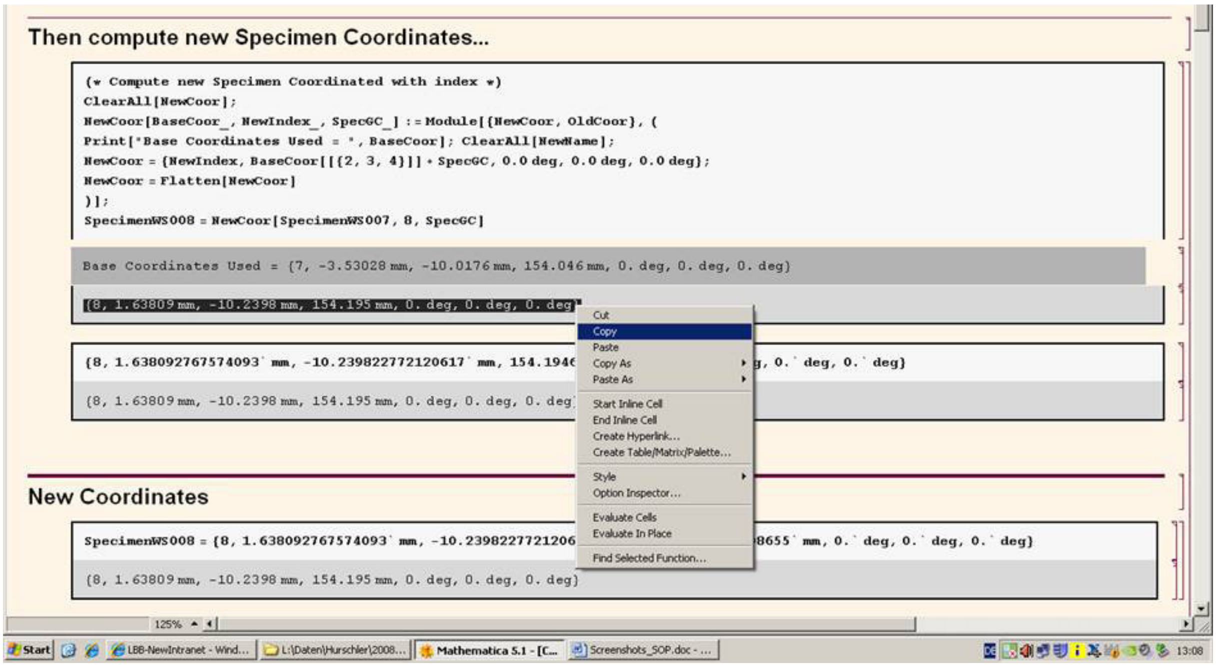


Bild 4

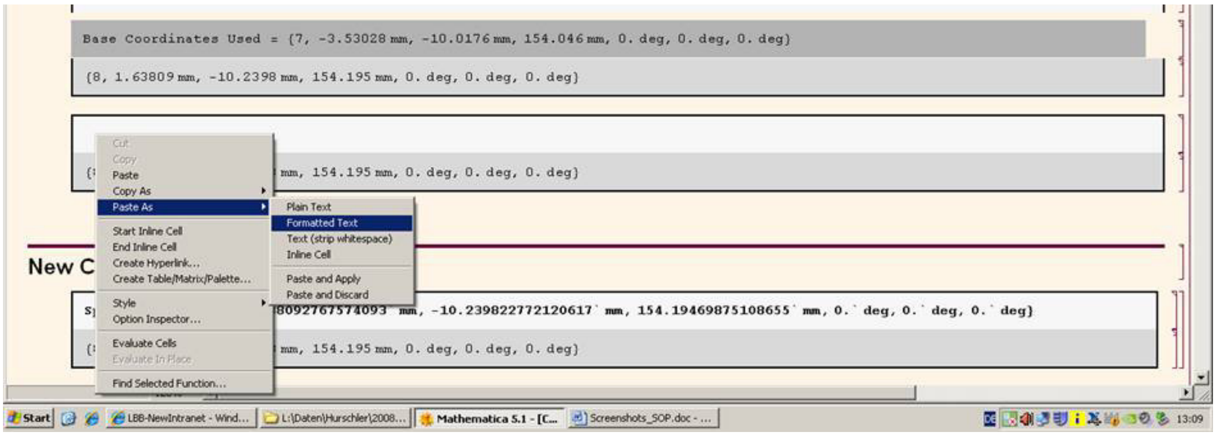


Bild 5

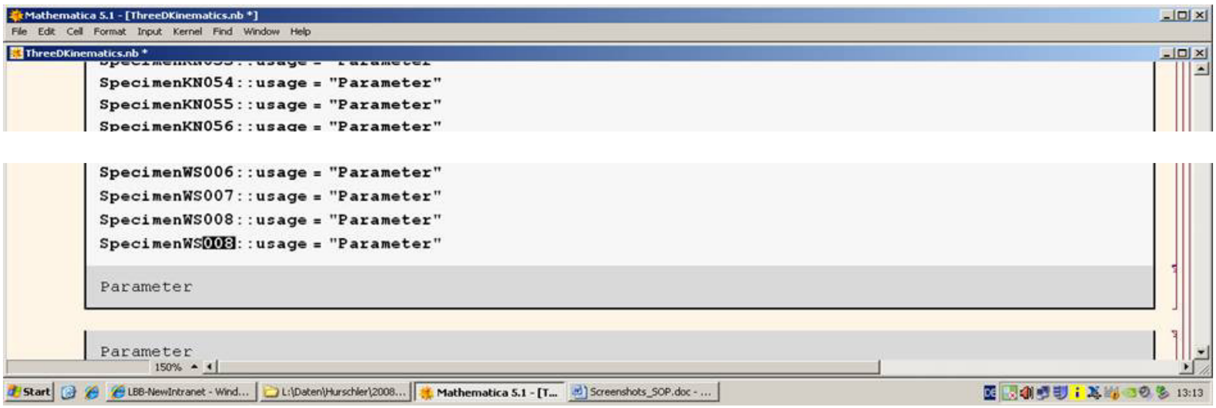


Bild 6

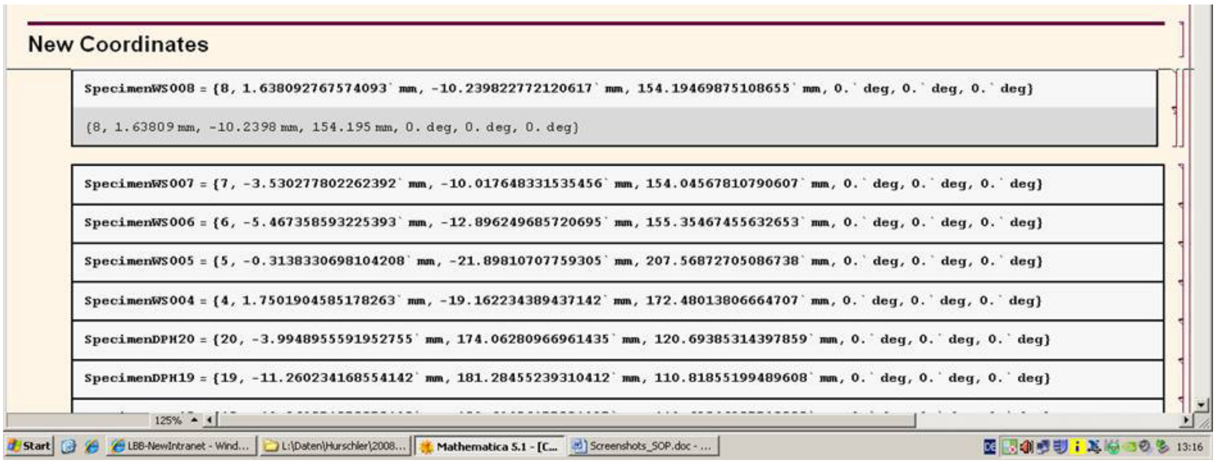


Bild 7

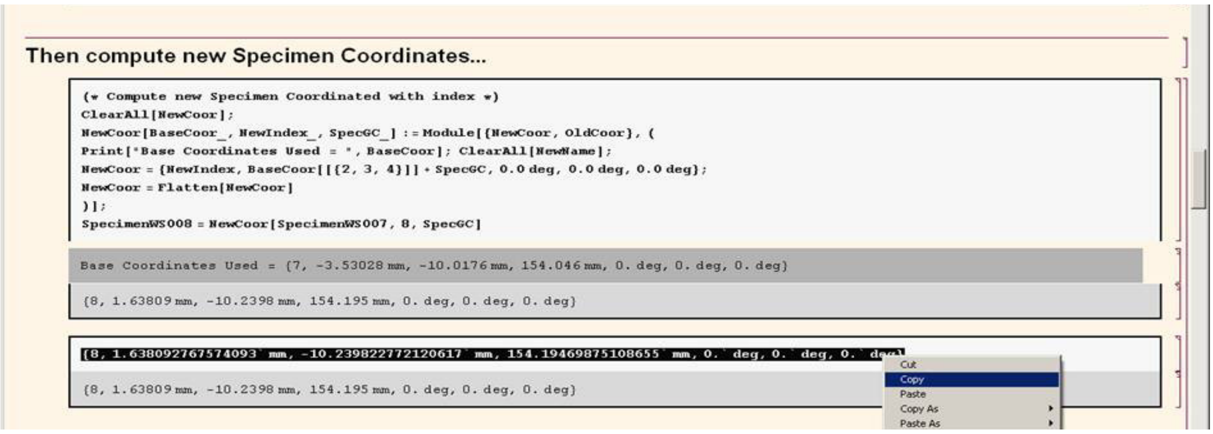


Bild 8

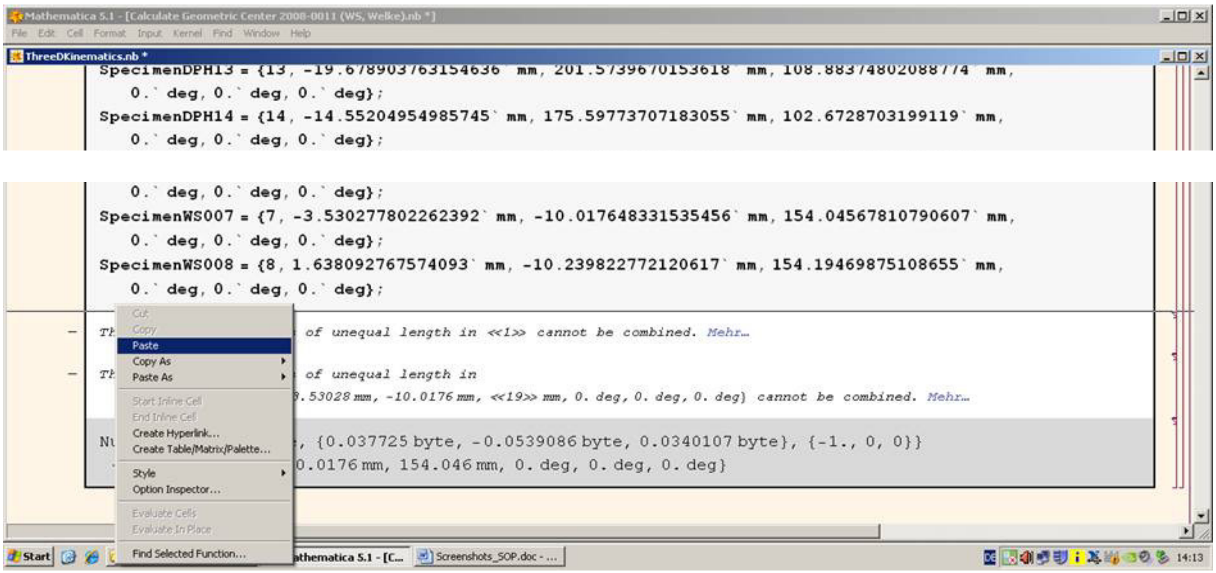


Bild 9

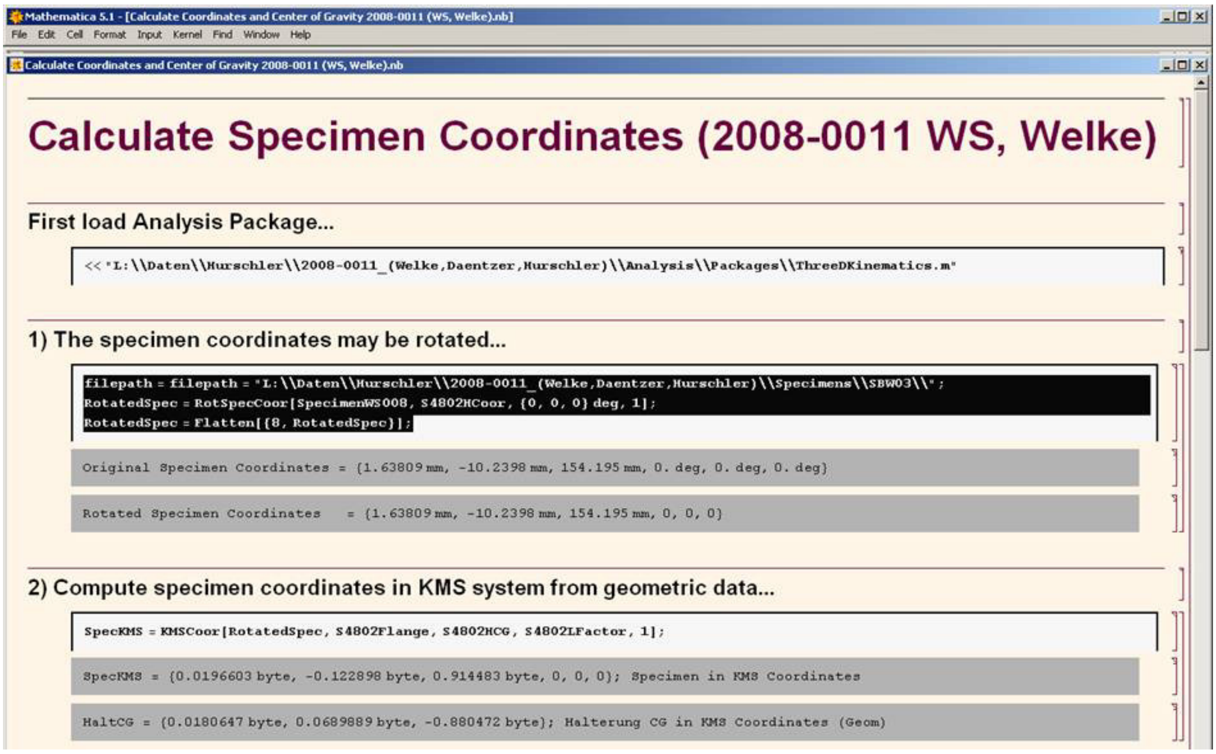


Bild 10

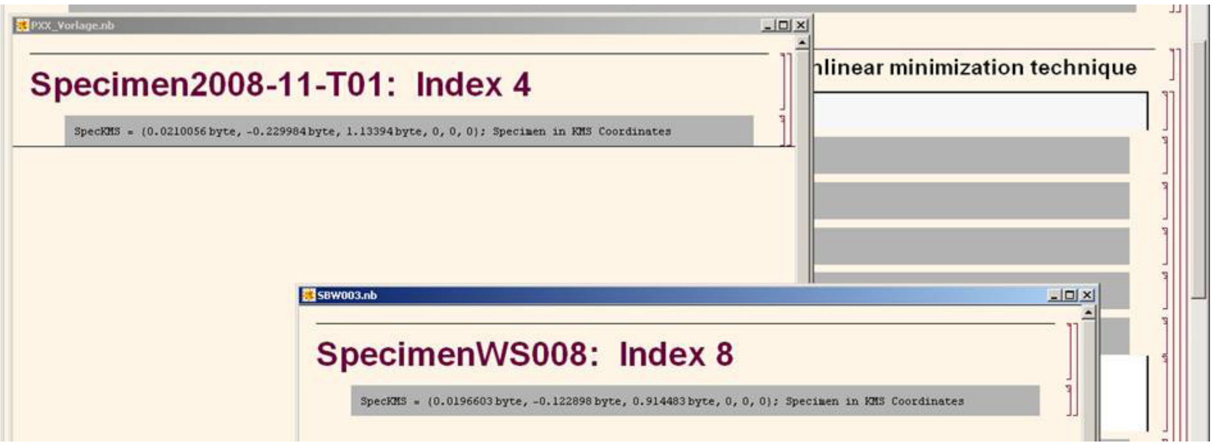


Bild 11

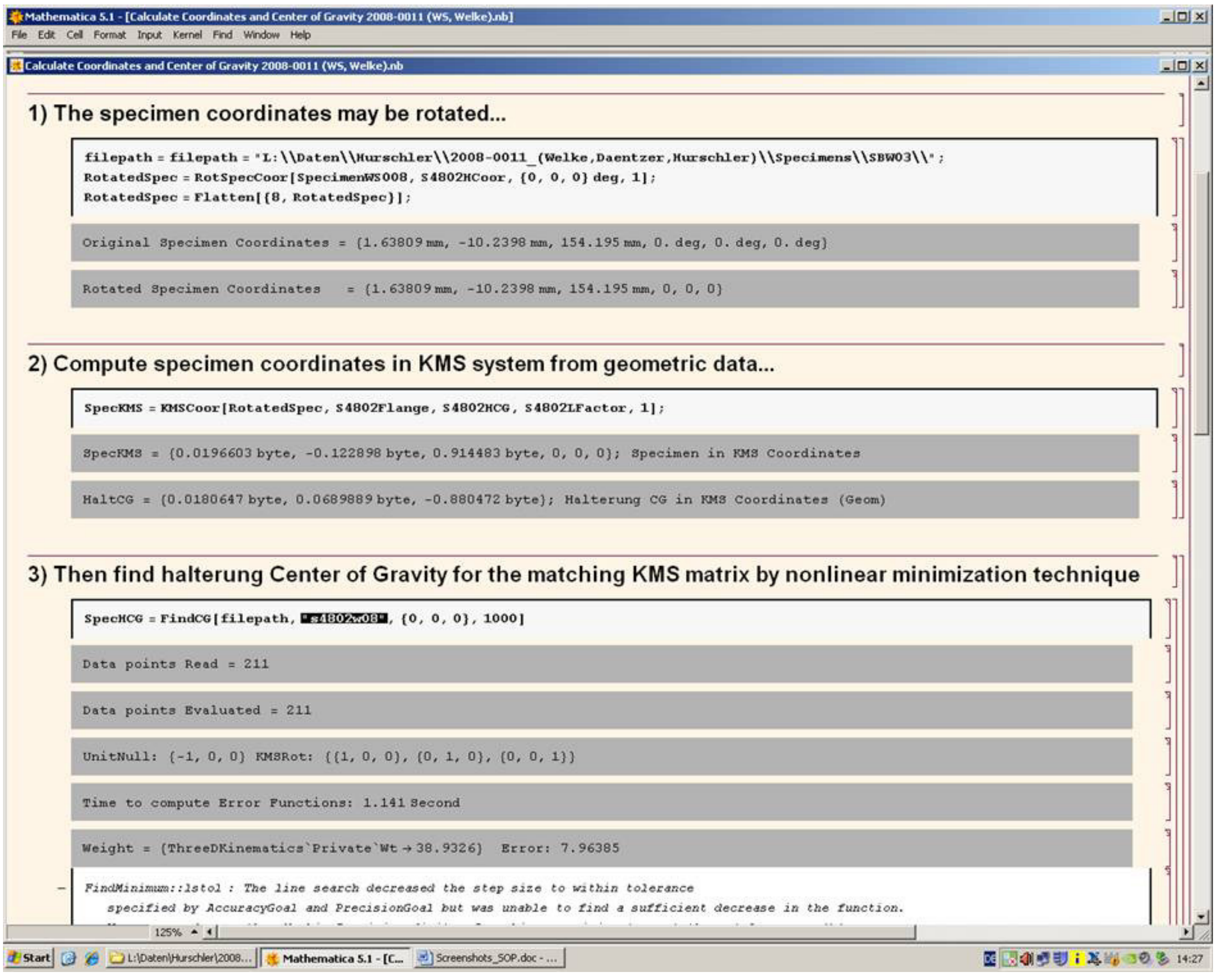


Bild 12

Bild 13

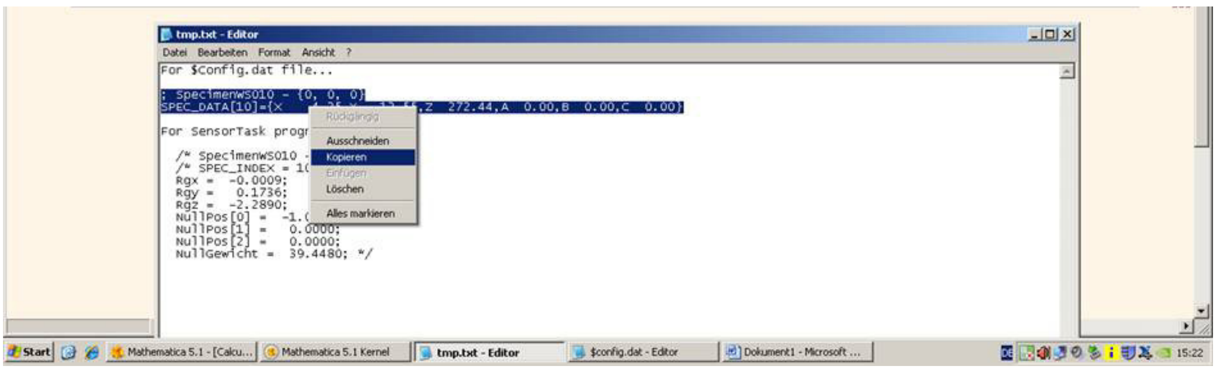


Bild 14

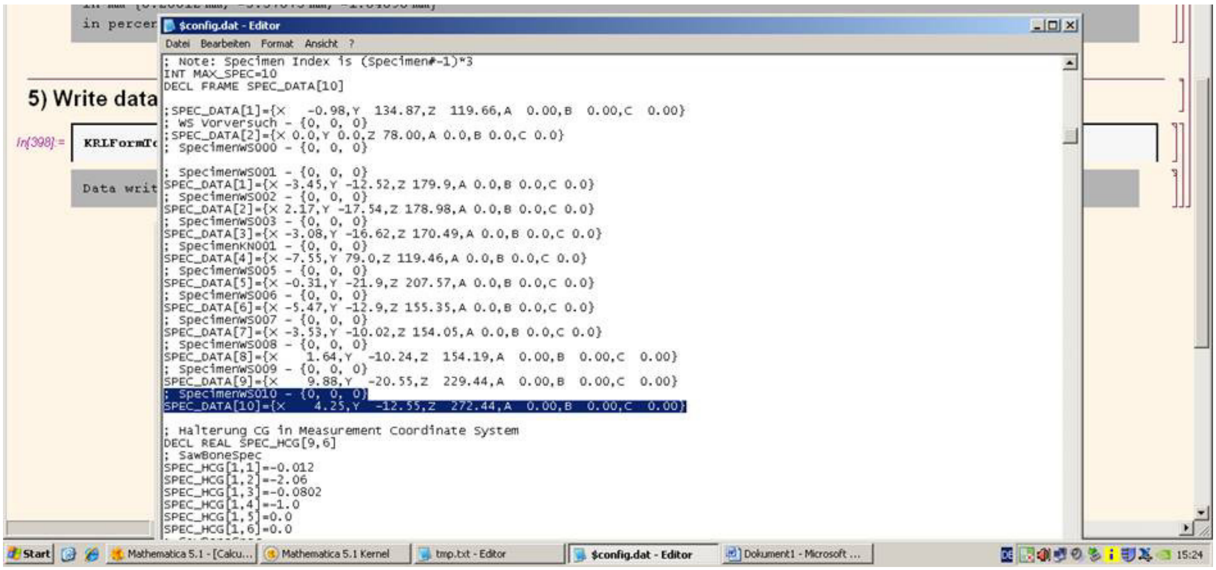


Bild 15

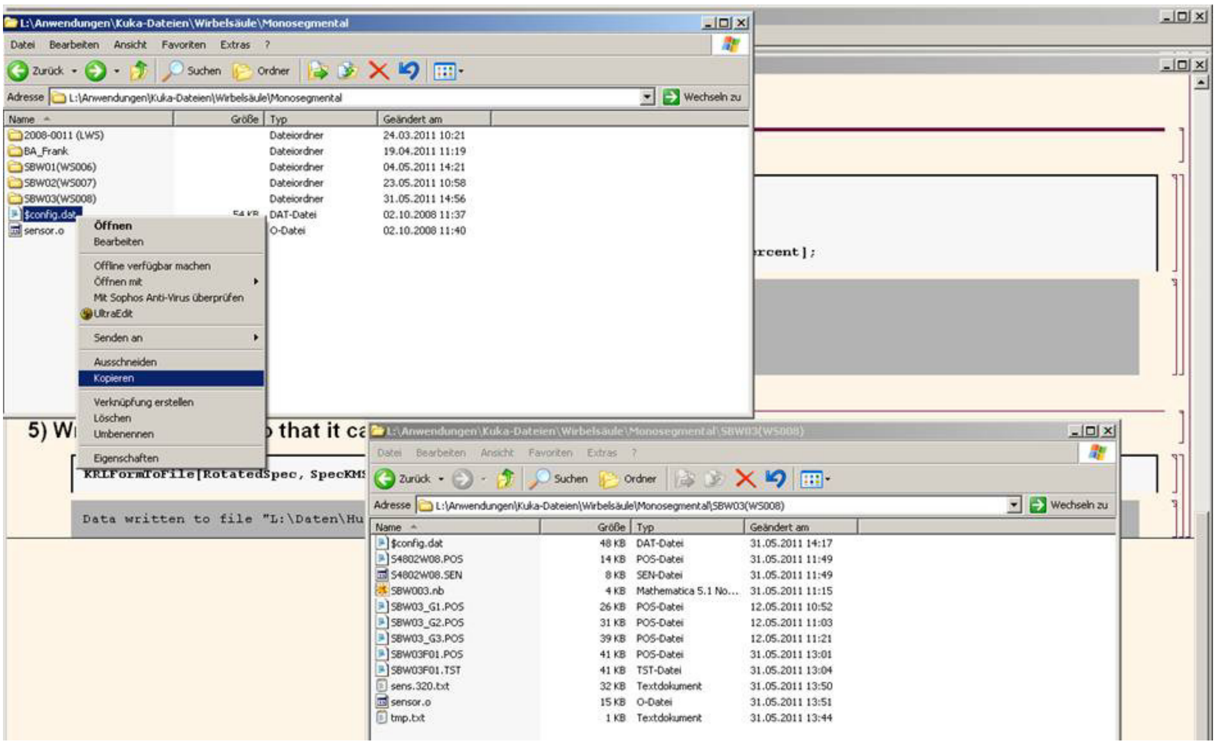


Bild 16

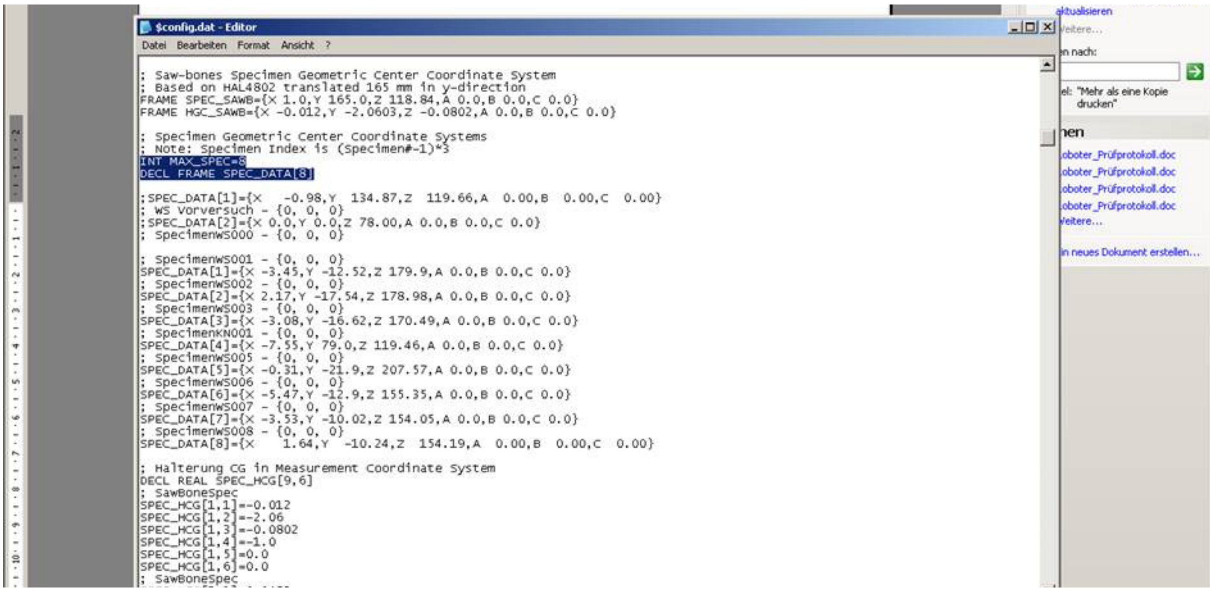


Bild 17

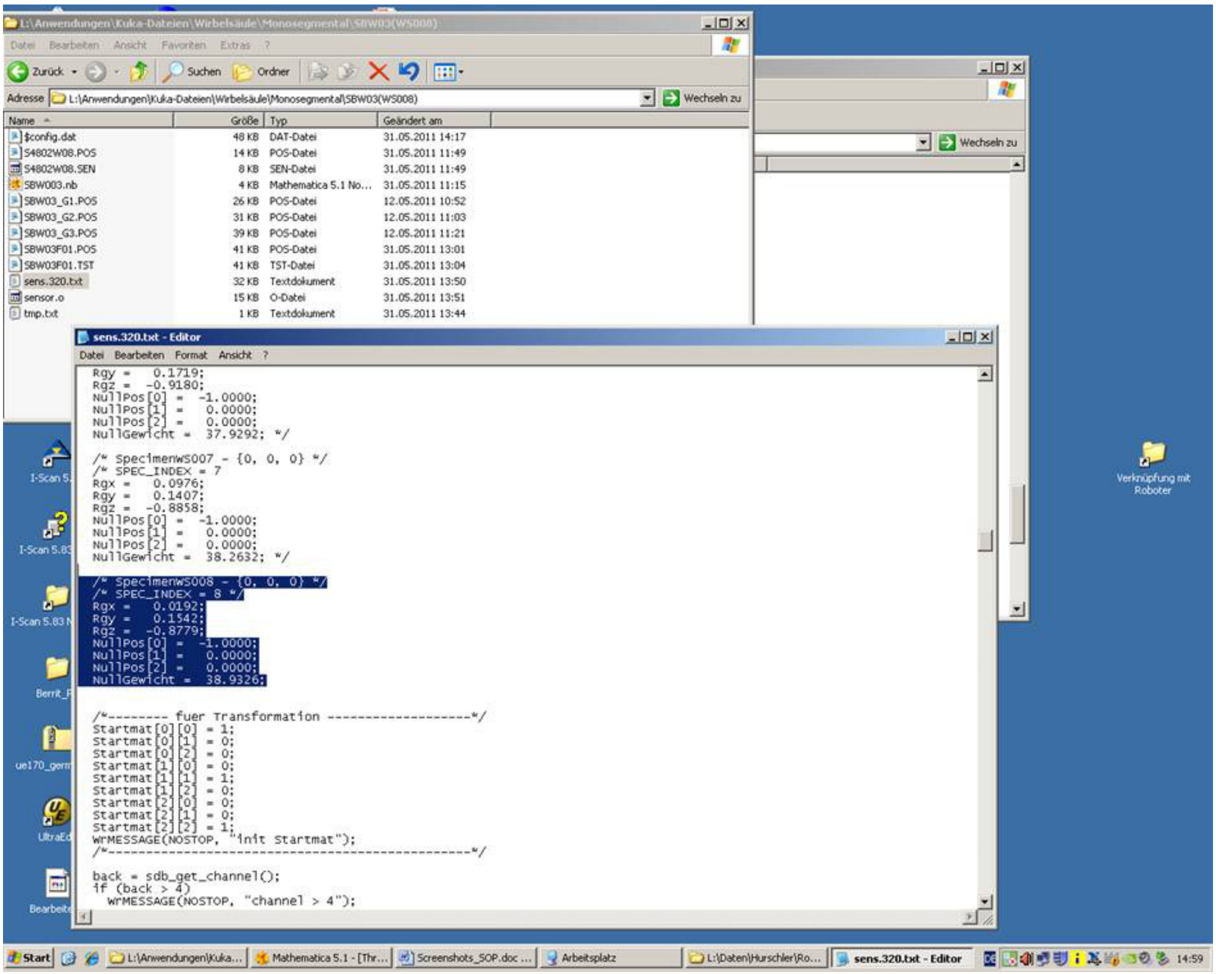


Bild 18

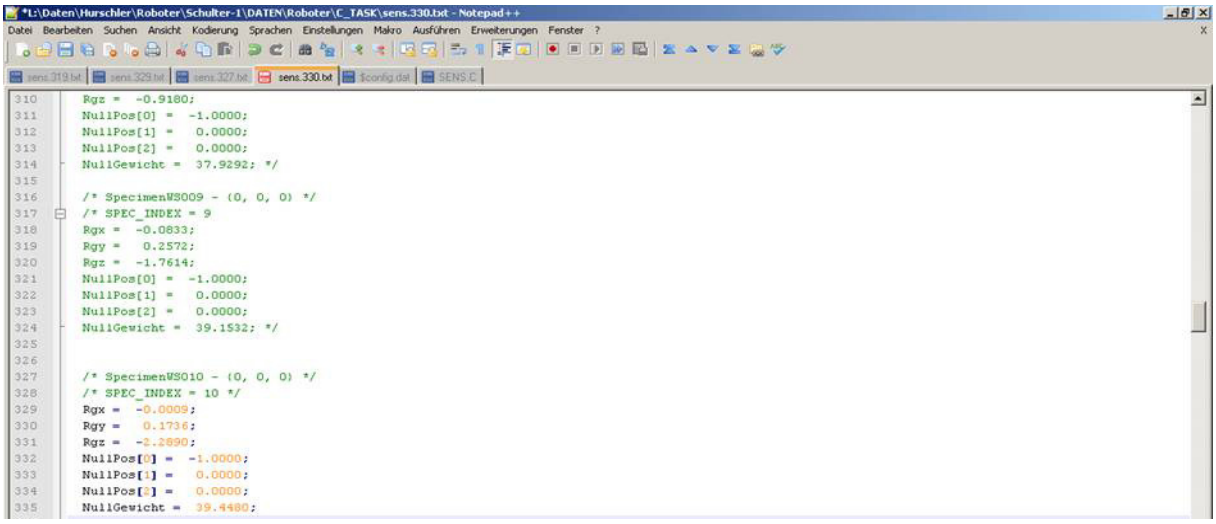
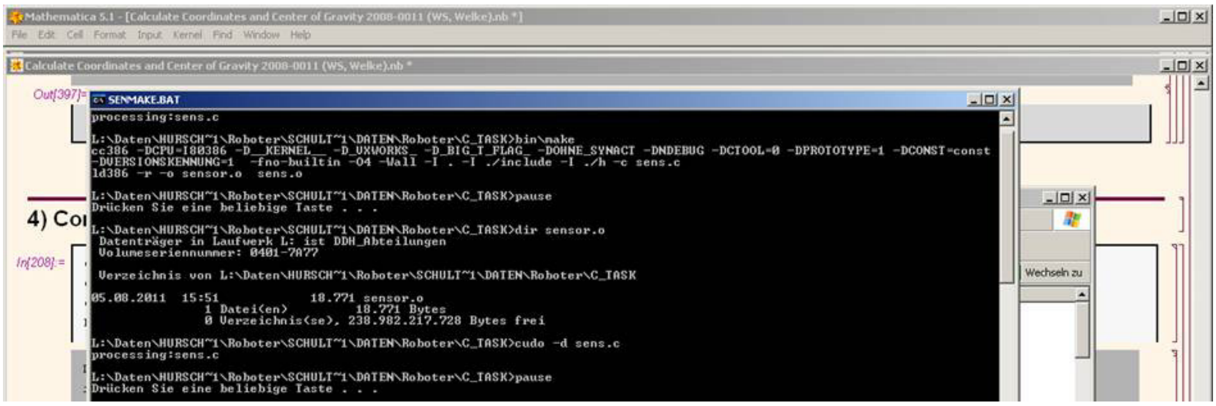
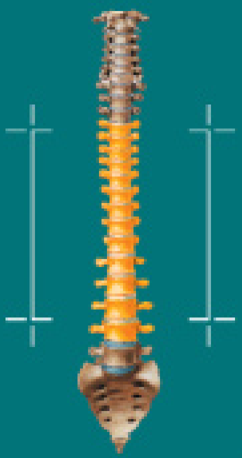


Bild 19



The Centaur *System*

Surgical Technique



The anterior choice

stryker SPINE

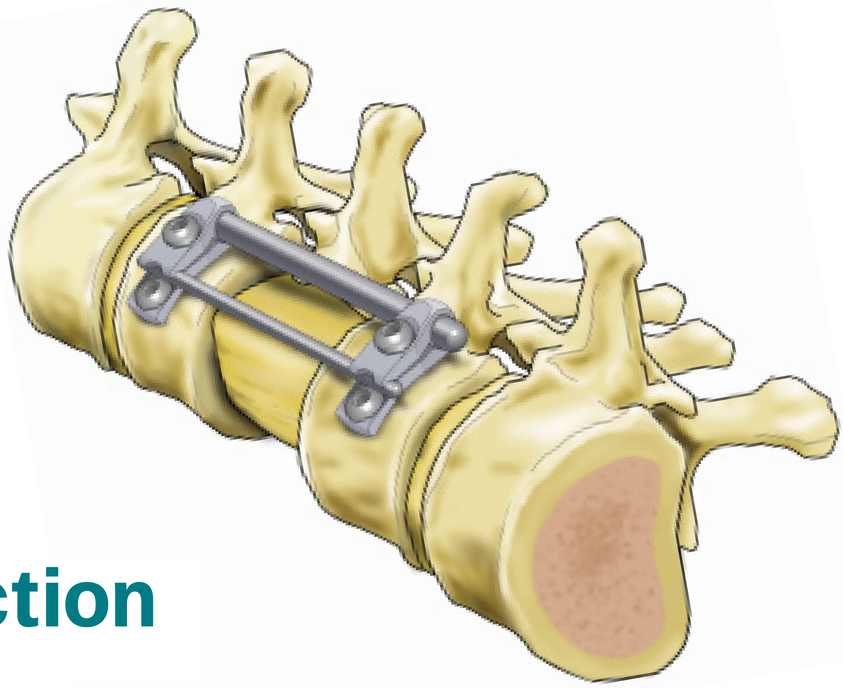
Centaur

Rod system

10 STEPS

Plate system

7 STEPS

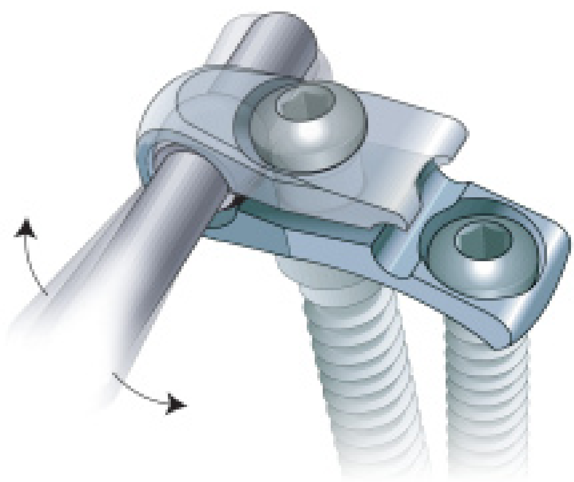


Introduction

An anterior surgical approach is particularly indicated in some patients to restore thoracolumbar spinal stability. Right anterior access is commonly used for the thoracic spine and left access for the thoracolumbar junction.
The Centaur system is used to correct deformities and reliably stabilize these reduction.

The Centaur Rod System combines vertebral body fixation with two bicortical screws and longitudinal connection with two rods forming a construct that provides both sagittal and rotational stability.
The Centaur Rod System has the versatility necessary to adapt to a wide variety of anatomical conditions. This adaptability, which facilitates reduction manoeuvres, are the result of not only the choice of rods to connect the vertebral body implants, but also from the use of ball-rings with-in the connectors which allows +/- 15° in all planes.
Lastly, the Centaur Rod System was conceived for simple and easy installation in both open and endoscopic procedures.

The various steps described below have been simplified to help clarify the concept of the instrumentation.



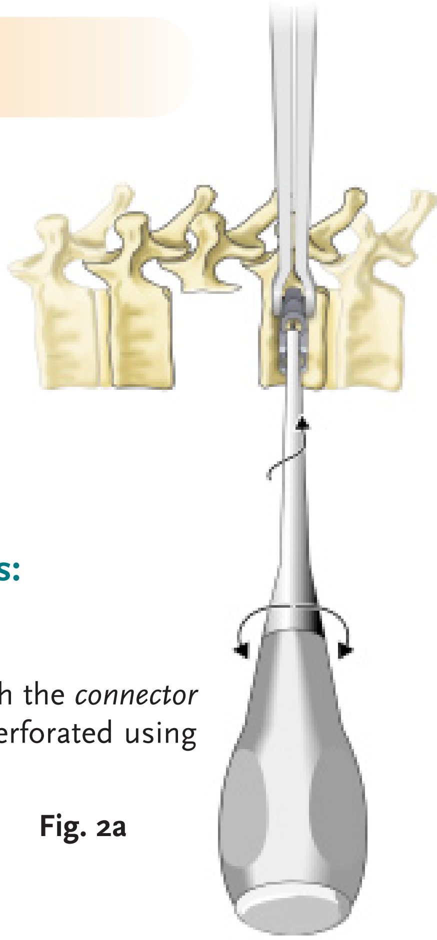
Step 1

Preparation

The spinal segment chosen for stabilization is exposed. Subperiosteal dissection is performed to access the lateral aspect of the vertebral bodies all the way to the anterior convexity. In this fashion the anatomical disposition and, if present, deformities are easier to evaluate in surgery thus optimizing the positioning of the implants. Once corporectomy has begun - it may be completed after implantation of the hardware and reduction. The discs are resected, the endplates of the adjacent caudal and cephalad vertebrae are prepared and cleaned of any intervertebral disc fragment, and existing lateral osteophytes are removed to "flatten out" the zone intended for osteosynthesis.

Step 2

Placement of the main screws



This step consists in the implantation of the *main screws* in the adjacent caudal and cephalad vertebrae.

2 options to define the entry points of the main screws:

1- Use of the connector as a drill guide
The *connector* can be used as a drill guide. It is maintained with the *connector holder* on the lateral part of the vertebral body. The cortex is perforated using the *square awl*, through the *connector* openings **(fig.2a)**.
Thus entry points and screw directions are defined.

Fig. 2a

2- Anatomical location
The *main screw* track is started equidistant from the two endplates, in the concavity of the lateral aspect of the vertebral body and 5 mm posterior to the central point of the sagittal plane **(fig.2b).**

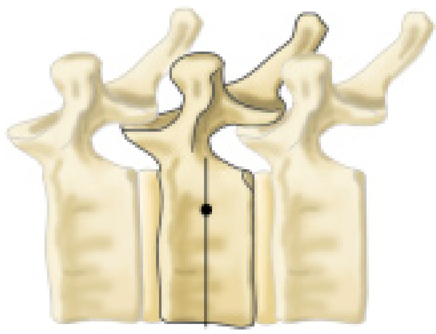


Fig. 2b

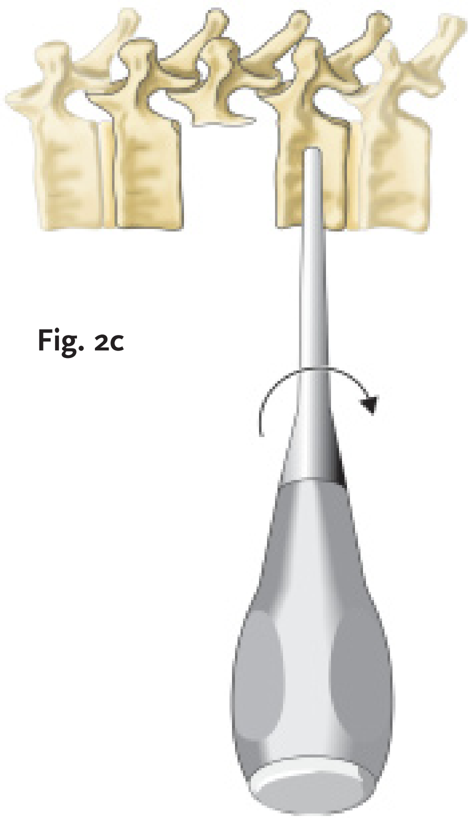


Fig. 2c

Once the entry point is defined, the cortex is perforated using the *square awl* **(fig.2c)**.

The length of the *main screw* is selected according to computed tomographic sections and/or by measuring with the *depth gauge* **(fig. 2d).**

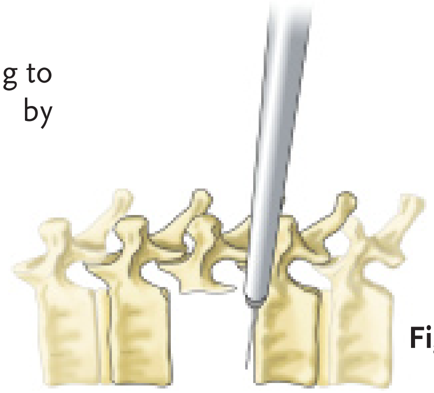


Fig. 2d

The *main screw* should be inserted until its neck is flush with the vertebral body surface, purchase should be bicortical. *Main screws* are self tapping (**fig. 2e**).

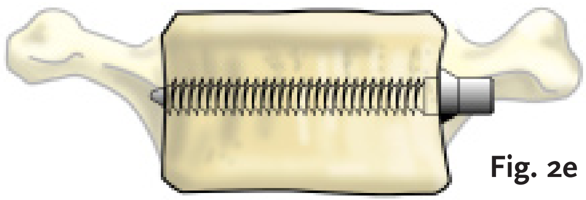


Fig. 2e

The *main screw* is oriented parallel to the endplates and the posterior vertebral wall (**fig. 2f**).

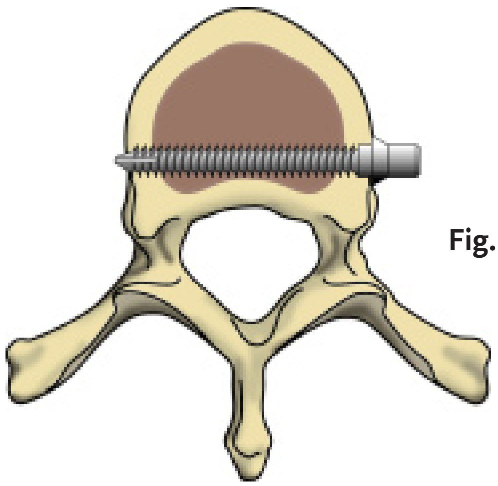


Fig. 2f

Once the *main screws* have been implanted, the *bone rasp* is used to flatten the bony surface around these screws.
The *bone rasp* is attached to the *twisted screwdriver*, then placed over the heads of the *main screws* **(fig.2g).**

Fig. 2g

Step 3

Placement of the connectors

The *connector* is taken using the *connector holder* and placed on the *main screw* parallel to the vertebral endplates **(Fig 3a & 3b).**

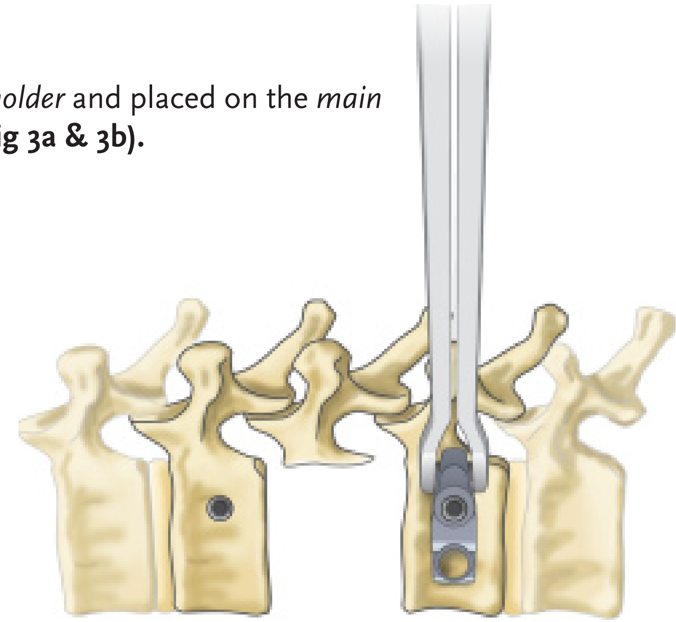


Fig. 3a

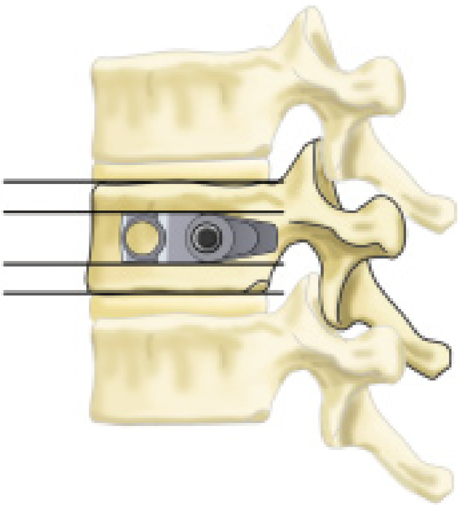
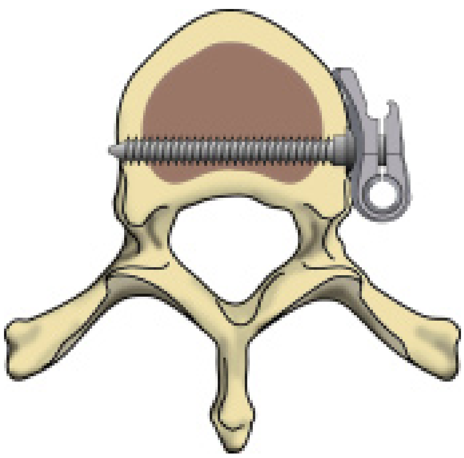


Fig. 3b

One should verify that the contact between the *connector* and the *main screw*, and between the *connector* and the bone is optimal **(fig. 3c).**



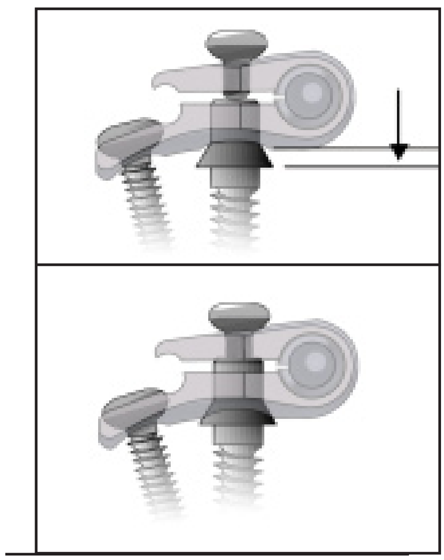


Fig. 3c

Step 4

Placement of the secondary screws

After having perforated the cortical bone with the *square awl* **(fig.4a)**, the *secondary screw* is inserted at its site **(fig.4b).**

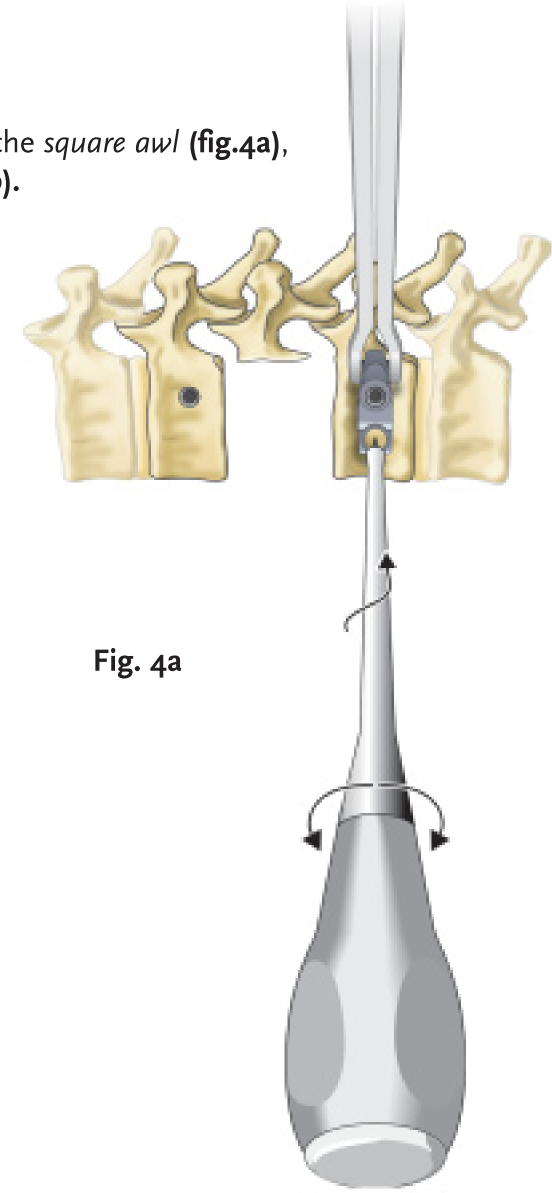


Fig. 4a

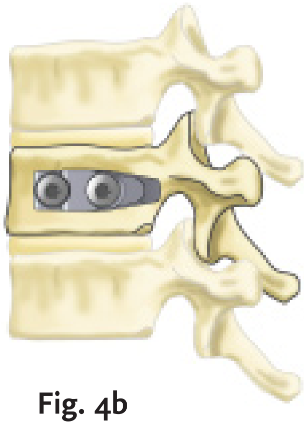


Fig. 4b

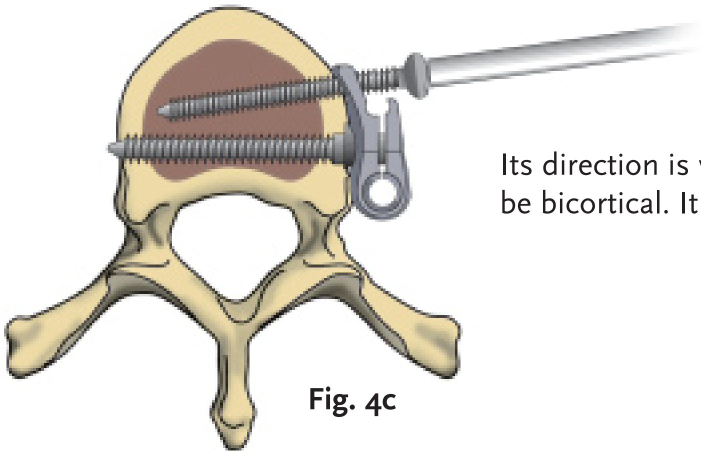


Fig. 4c

Its direction is variable and purchase should be bicortical. It is also self tapping **(fig.4c).**

Step 5

Placement of the main rod

The main 6 mm rod is selected according to the proper length. It can be curved beforehand for better fit to the contours of the spine. Carried in the *rod holder,* the rod is slipped into the *ball-ring* of each *connector* **(Fig. 5a and 5b)**. The *ball-rings* make this manoeuvre possible even if the vertebral surfaces are not aligned. This unique feature also permits the surgeon to guide and facilitate the reduction manoeuvers.

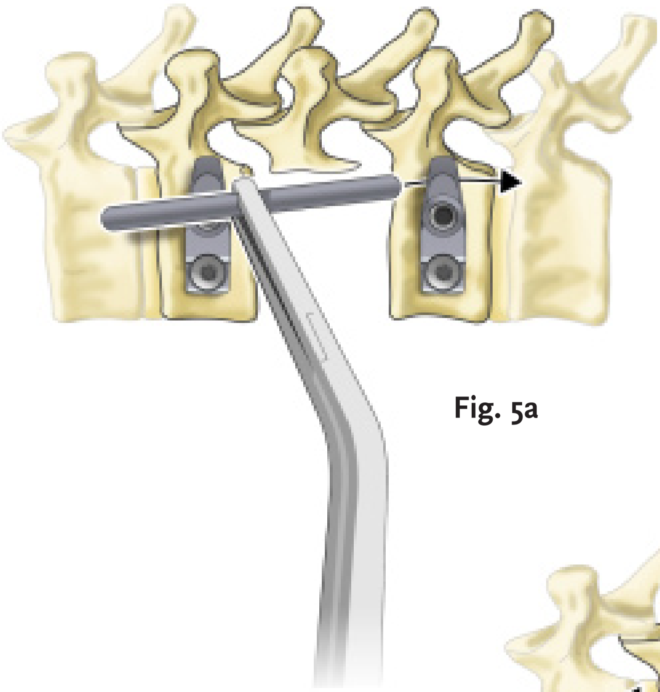


Fig. 5a

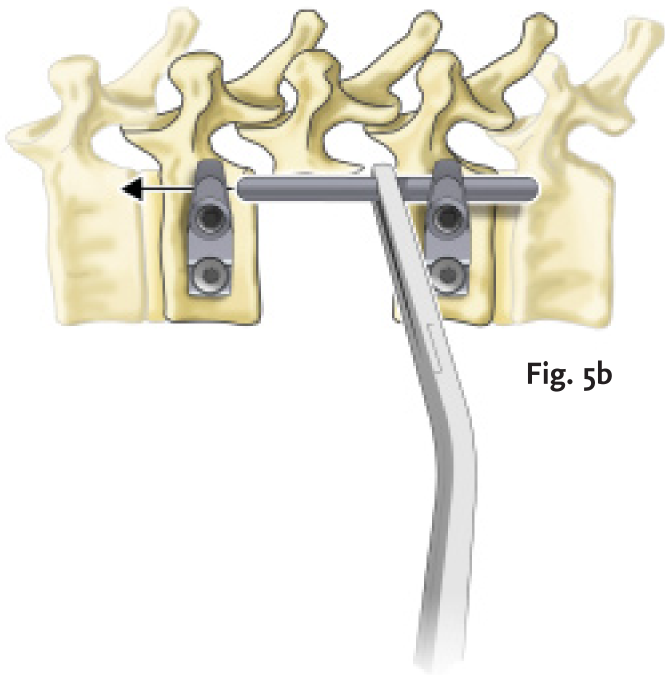


Fig. 5b

Step 6

Placement of the tightening screws

The *rod tightening screws* are inserted into the head of the *main screws*. They are tightened only after the reduction manoeuvres **(Fig. 6a and 6b)**.

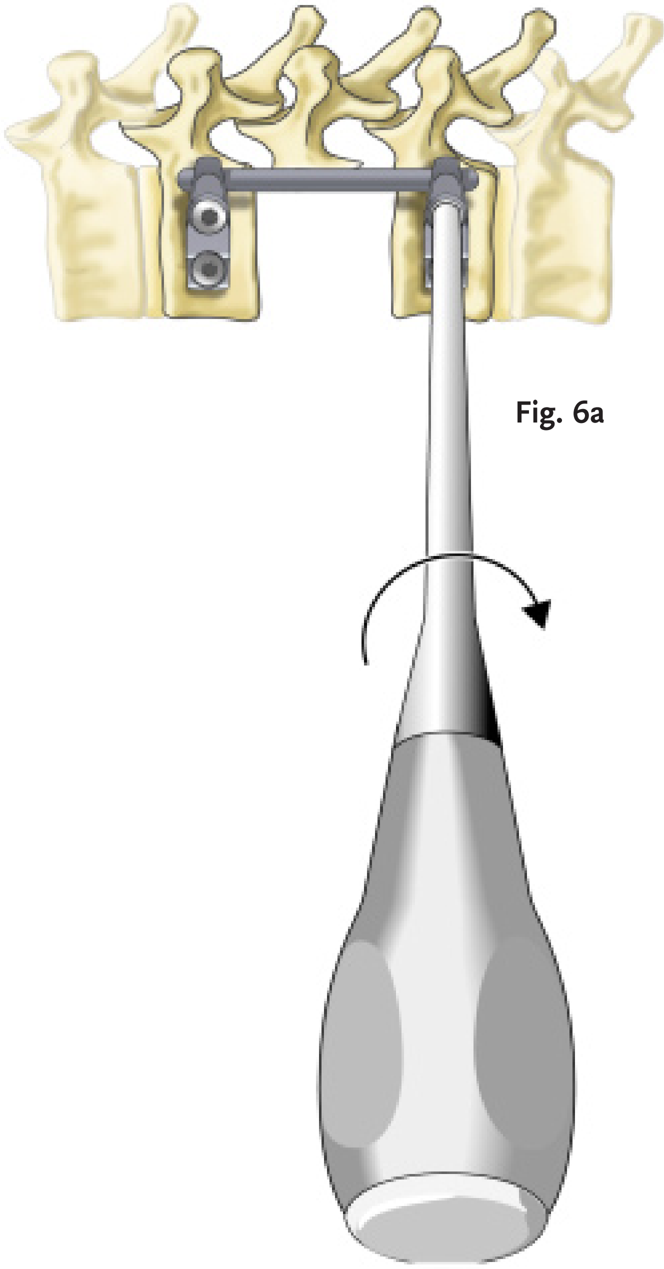


Fig. 6a

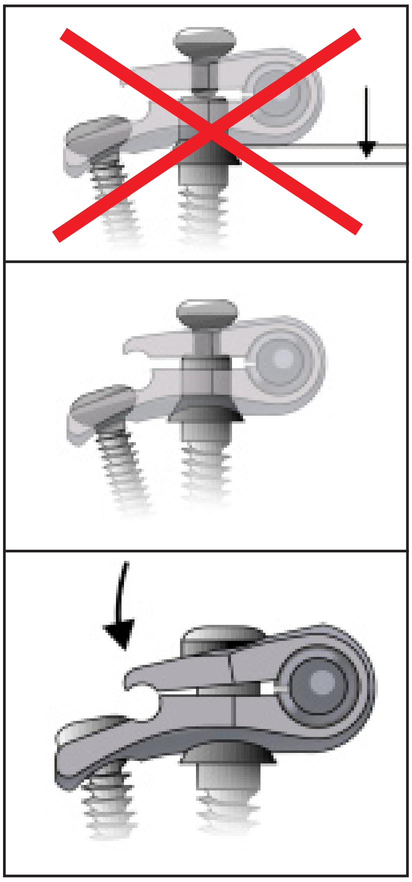


Fig. 6b

Step 7

Reduction

The correction of the deformity is obtained by using the *vertebral body distractor* **(Fig. 7a).** The surgeon may also apply the *vertebral body distractor* to the implants **(Fig. 7b)** or just one side to an implant and the other to the interbody space. Once reduction is obtained, the *rod tightening screws* can be temporarily tightened to maintain this reduction.

This allows, if necessary, the ability to either complete the corporectomy or open the posterior wall to decompress the spinal cord. The position of the rod was conceived to leave enough operative space for such procedures.

The graft implant or the vertebral body replacement is selected to fill the cavity created by the corpectomy.

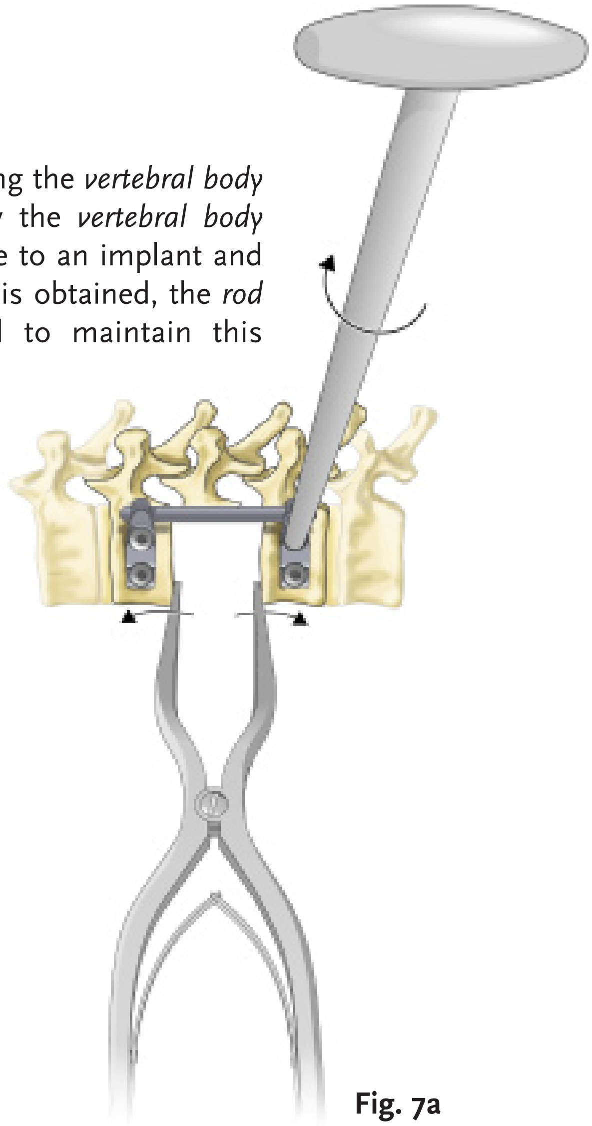


Fig. 7a

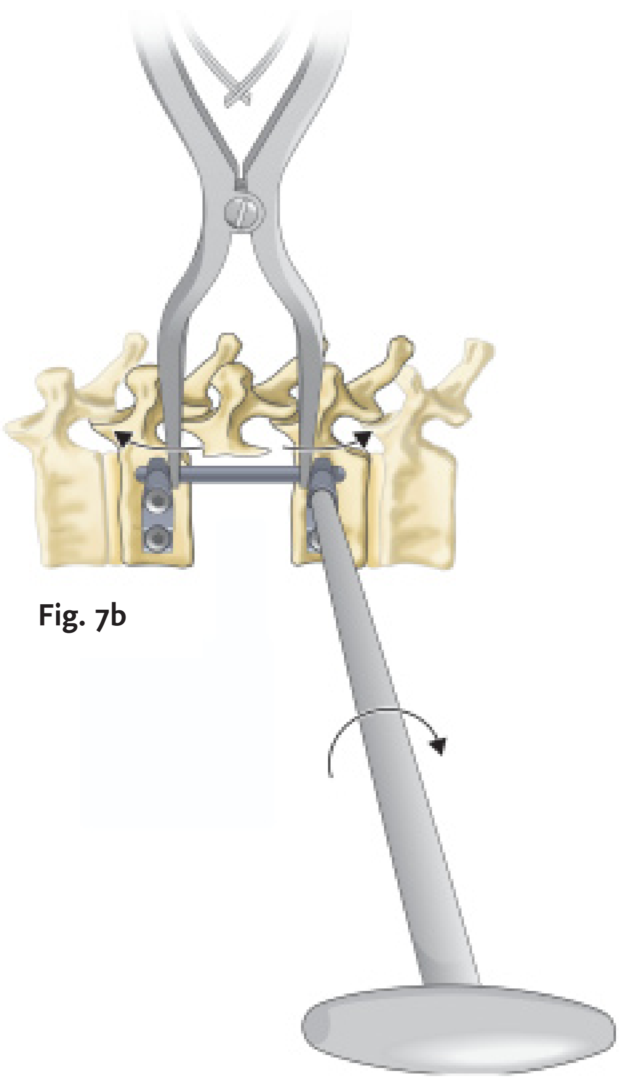


Fig. 7b

Note: the *tightening screwdriver* has to be perfectly inserted in the top Hex of the *rod tightening screws.*

Step 8

Placement of the filling material

The graft or the interbody implant is easily placed due to the distraction. Compresion is then exerted using the *rod contractor* placed on the 6 mm *rod* against *connectors*. The *rod tightening screws* are loosened to allow this compression **(Fig. 8)**.

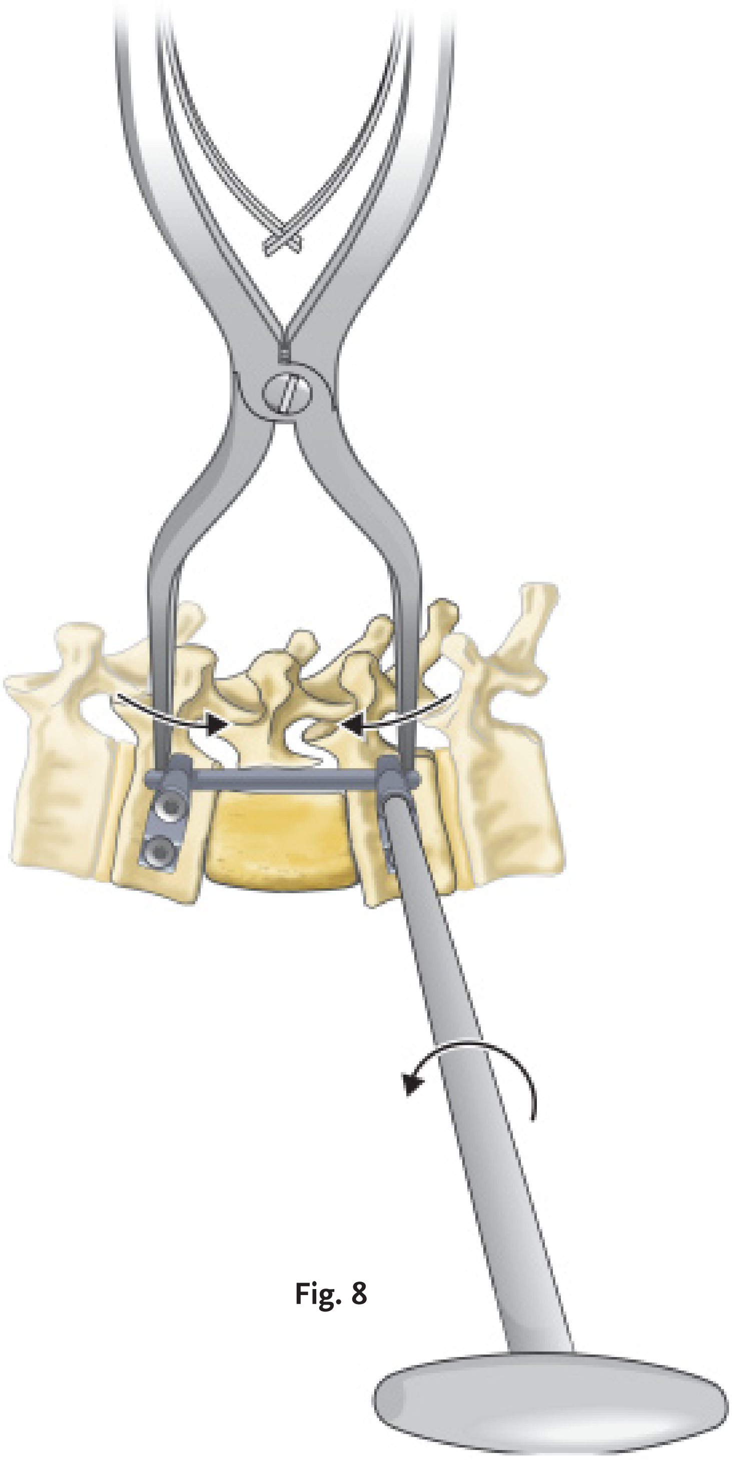


Fig. 8

Placement of the secondary rod

While maintaining compression, the surgeon determines the length of the 4 mm *anterior rod*. This *rod* is bent as needed **(fig.9a).** A trial rod is useful in certain cases. The 4 mm *rod* is placed in the anterior casings of the two *connectors* and the *rod tightening screws* are fully tightened **(fig.9b).**

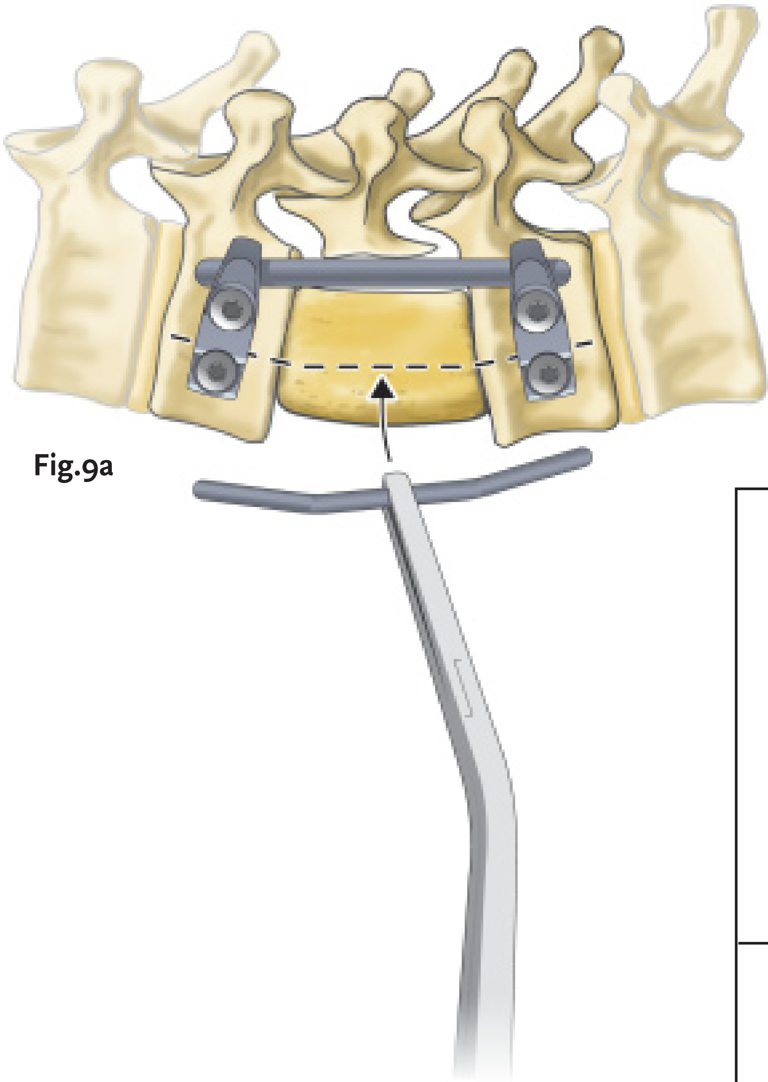


Fig.9a

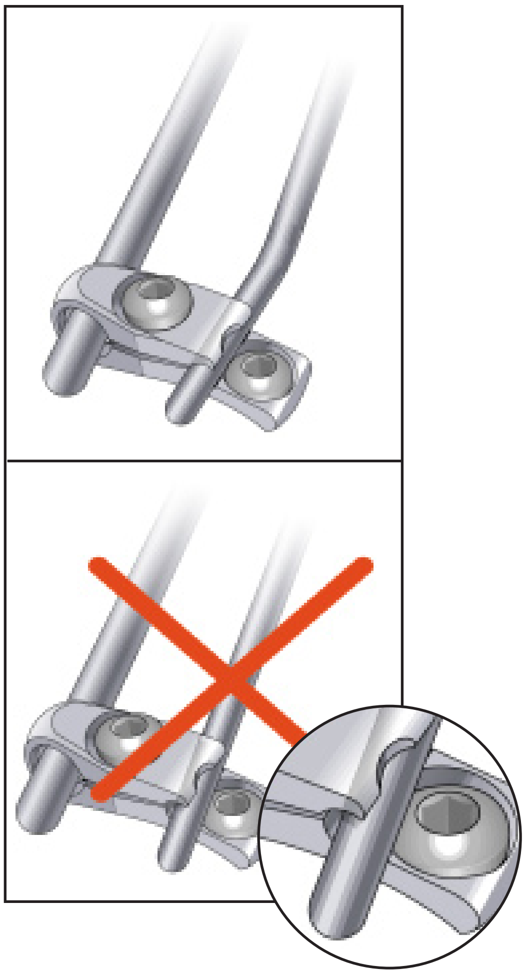


Fig. 9b

Step 10

Final tightening

It is important to ensure final locking by using the *tightening screwdriver* and the *anti-rotation wrench* at the same time **(Fig. 10)**.

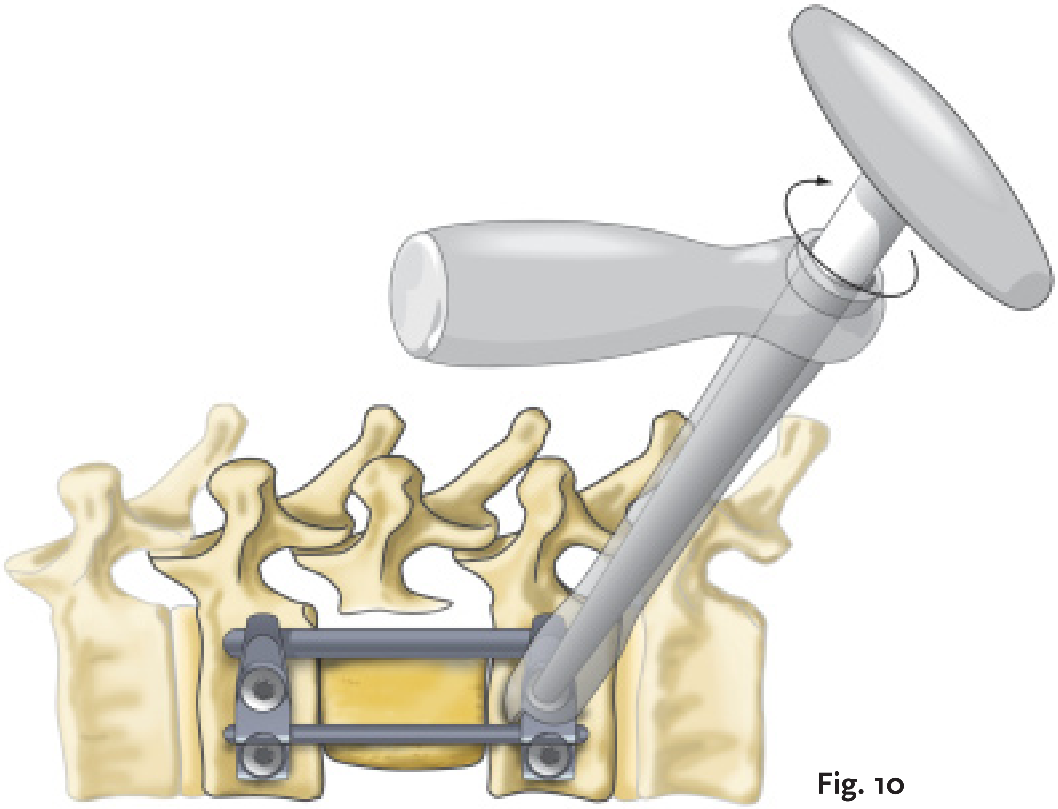


Fig. 10

Note: The *tightening screwdriver* has to be **perfectly inserted** in the top Hex of the rod *tightening screws.*

Incidents & Solutions

Incident	Cause
The connector does not fit completely on the head of the screw.	The positioning of the connector is hampered by the rib head. The main screw is too far down into the cortical (neck of the screw buried).
The main rod can not be inserted easily in the ball-ring.	The ball-ring is not well oriented in the connector.
The anterior part of the connector does not properly fit the bone surface.	The main screw entry point is too anterior and its direction is too oblique.
The secondary rod is not stable enough during the final tightening.	The connector does not keep the rod in position.
The exposure does not permit proper orientation of the screwdriver for insertion of the main or secondary screw.	
The tightening screw cannot be started into the main screw.	The direction is improper. The tightening screw drags the main screw along with every turn of the main screw into the bone instead of tightening the construct.

Solution

Use the bone rasp or a bur to flatten out the zone around the main screw.
Slightly unscrew the main screw.

Position the connector using the connector holder which automatically corrects the ball-ring orientation.

Use the connector as a drill guide at the beginning of the procedure or modify both the direction and the entry point of the screw.

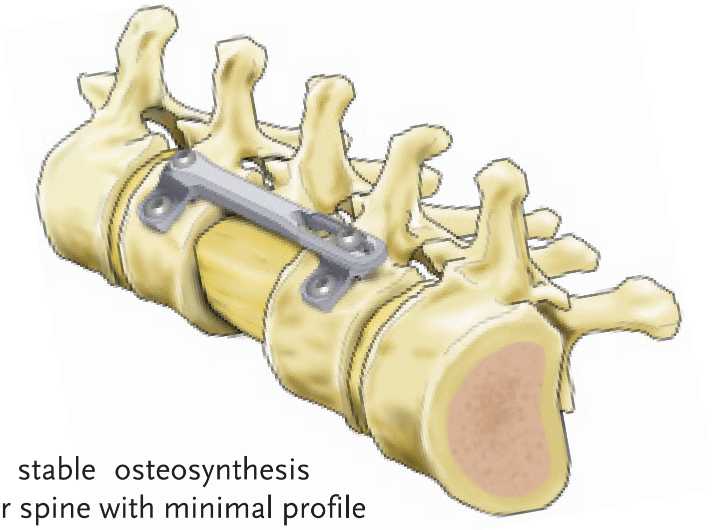
Bend properly the secondary rod to get a perfect fit into the connector.

Use the rod holder that can catch both rods and firmly maintain the secondary rod during final tightening.

Use the round tip screwdriver which permits a variable angulation of 15°.

Correctly orient the tightening screw before starting it in the main screw.

The plate support or the plate is not flush on the bone around the main screw preventing the construct from being locked. Place them properly before trying to lock the construct.

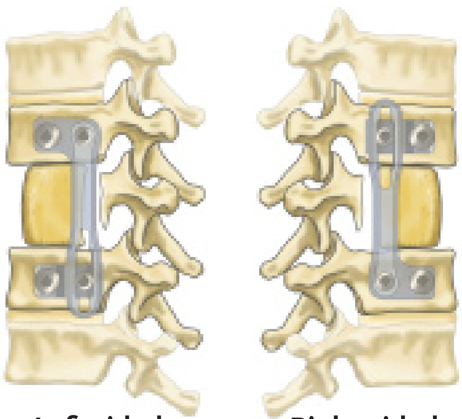


Introduction

The Centaur/Plate system provides a stable osteosynthesis environment for the thoracic and lumbar spine with minimal profile which facilitates the placement of bone grafts or other graft material (cement, cage...). Furthermore, the Centaur/Plate system permits precise radiological follow-up.

The plate has a L shape. The short part is fixed directly to the vertebral body and the long part is connected to a plate support fixed to the other vertebral body.

The Centaur/Plate design allows both right and left approaches.



Left-sided approach **Right-sided approach**

It presents two innovations:

1 – It permits distraction and compression before and after the placement of the graft or other filling material. In practice, the plate may be used as a distractor.

2 - It facilitates the reduction of kyphosis.

3 geometries of plates

Straight, kyphotic, and lordotic plates are used depending on the spinal level involved.

Lastly, the Centaur/Plate system was designed to be simple and easy to implant in either open surgery or minimally invasive surgery.

The different steps described below have been simplified for better understanding of the concept of this instrumentation.

Step 1

Preparation

The spinal segment that is to be stabilized is accessed through an anterior approach (thoracotomy, lumbotomy, or thoracophrenolumbotomy according to the level).

After ligation of the segmental vascular pedicles involved, the lateral aspect of the vertebral bodies is exposed from the posterior side to the middle. It is usually necessary to excise the anterior part of the rib heads, which may interfere with the placement of the hardware.

The resection (discectomy or corpectomy depending on the case) may be performed before or after the implantation of the main screws. Resecting first gives a better view of the orientation of the vertebral endplates facilitating proper placement of the screws. At this stage, it is important to resect any lateral osteophytes that may be present to provide a flat surface for the hardware.

Step 2

Insertion of the main screws

This step consists in the implantation of the *main screws* in the adjacent caudal and cephalad vertebrae.

The *main screw* track is started equidistant from the two endplates, in the concavity of the lateral aspect of the vertebral body at its anteroposterior junction: 1/4 posterior 3/4 anterior **(Fig.2a)**.

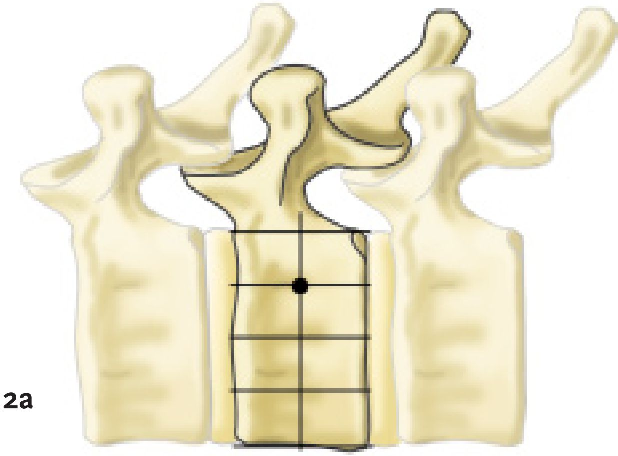


Fig. 2a

Once the entry point is defined, the cortex is perforated with the *square awl*.

The *main screw* should be inserted until its neck is flush with the vertebral-body surface, purchase should be bicortical. Screws are self tapping **(fig.2b).**

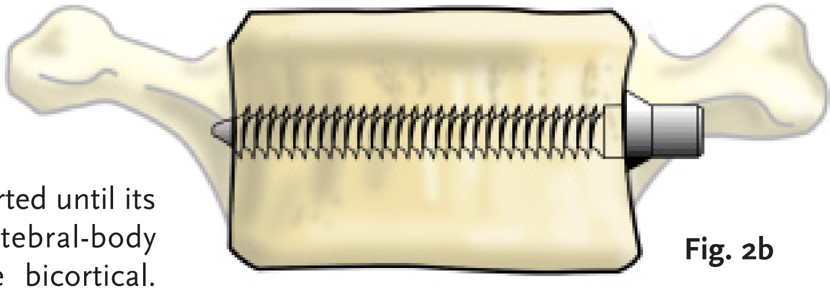


Fig. 2b

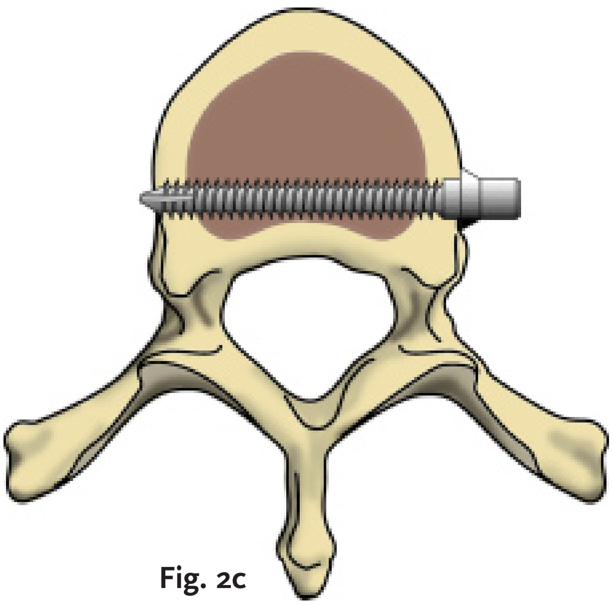


Fig. 2c

The *main screw* is oriented parallel to the endplates and to the posterior vertebral wall. The plate being strictly perpendicular to the screws, any mistake at the insertion step will induce a bad positioning of the plate **(fig.2c)**.

The length of the *main screw* is selected according to computed tomographic sections and/or by measuring with the *depth gauge* **(fig.2d).**

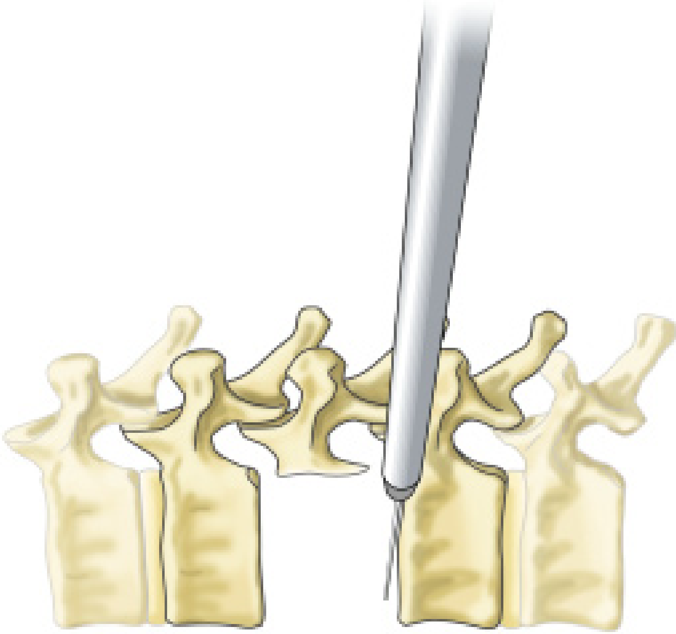


Fig. 2d

Once the *main screws* have been implanted, the *bone rasp* is used to flatten the bony surface around these screws and make easier the positioning of both the *plate support* and the *plate*. The *bone rasp* is attached to the *twisted screwdriver*, then placed over the heads of the *main screws* **(fig.2e).**

Fig. 2e

Step 3

Placement of the plate support

The *plate support* is placed on the caudal *main screw* in left-sided approaches and on the cephalad *main screw* in right-sided approaches **(fig. 3a).**
The placement of the plate facing the *plate support* is logical:
- on the cephalad vertebra in left approaches
- on the caudal vertebra in right approaches

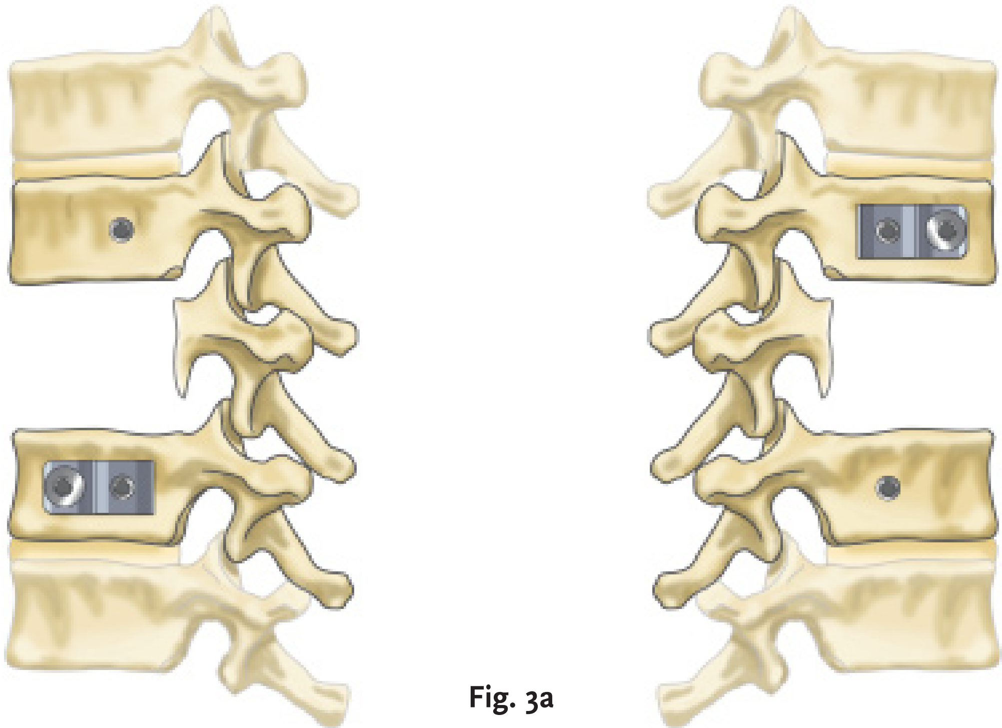


Fig. 3a

Left approach **Right approach**

The surgeon verifies that the curve of the *plate support* fits with the vertebra in the horizontal plane and, if necessary, modifies the shape using the *adjustment forceps* **(fig. 3b).**
The *plate support* may be bent to accentuate its curvature.

Caution: Rebending the *plate support* to undo such alterations must be strictly avoided.

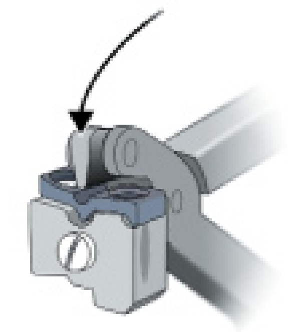


Fig. 3b

The *plate support* is placed on the *main screw* using the *plate support holder*. It is secured, parallel to the vertebral endplates, with the *secondary screws*.
(fig. 3c).

Note: Before inserting the *secondary screw*, check that the *plate support* is in contact with the neck of the *main screw*.

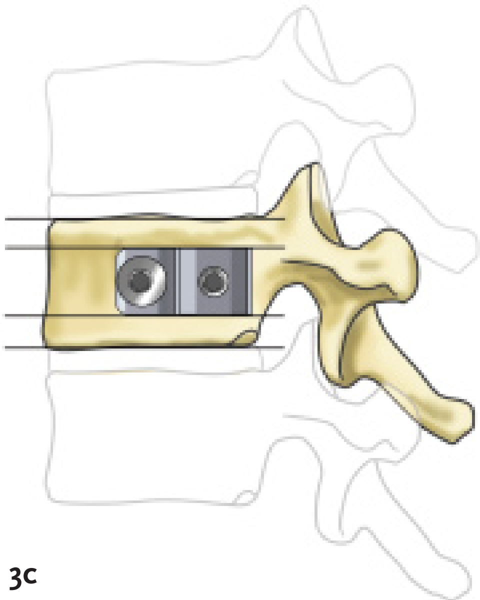


Fig. 3c

After perforation of the first cortical layer – using the *square awl* - the *secondary screw* is inserted in a slightly anteroposterior direction. It is also bicortical and self tapping **(fig. 3d).**

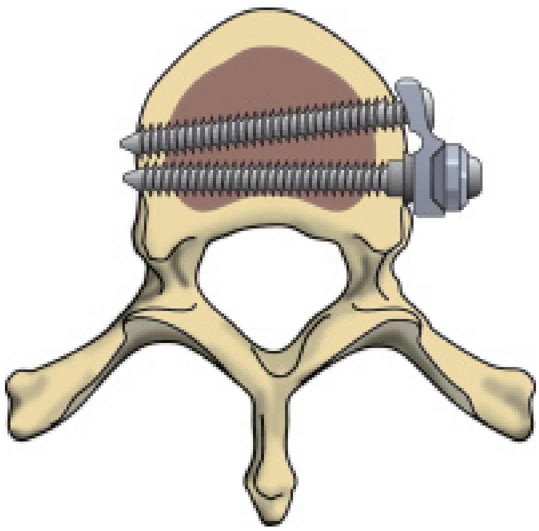


Fig. 3d

Step 4

Placement of the plate

Centaur plates are available in three geometries **(fig.4a).**

Fig. 4a

Kyphotic Plate **Straight Plate** **Lordotic Plate**

The choice of *plate* size should take into account the compression or distraction manoeuvres that the surgeon intends to carry out.
After any needed horizontal curvature modification performed in the same manner as for the *plate support* **(fig 4b)**, the *plate holder* is used to place the *plate* so that its opening is on the head of the *main screw*.
The *secondary screw* is then inserted in such a way that the horizontal portion of the plate is parallel to the vertebral endplates.

Caution: Once the curvature of the integrated plate support is modified, it is not advisable to reverse any modifications made.

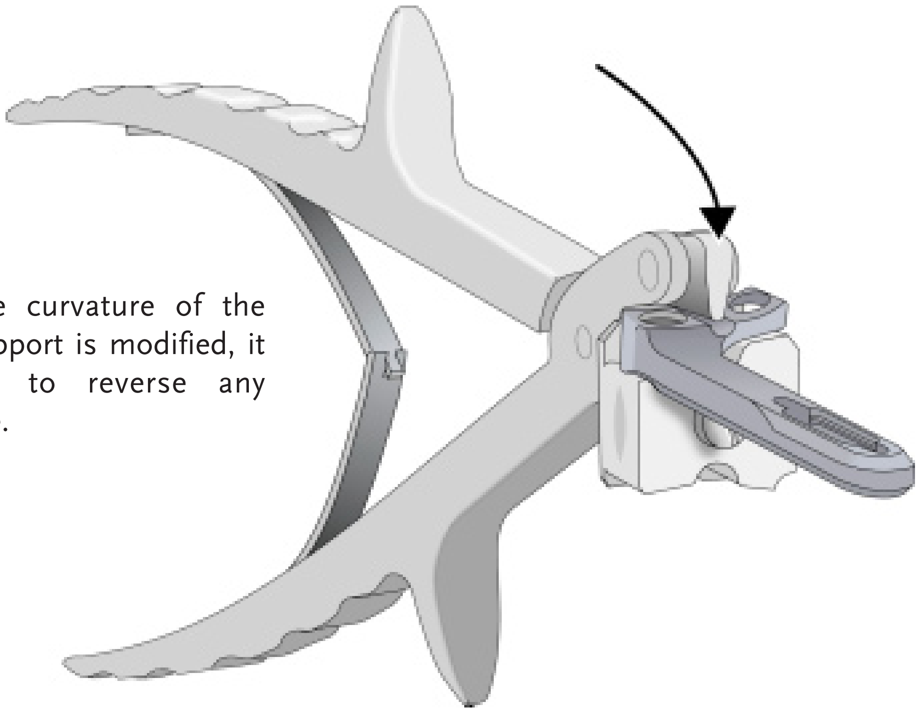


Fig. 4b

Step 5

Assembling of the two parts

Using the *plate holder*, the surgeon positions the plate over the *plate support*, on the head of the *main screws*, and inserts the *plate tightening screw* in the head of the *main screw* **(fig.5a – 5b).**

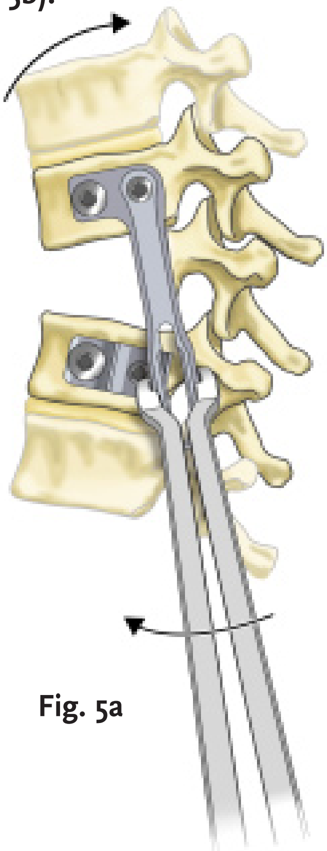


Fig. 5a

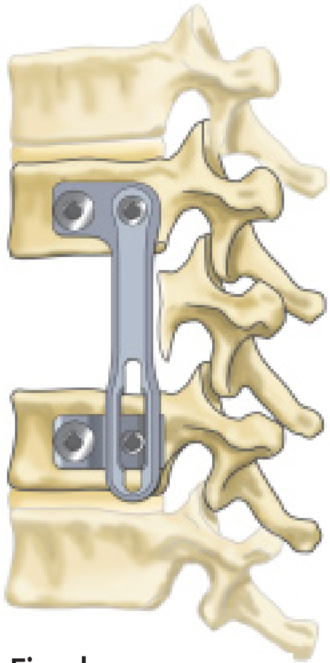


Fig. 5b

The two parts are designed to accept a maximum misalignment of 15° and as the *plate tightening screw* is tightened, the large section of the *plate* shifts in the *plate support* and becomes strictly perpendicular to it **(fig. 5c).**

The system is conceived so that tightening the *plate tightening screw* does not loosen the *main screw* anchorage.

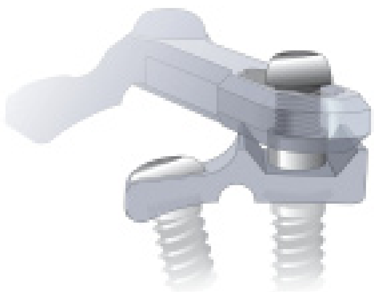
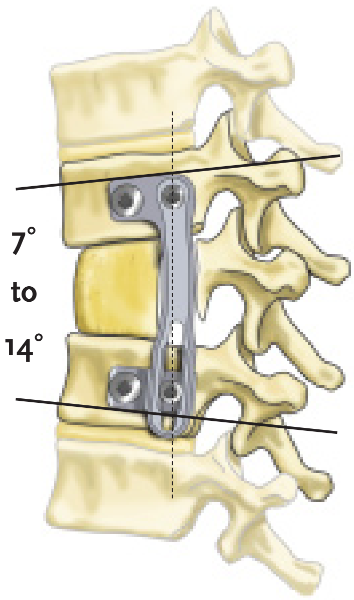


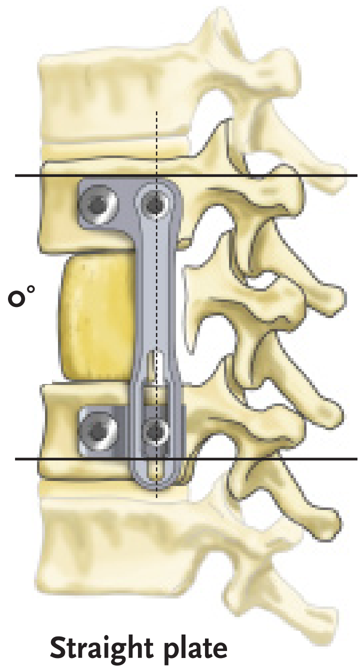
Fig. 5c

Important Note: Provided that the *plate support* and the horizontal portion of the *plate* are parallel to the endplates of each vertebra, unifying the two parts automatically produces:

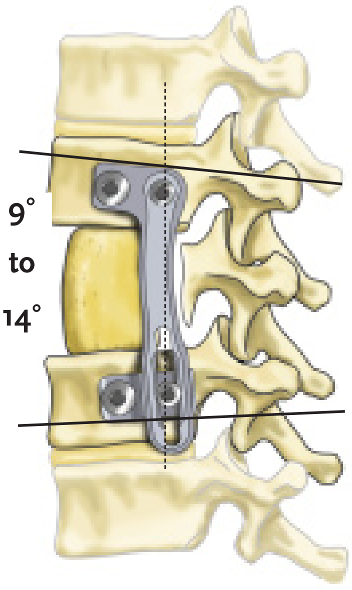
- A kyphosis of 7 to 14° when lordotic plates are used,
- 0° of kyphosis with straight plates,
- A lordosis of 9 to 14° when lordotic plates are used.



Kyphotic plate



Straight plate



Lordotic plate

Note: Kyphotic & lordotic plates are bent following the same radius. Disalignment angulation will vary with the length of the plate.

Caution: If one does not intend to reduce the kyphosis, it is better to assemble the *plate* to the *plate support* before inserting the anterior *(secondary) screws*. Consequently, the *plate support* and the horizontal bar of the L will not be parallel to the endplates in such cases.

Step 6

Distraction

Distraction is an essential step in correcting a kyphosis, but it also facilitates insertion of filling materials (bone graft, cage, or cement).
With the Centaur/Plate system, distraction may be carried out in two different manners, according to the severity of kyphosis :

6.1 - DISTRACTION BEFORE PLATE POSITIONING

A - Distraction applied to the screw heads (little or no kyphosis)

The *vertebral body distractor* is applied to the heads of the *main screws* **(fig 6a).**
Such distraction is insufficient to restore satisfactory lordosis in patients with kyphosis since the force is exerted through the *main screws* to the posterior part of the vertebral body. This type of distraction is used to restore the height of the interbody space and thus facilitates the insertion of filling materials.
The Centaur/Plate is then placed following the previous steps.

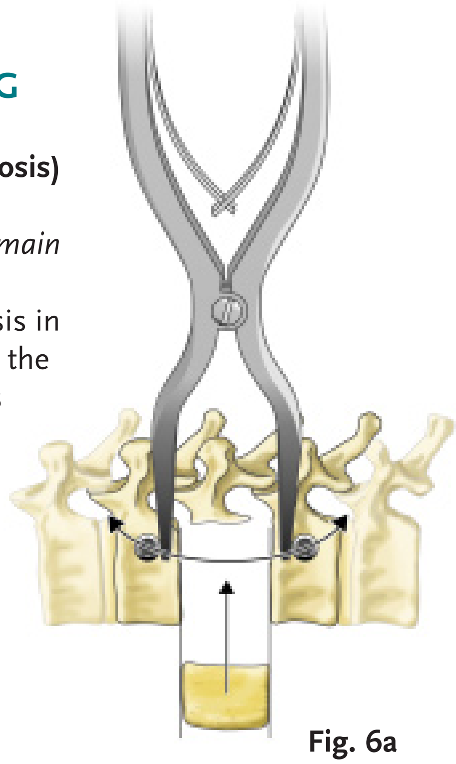


Fig. 6a

B - Distraction applied to the vertebral endplates (severe kyphosis)

The *vertebral body distractor* is placed in the frontal plan with its blades applied to the anterior part of the endplates providing a lordosing distraction while leaving room to insert filling materials **(fig.6b)**
The Centaur/Plate is then placed following the previous steps.

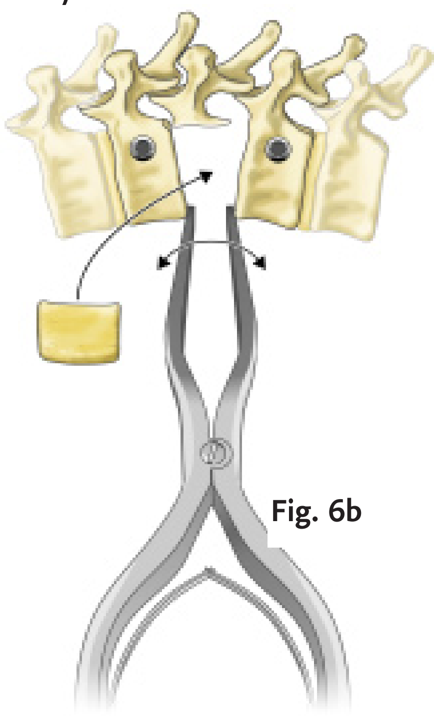


Fig. 6b

6.2 – DISTRACTION USING PLATE AS A DISTRACTOR DEVICE

In this case, once the *plate* is assembled, the *plate contractor/distractor* is used to apply the sufficient distraction for the insertion of filling material **(fig.6c)**
Distraction is maintained by tightening the *plate tightening screws*.

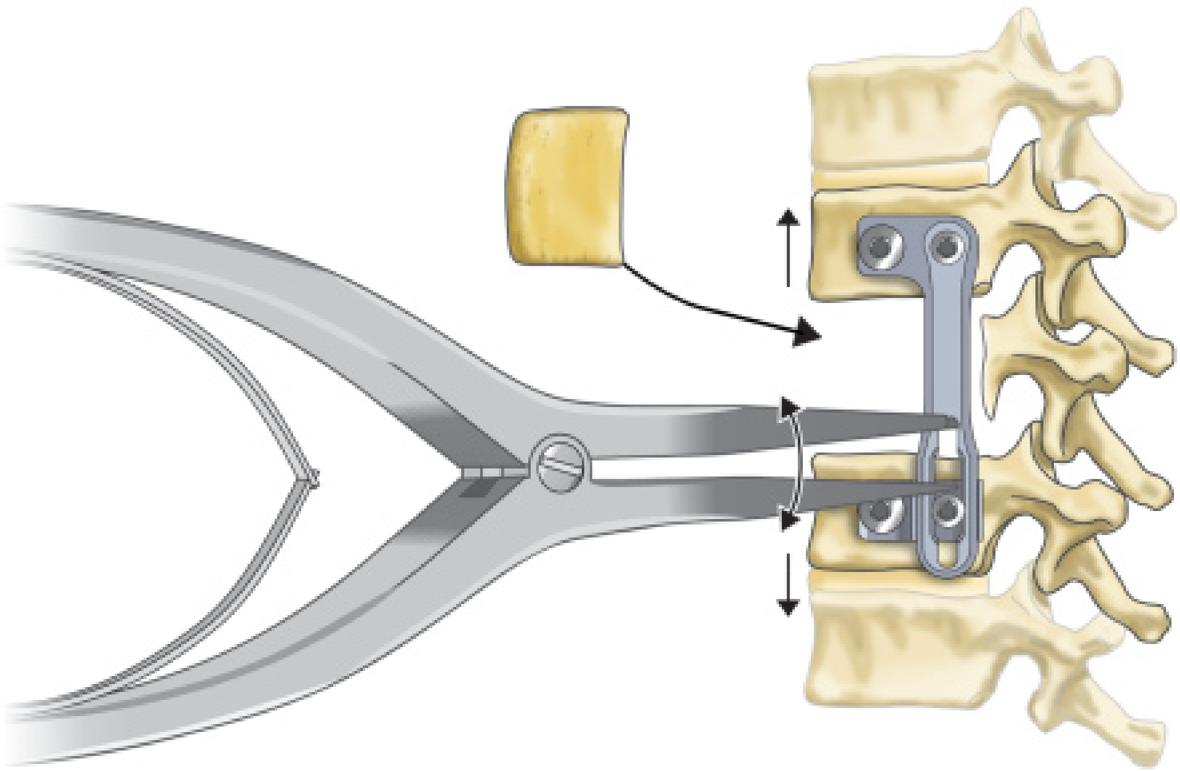


Fig. 6c

Step 7

Compression and final tightening

After graft or corporectomy device is inserted, compression can be carried out by loosening the *tightening screws* and using the *plate distractor-contractor* **(fig. 7a)**

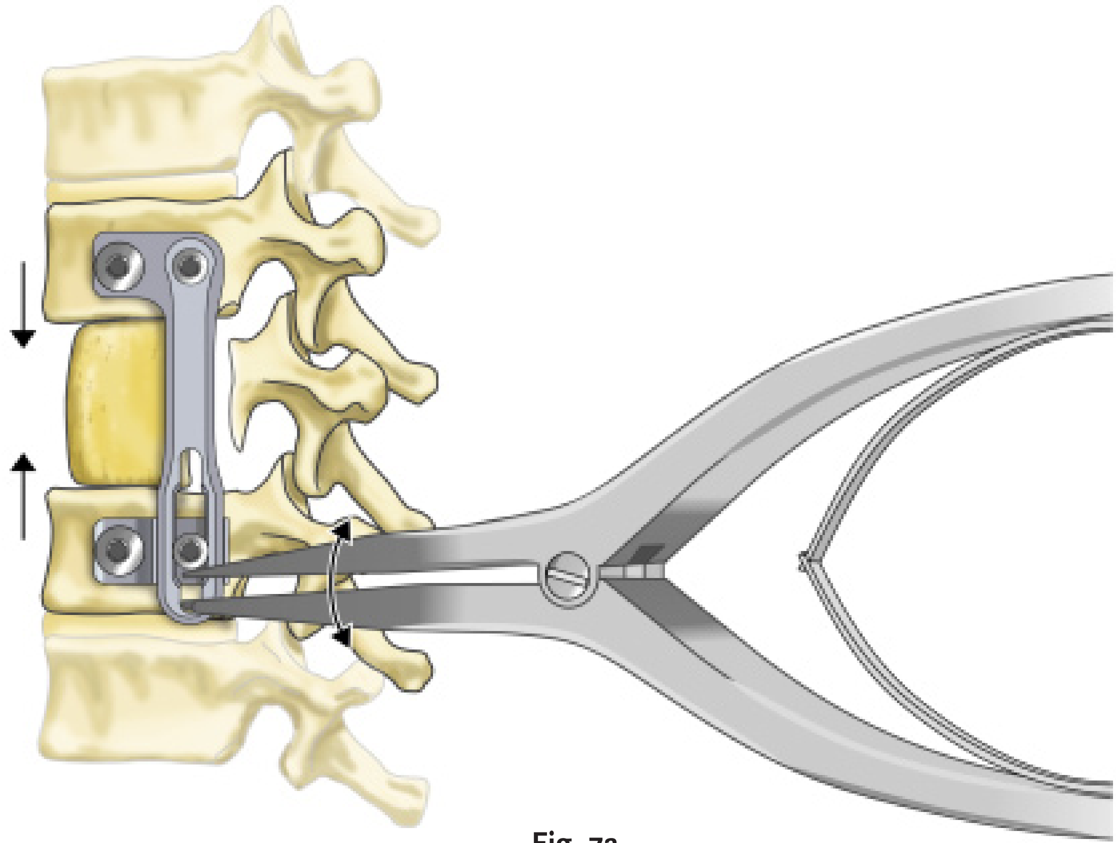


Fig. 7a

Once the compression applied, the construct is tightened using the *tightening screwdriver* on the *tightening screws* **(fig. 7b).**

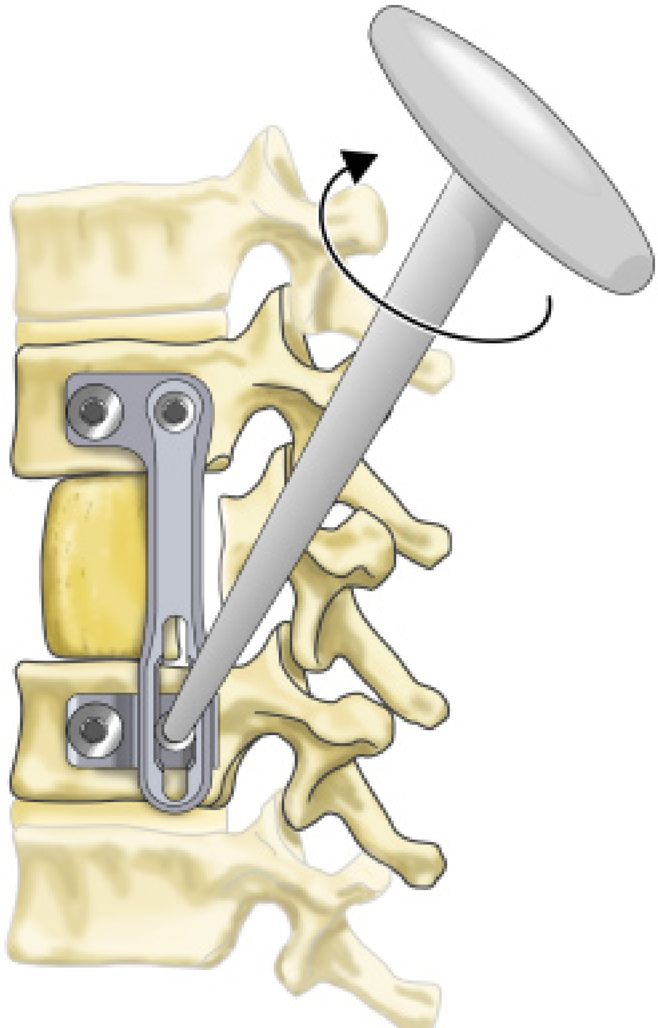


Fig. 7b

Incidents & Solutions

Incident	Cause
It is not possible to install the plate or the plate support onto the main screw.	The main screw is not horizontal. The rib head or an osteophyte may keep the plate from lying flush on the side of the vertebral body.
The long side of the plate is too far from the lateral aspect of the vertebra.	The main screw is not horizontal.
The anterior part of the plate support remains too far from the vertebral body.	The main screw is not horizontal. (anteroposterior direction) The main screw has been inserted too far anteriorly. The radius of the vertebral body curve is less than that of the plate support.
The plate support fits onto the main screw but does not go all the way to the bottom.	The main screw is not horizontal. (anteroposterior direction) The rib head or an osteophyte may keep the plate from lying flush on the side of the vertebral body.
The exposure does not permit proper orientation of the screwdriver for insertion of the main or secondary screw.	
The tightening screw cannot be started into the main screw.	The direction is improper. The tightening screw drags the main screw along with it driving the main screw further into the bone instead of tightening the construct.

Solution

Modify the direction of the main screw.

Use the bone rasp or a bur to flatten out the zone around the main screw.

Modify the direction of the main screw.

Modify the direction of the main screw.

Insert the main screw further back.

Reshape the plate support using, the adjustment forceps.

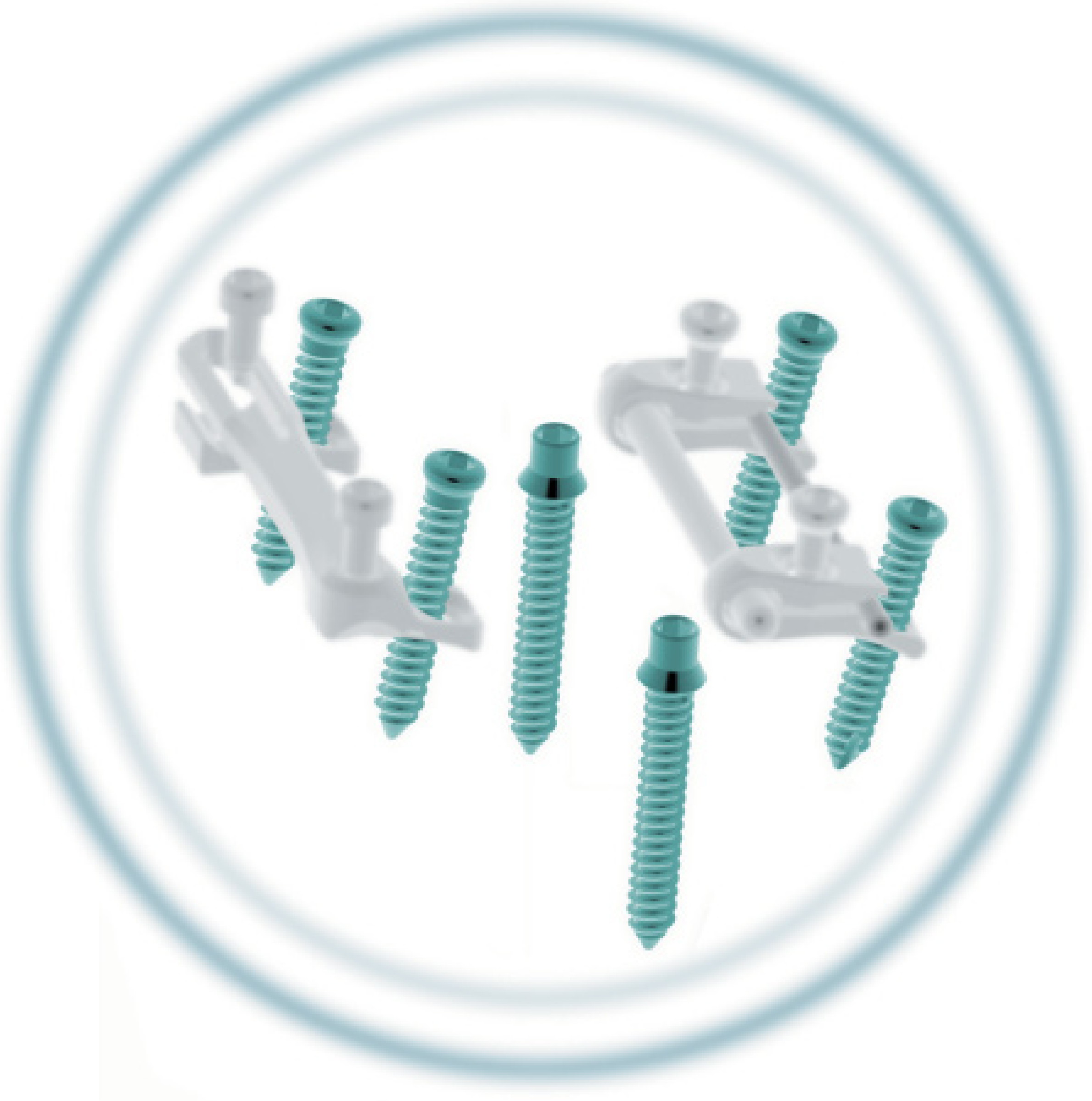
Modify the direction of the main screw.

Use the bone rasp or burr to flatten out the zone around the main screw.

Use the round tip screwdriver which permits a variable angulation of 15°.

Correctly orient the tightening screw before starting it in the main screw.

The plate support or the plate is not flush on the bone around the main screw preventing the construct from being locked. Place them properly before trying to lock the construct.



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