

# Precise guided implantation of pedicle screws by using a K-wire and a "Goniometer" (Awl with protractor)

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## Introduction

The aim of this work is to measure the accuracy of the placement of pedicle screws intraoperatively by using a K-wire together with a Goniometer (awl with integrated protractor).



The pedicle screw entry point marked on the axial CT image is found anatomically intraoperatively.



Through lateral fluoroscopy the direction of the pedicle direction is determined.



The predetermined pedicle screw entry angle is reproduced intraoperatively by using a Goniometer.

## Material und methods

420 consecutive patients (218 men, 202 women) with fractures, inflammation and tumors in the spine underwent a dorsal Spondylosis with an internal fixation during the period from January 2003 to December 2014 at the Department of Neurosurgery of the hospital Plau am See. The average age of patients was 58.2 years (range: from 14 till 83 years). 41 patients were fused at the thoracic level, 300 patients in the thoracolumbar transition region and 79 patients at the lumbar region. The localization of the instrumentation ranged from thoracic vertebrae 2 to sacral vertebrae 1. 2552 Screws were placed in the vertebrae by using a "Goniometer" and a K-wire. In 202 patients 4 pedicle screws were implanted and in 218 patients 8.

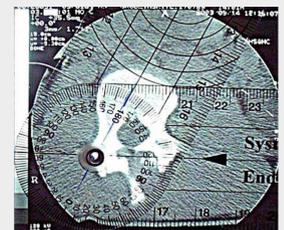
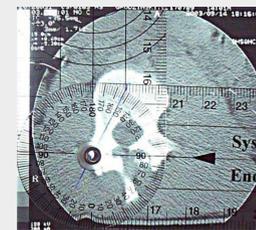
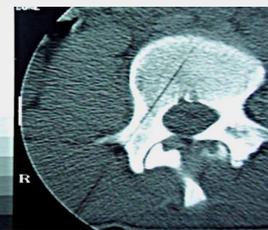


The Goniometer is a cannulated awl with integrated protractor. By using the pointed end of the awl, a channel on the pedicle into the vertebral body is drilled at the predetermined angle. The awl has an integrated angle scale, which shows the angle between the main body of the awl and the vertical axis by means of a pendulum. When the awl is inclined laterally, the pendulum is moved through the scale following the gravity.

## Pre-surgery management

In the following part will be described the placement of pedicle screws at the lumbar vertebrae 3 as an example of the pre-surgery management. The CT images with the biggest pedicle cross sections are chosen. The entry point of the pedicle screw is drawn on the axial CT image.

The angle of inclination of the pedicle screw to follow is measured by a conventional protractor and documented. In this case, the angle for the lumbar vertebrae at the right side is 28 °.



## Surgery technique

The operation takes place in a prone position, held under control by the lateral projection of the image converter. Over a short access cut the pedicle is exposed in order to be instrumented.

A long K-wire is placed through the goniometer into the vertebral body and then the goniometer is removed.



A tap is inserted over the K-wire and the thread is cutted. The pedicle screw is introduced through the K-wire into the vertebral body.

The screw entry point marked on the axial CT image is found anatomically. The entry point together with the pedicle direction shown in the lateral fluoroscopy and the predetermined inclination angle of the screws, allows a three-dimensional unique and safe approach. With these information the pedicle is drilled with the goniometer and the screw is introduced over the K-wire into the pedicle



Tapping

Pedicle screw insertion

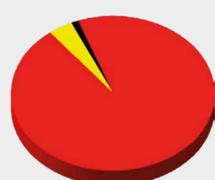


Diagram  
• central  
• decentralized  
• malposition

### Chart

Evaluation of the screw position by using awl with integrated protractor and K-wire

Screw position	central	decentralized	malposition
„No. of Screws (n=2552)“	2468	76	8
„Percentage (%)“	96,7	3	0,3

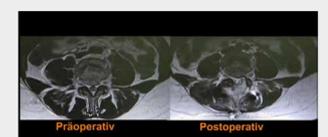
## Results

From January 2003 to December 2014 420 patients were treated with posterior spinal fusion in the neurosurgical department of the hospital Plau am See. A total of 2552 pedicle screws were inserted into the pedicle using the Goniometer and K-wire. Postoperative computed tomographic control proved that 96.7% of the screws were medially placed. 3% of the placed screws presented a slight medial deviation without invading the cortical wall of the pedicle (less than 2mm). Eight screws (0.3%) had to be corrected after the postoperative CT control. No intraoperative complications such as vascular or nerve injuries could be detected. By one of 420 patients occurred a postoperative wound infection.

No patient showed surgery related postoperative neurological or functional deterioration.

## Discussion

The awl with integrated protractor in conjunction with the K-wire has become the regular surgery technic for dorsal instrumentation from unstable thoracolumbar spine injuries as well as in inflammatory and tumorous spinal disorders at the neurosurgical department of the hospital Plau am See. Especially with irregular anatomical conditions such as in dislocated spinal injuries or scoliosis, the pedicle screw angle of inclination on the CT image can defer within a vertebral body at the left and right pedicle. By using the Goniometer it can be intraoperative accurately predetermined the variation in the screw inclination angle. The accurate position of the determined angle is maintained by using a K-wire in order to guide de Screw and so minimize the risk of screw malposition. The malposition of eight screws in this study could be due to an intraoperative misidentification of the screw access point on the CT image. All this patients presented difficult anatomical conditions.



Intraoperative X-rays

Postoperative CT-control of screw position