Article

The influence of torsion of the spine on techniques of facet joint blocks without help of visualization

Studencnik Georg (1), Ebner Franz (2), Studencnik Fritz (2), Feigl Georg (3)

(1) Department of Trauma Surgery, LKH Hochsteiermark, Bruck an der Mur, Austria
(2) Department of Radiology, Medical University of Graz, Austria
(3) Institute of Anatomy, Medical University of Graz, Austria

ABSTRACT

AIM: The facet joint block is a common procedure in treating and diagnosing facet joint pain usually performed with or without optical guidance. Especially the uncontrolled methods are not well investigated with respect to the precision of the needle's positioning in patients with scoliosis. METHODS: X-rays from 49 patients with different levels of scoliosis were analyzed retrospectively by measuring the Cobb angle. Subsequently, the patients were arranged in three groups with a rising Cobb angle. Furthermore, the position of the lumbar spine was determined based on computerized tomography (CT) data, aiming for a three dimensional model of the lumbar spine. With this it became possible to calculate the spatial position and rotations around the anatomical axis of specific vertebras. Afterwards, two uncontrolled facet joint block methods using two different definitions of a fingerbreadth (15 mm, 20 mm) were simulated and the point of injection on the skin was identified using vector analysis. The radial distances between a predefined ideal injection point at the lower joint space and the injection points obtained by both methods were measured and correlated with the groups of different Cobb angles. RESULTS: The mean radial distances between the ideal injection points and the injection points for both methods increased with rising Cobb angles. A maximum radial distance of 31.1 mm from the ideal injection point was observed. CONCLUSION: Rising Cobb angle leads to higher risk of incorrect positioning of the needlepoint. This inaccuracy may be responsible for further complications.

KEYWORDS: uncontrolled facet joint block; scoliosis; lumbar back pain

Correspondence to: Dr. Georg Studencnik, Abt. f. Unfallchirurgie LKH Hochsteiermark, Tragösserstraße 1, 8600 Bruck a. d. Mur, e-mail: georg_studencnik@hotmail.com, tel.: 0043 66488301100

Date received: August 10th 2017
Date accepted: September 11th 2017

INTRODUCTION

Scoliosis is a common medical condition with prevalence of 8.3% (1) which represents a curved spine from side to side as well as rotations of the vertebra around the three anatomical axes. These deformities of the human spine change the topographic anatomic conditions and the deformed spine is vulnerable to degenerative changes as well. Low back pain is a common symptom which is often caused by degeneration of the facet joints. Therefore, the facet joint injections or the medial branch blocks are, on the one hand, diagnostic tools to verify the origin of the pain and, on the other hand, an important option for pain treatment in the case of verified facet joint syndrome. Especially the diagnostic facet joint injection is the gold standard to diagnose facet joint syndrome which was investigated by large number of studies (2–5). In diagnostic settings, optical guidance is essential for reaching confident diagnosis. In the case of pain treatment methods with optical guidance, as well as methods without optical verification of the accurate placement of the needle, are in use. In terms of preventing the patient from high exposure to radiation are facet joint injections

DOI: 10.5281/zenodo.1161779

or medial branch blocks without optical guidance a common procedure. Otherwise, the usage is more expensive and many doctors' practices are lacking fluoroscopy and computer tomography so that they are not able to offer patients optical guided facet joint block methods.

The aim of this study is to investigate the effect of scoliosis on the accuracy of facet joint blocks without optical guidance. Therefore, we simulated two common methods in neural therapy of fact joint block without optical guidance (6,7) on the CT data of 49 patients with different levels of scoliosis and measured the accuracy of these techniques. The accuracy is not only important for effective pain treatment, but especially with regard to complications caused by a false needle's placement, it should be as important as a successful pain treatment.

MATERIALS AND METHODS

This study was reviewed and confirmed by the ethic committee of the medical university of Graz which is registered by the office of human research protection from the United States Department of Health & Human Service. (Eknr: 25-519 ex 12/13). The search of appropriate patients was performed by the Institute for medical Informatics, Statistics and Documentation from the Medical University of Graz. We searched retrospectively for adult patients who were under medical treatment at the University Hospital of Graz between years 2008 and 2013. The search included all patients irrespective of race and sex with documented lumbar scoliosis and having X-ray of the spine and computerized tomography of the lumbar spine performed in the past. This retrospective search identified 25 male and 24 female patients who had no operations on the spine before the lumbar spine computerized tomography was performed. Because of the situation that in clinical settings not every computer tomography of the lumbar spine includes every segment of the lumbar spine our sample size was reduced from 125 to 62 male lumbar segments and from 120 to 64 female lumbar segments.

Afterwards, the patients were split into three groups with different levels of scoliosis. Therefore they were differentiating by Cobb angle (8) which is a common classification of the severity of scoliosis. The first group contained all patients with a Cobb angle lesser than 10 degrees which is conformable with the healthy population. The second group included all patients with a Cobb angle between 10 and 20 degrees. The third group contained the patients with a Cobb angle greater than 20 degree. Subsequently for simulating on the patient's CT data the two methods for facet joint block without optical guidance we read out the coordinates of the marks which the doctors would touch for exerting these facet joint blocks. At this point it is necessary to explain these two methods exactly. In both methods the patient is in ventral position or in a sitting position exerting a humpback. If doctors operate the first method (6) they touch the spinous process of the inferior vertebra concerning the facet joint which should be blocked. Afterwards they change the position of the needle one breadth of a finger cranial and two centimeter lateral of the spinous process and puncture in a sagittal way perpendicular to the skin till they reach resistance to the bone. If they use the second method (7) they touched the inferior spinous process regarding the facet joint which should be blocked as well as the superior spinous process regarding this facet joint. Afterwards for determining the ideal point of puncture the facet joint they measure the central point between the superior and the inferior spinous process and change the position from this central point one breadth of a finger lateral to the side of the facet joint which should be blocked. Subsequently they puncture in the same sagittal way perpendicular to the skin till they reach resistance of the bone. Before simulating the two methods we were confronted with a problematic situation. There is no satisfactory information about the breadth of a finger in the common literature. The only available description of the breadth of a finger was from Webster N. (1830) (9) who defined it with ¾ inch. In terms of that not everybody breadth of

Table 1. Variants of the different methods with different breadths of a finger.

	Facet joint block method	Breadth of a finger
Variant 1a (Var1a)	Tilscher (2007)	15 mm
Variant 1b (Var1b)	Tilscher (2007)	20 mm
Variant 2a (Var2a)	Weinschenk (2012)	15 mm
Variant 2b (Var2b)	Weinschenk (2012)	20 mm

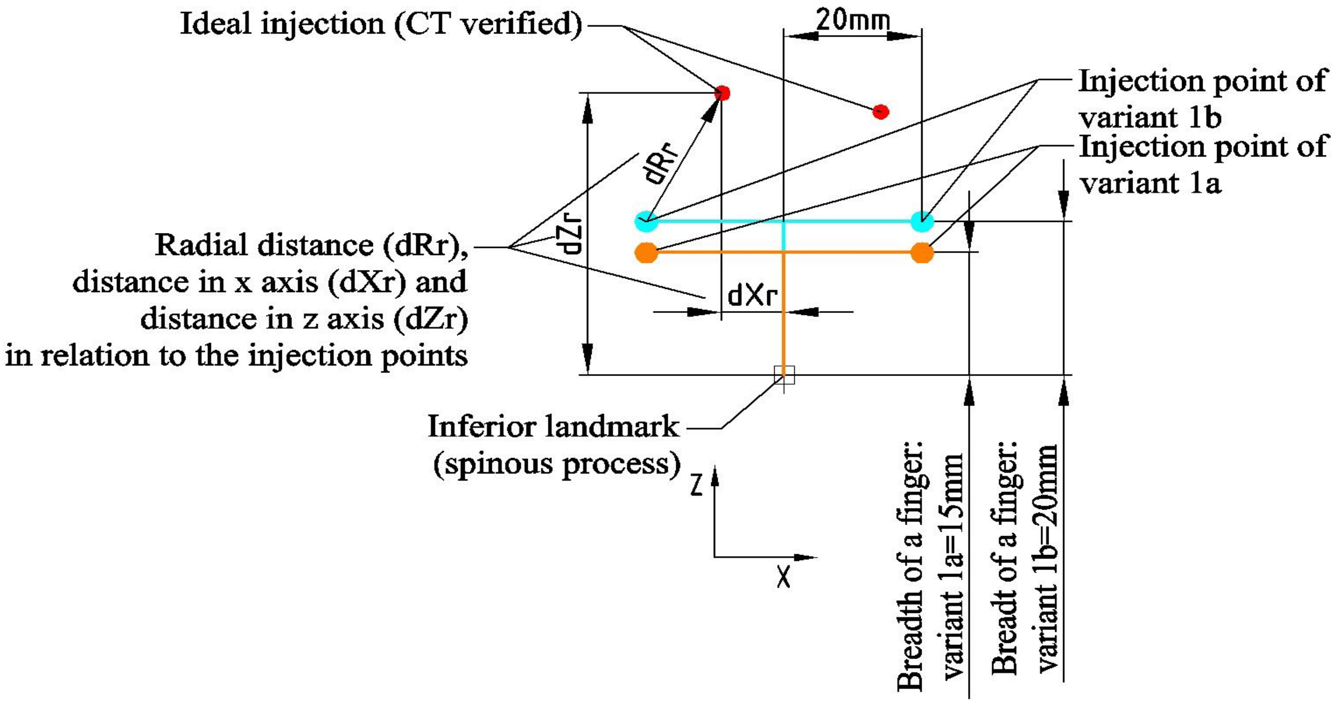

Figure 1. Projection of the points on a coronal plane from the CT image of variant 1a and 1b.

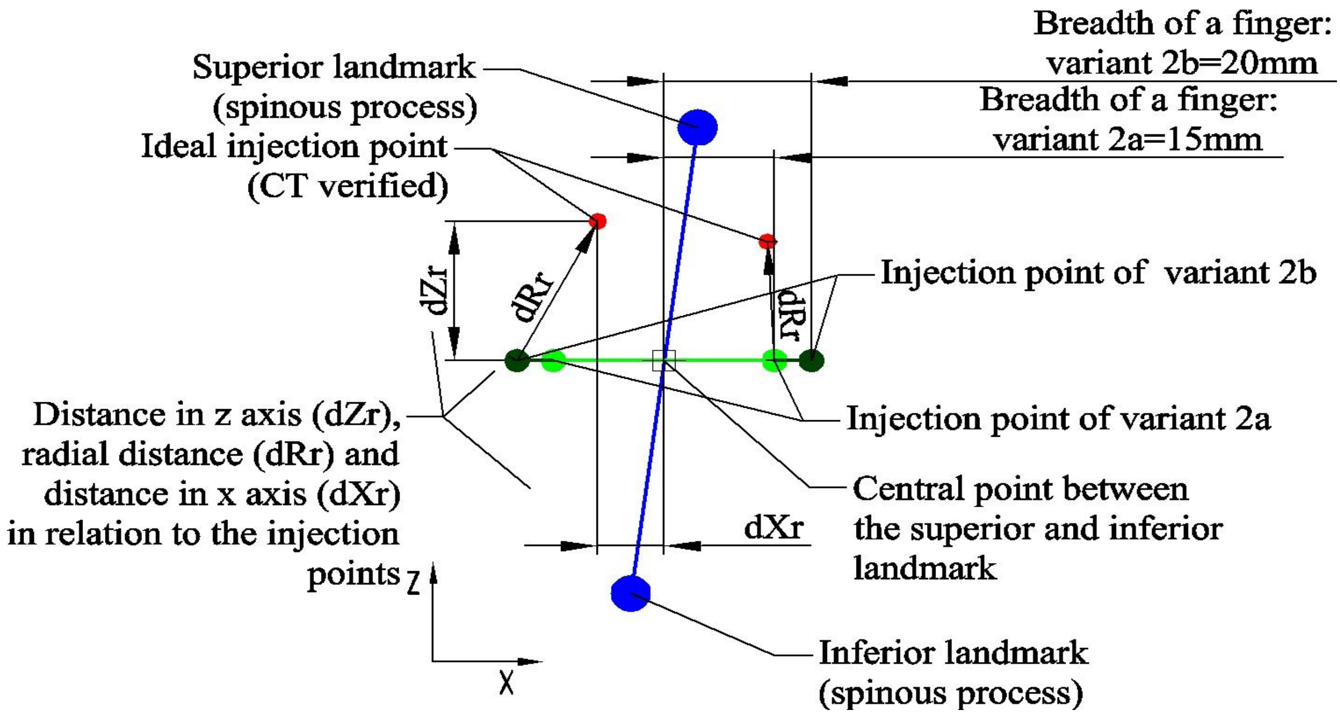

Figure 2. Projection of the points on a coronal plane from the CT image of variant 2a and 2b.

finger would be ¾ inch we decided to simulate these two methods with two different definitions of the breadth of a finger (Table 1). We defined the breadth of large a finger with 20 millimeters and for a small finger with 15 millimeters.

For simulating these two methods we read out on the one hand the coordinates in all axes of the point which doctor are going to touch for processing these two techniques and on the other hand the coordinates of the ideal point of injection. The coordinates of the point where doctors are going to touch the spinous process was defined as the point of the spinous process which we could see first in the coronal view of the CT data if we scrolled from the back to the front. The ideal point of placement of the needle's point was defined exactly as the point of the inferior recesses of the facet joint when we were able to see the complete inferior joint space in the axial

Table 2. Mathematical formulas used for calculations.

$dRr = \sqrt{[\text{finger}(20\text{ mm}) - dXr]^2 + dZr^2}$
$dRl = \sqrt{[\text{finger}(20\text{ mm}) - dXl]^2 + dZl^2}$
Variant 1: Tilscher 2007
$dXr[mm] = \text{inferior landmark } sag(x)[mm] - \text{CT verified injection point right } sag(x)[mm]$
$dZr[mm] = \text{CT verified injection point right } ax(z)[mm] - \text{inferior landmark } ax(z)[mm]$
$dXl[mm] = \text{CT verified injection point left } sag(x)[mm] - \text{inferior landmark } sag(x)[mm]$
$dZl[mm] = \text{CT verified injection point left } ax(z)[mm] - \text{inferior landmark } ax(z)[mm]$
Variant 1a: Tilscher 2007 (Breadth of a finger=15 mm)
$dRr = \sqrt{[\text{fixed distance}(20\text{mm}) - dXr]^2 + [dZr - \text{finger}(15\text{mm})]^2}$
$dRl = \sqrt{[\text{fixed distance}(20\text{mm}) - dXl]^2 + [dZl - \text{finger}(15\text{mm})]^2}$
Variant 1b: Tilscher 2007 (Breadth of a finger =20 mm)
$dRr = \sqrt{[\text{fixed distance}(20\text{mm}) - dXr]^2 + [dZr - \text{finger}(20\text{mm})]^2}$
$dRl = \sqrt{[\text{fixed distance}(20\text{mm}) - dXl]^2 + [dZl - \text{finger}(20\text{mm})]^2}$
Variant 2:Weinschenk 2012
$\text{central point } sag(x) = \frac{\text{superior landmark } sag(x)[mm] + \text{inferior landmark } sag(x)[mm]}{2}$
$\text{central point } sag(z) = \frac{\text{superior landmark } ax(z)[mm] + \text{inferior landmark } ax(z)[mm]}{2}$
$dXr[mm] = \text{central point } sag(x) - \text{CT verified injection point right } sag(x)[[mm]$
$dZr[mm] = \text{CT verified injection point right } ax(z)[mm] - \text{central point } ax(z)[mm]$
$dXl[mm] = \text{CT verified injection point left } sag(x)[mm] - \text{central point } sag(x)[mm]$
$dZl[mm] = \text{CT verified injection point left } ax(z)[mm] - \text{central point } ax(z)[mm]$
Variant 2a:Weinschenk 2012 (Breadth of a finger=15 mm)
$dRr = \sqrt{[\text{finger}(15\text{ mm}) - dXr]^2 + dZr^2}$
$dRl = \sqrt{[\text{finger}(15\text{ mm}) - dXl]^2 + dZl^2}$
Variant 2b: Weinschenk 2012 (Breadth of a finger=20 mm)
$dRr = \sqrt{[\text{finger}(20\text{ mm}) - dXr]^2 + dZr^2}$
$dRl = \sqrt{[\text{finger}(20\text{ mm}) - dXl]^2 + dZl^2}$

view the first time. All measuring points were checked in sagittal, coronal and axial view. Subsequently we collect the coordinates and simulate the two methods with using vector analyses to get knowledge about the accuracy of the two methods and differences between the three groups with different severity of scoliosis.

Therefore, we measured the radial distances between the point of injection of the two different methods on the skin and the point on the skin which physicians have to choose if they want to reach the ideal point for a successful facet joint block. Figures 1 and 2 represent the sketches of the two techniques and the associated mathematical formulas (Table 2).

After simulating the two methods we perform a descriptive statistics of our results using IBM SPSS Statistics.

RESULTS

In terms of the demographic characteristics of our study we were able to collect the CT data of 24 male patients and 25 female patients. Because of the situation that in case of clinical routine not every lumbar CT scan includes all lumbar segments the number of lumbar segments we tested decreased from 196 to 126 lumbar segments. With respect to the sexes we had 62 male und 64 female lumbar segments for our investigation.

The measurement of Cobb angles results 24 patients with a Cobb angle lesser than 10 degree, 17 patients with a Cobb angle between 10 and 20 degree and 8 patients with a Cobb angle greater than 20 degree.

First of all we investigated both sexes separately to look for specific differences (Figure 3). We couldn't find any distinctive gender related differences. In both sexes we determine that regardless of which method has been chosen the groups with higher Cobb angle have larger mean radial distances to the ideal point of injection than the group with Cobb angle lesser than 10 degree.

It seems that in case of rising Cobb angle the mean radial distance increase. Therefore we were able to detect a maximum radial distance of 31.1 mm with the use of Tilscher's method and fingerbreadth of 20 mm.

In respect of the different methods and the different definitions of the breadth of a finger we determined that variant 1b (Tilscher, fingerbreadth=20 mm) is almost certainly the worst option and variant 2b (Weinschenk, fingerbreadth=20 mm) the best one. In contrast to that variant 1a (Tilscher, fingerbreadth=15 mm) differed rarely from variant 2a (Weinschenk, Fingerbreadth=15 mm).

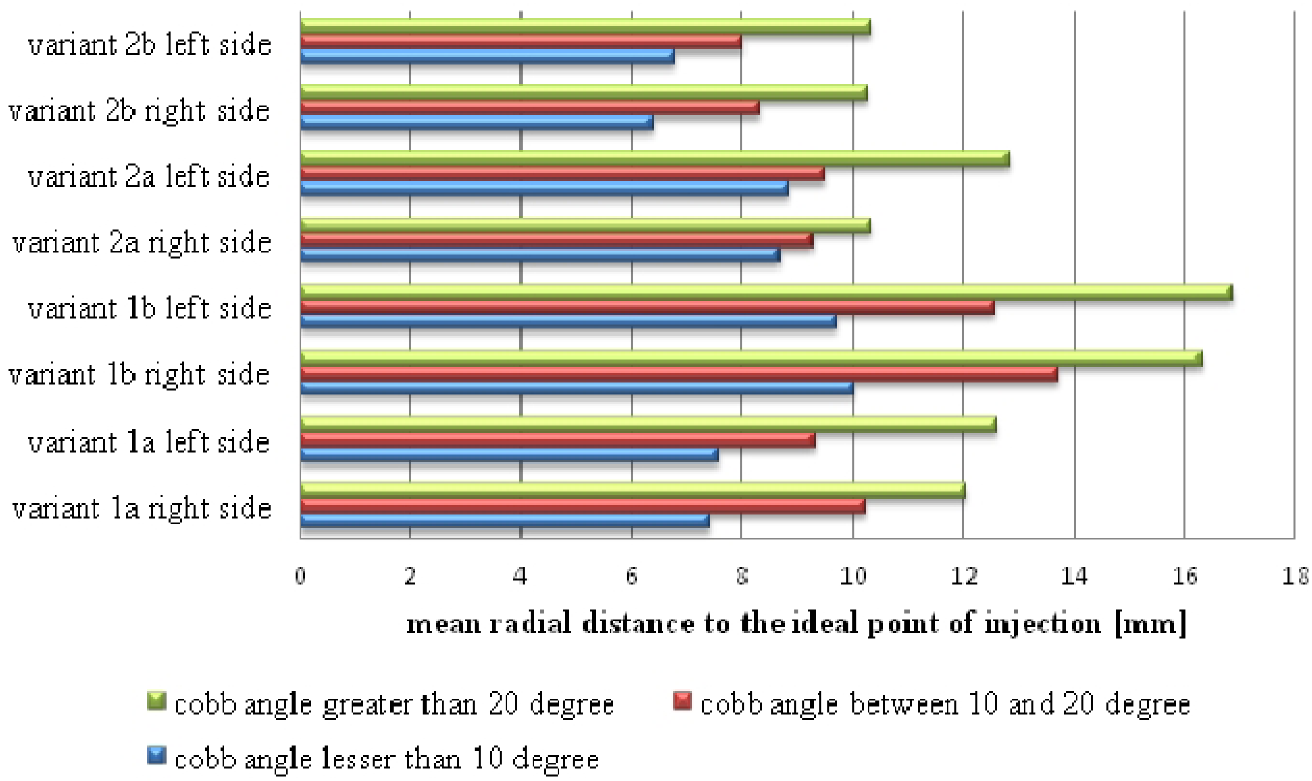

Figure 3. Severity of scoliosis scale (both sexes).

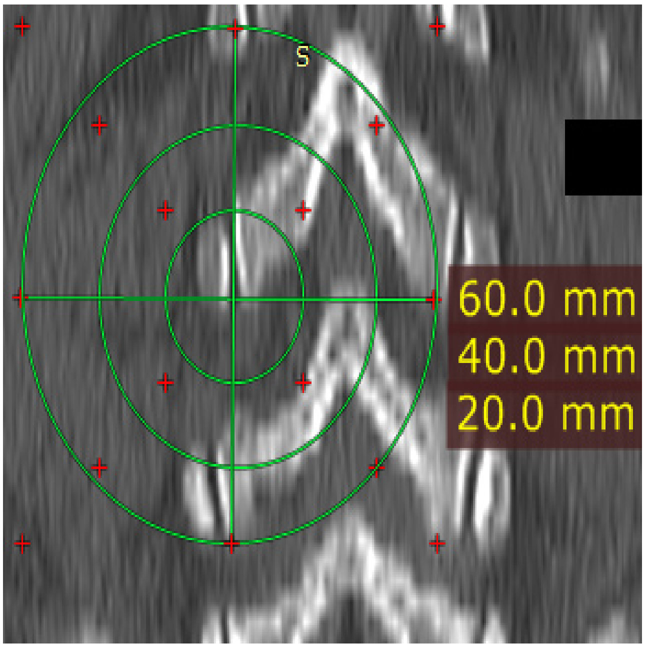

Figure 4. Possible points of injection with rising inaccuracy.

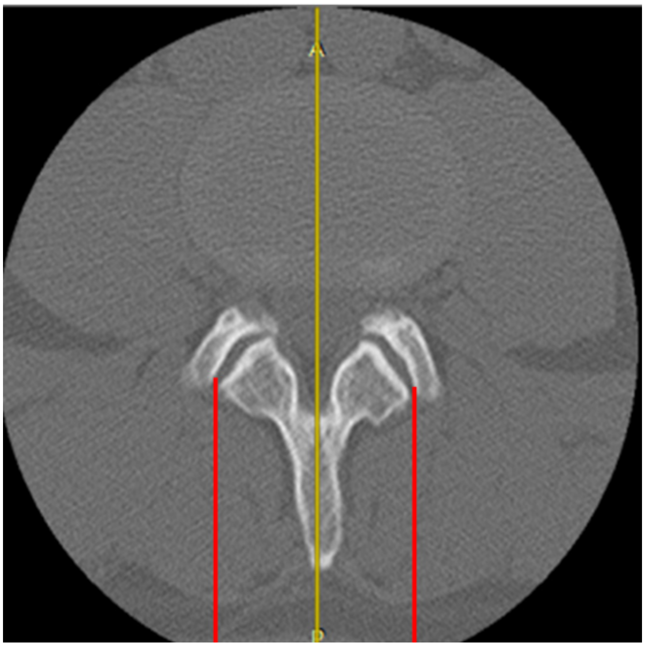

Figure 5. Common vertebra.

DISCUSSION

The aim of this study was to investigate the effect of scoliosis on the accuracy of facet joint block without help of any visualization systems. Therefore we searched for studies with respect to this topic and were really surprised that the current and previous literature contains only studies about the effectiveness of facet joint block with guidance of fluoroscopy, ultrasound or CT in great quantities. So we were not able to compare our result with the results of other studies.

Our findings show clearly that there are essential differences with respect to the accuracy of facet block between patients with different levels of scoliosis. We know that there are some important limitations in our study. First of all the CT data of the patients were operated in clinical routine while the patient was in dorsal position. If physicians perform facet joint blocks the patient will be in face-down position.

Furthermore, because of the situation that we strictly simulated these two methods with use of vector analyses we were not able to simulate the subjective practical experience of the physicians who used these techniques of faced joint block.

Another limitation was that in reality physicians won't be able to touch the top of the spinous process in that exact way as we could define the landmarks with the use of CT data. Especially in case of obese patients it may is difficult to touch exactly the landmarks. Windisch et al. already identified this problem while examine the accuracy of Tuffier's line (10).

In fact the facet joint block is a common procedure of pain treatment for lumbar back pain caused by the facet joints. In case of scoliosis the inaccuracy of the needles positioning rise in such a way that nobody is able to guarantee a safe and effectiveness therapeutic injection.

In our study we measured mean radial distances to the ideal point of injection between 7 mm and 17 mm. In one case we were able to detect a radial distance of 31.1 mm. Such a distance allows a wide range of possible injection points.

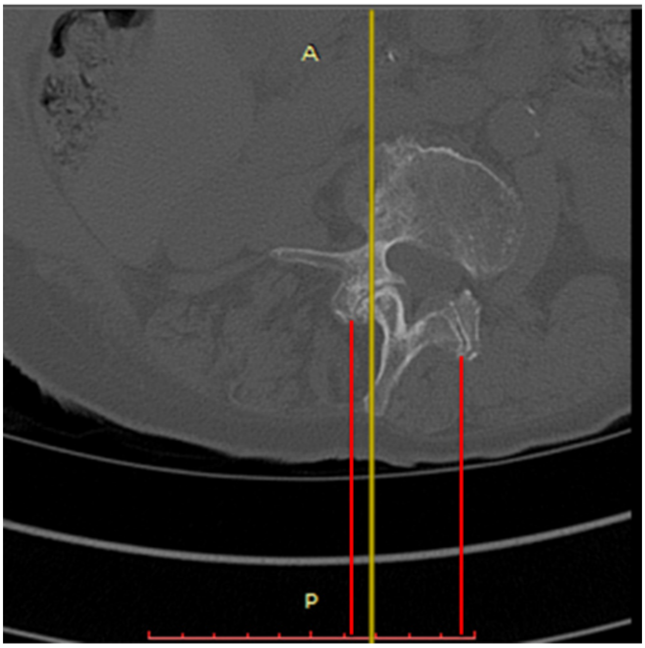

Figure 6. Twisted vertebra.

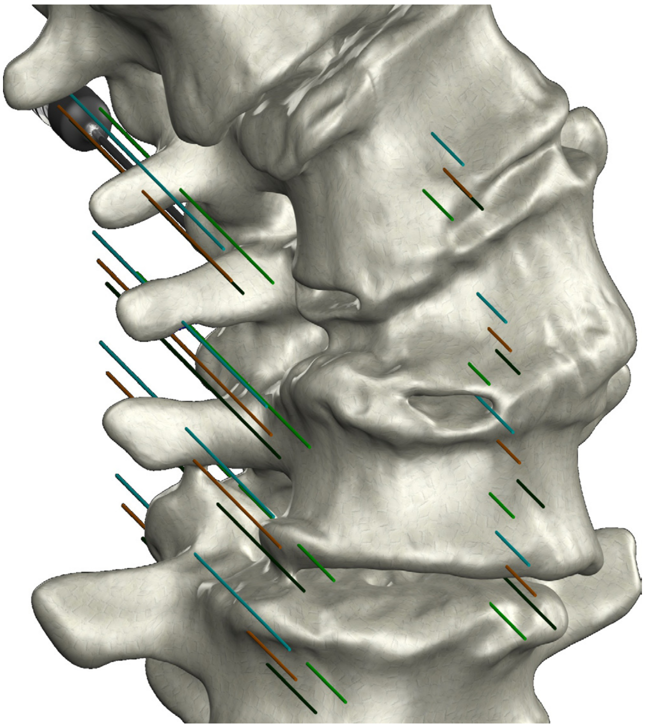

Figure 8. Lumbar spine with scoliosis.

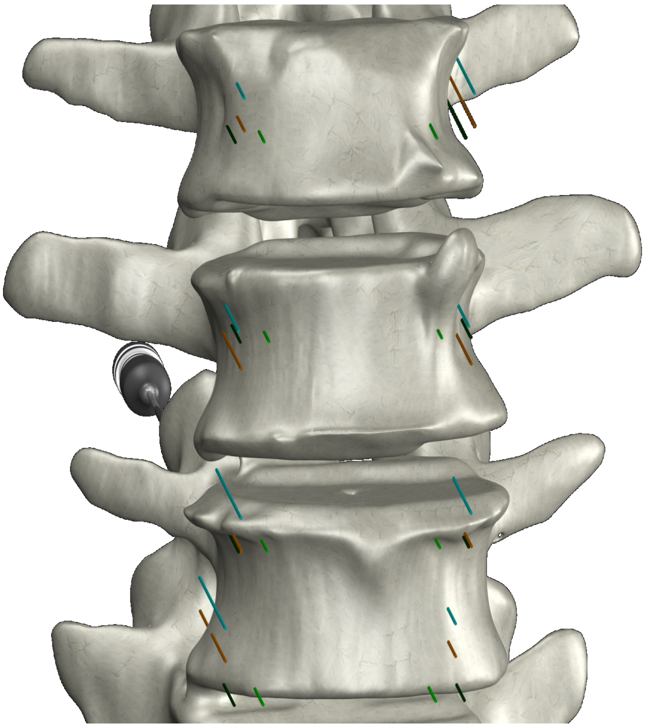

Figure 7. Common lumbar spine.

The following picture shows a lumbar facet joint in coronal view. We added with the software RadiAnt Dicom Viewer circles with a diameter of 20 mm, 40 mm and 60 mm to the picture for better appreciation of the inaccuracy.

The area of possible injection points increased enormously with rising diameter and includes vulnerable anatomical areas such as the intervertebral foramen lateral of the facet joint or the posterior ligaments of the lumbar spine at the medial side. Injection in these areas could be responsible for complication and ineffective facet joint blocks.

Figures 5-8 show two cases. On the one hand a lumbar spine with a Cobb angle lesser than 10 degree and on the other hand a lumbar spine with a Cobb angle higher than 20 degree. We simulated the methods on both spine and made a model with the CT data of the patients. It becomes apparent that there are enormous differences between the accuracy of the two spines.

Furthermore, there are huge differences with respect to the points of injection between the left and ride side on the model with a Cobb angle higher than 20 degrees.

The causal relationship of the differences between the sides and the level of scoliosis is that scoliosis is not only a curvature of the spine in frontal plane. It is a three-dimensional problem which includes rotations of the vertebra around the three anatomical axes.

CONCLUSION

Rising Cobb angle leads to higher risk of incorrect positioning of the needlepoint. This inaccuracy may be responsible for further complications. Especially injection to far medial could be responsible for dura lesions or injections into the subarachnoid area.

Injection to far lateral could lead the needle to the region of the intervertebral foramen and the spinal nerve. In order to secure patients with scoliosis from complications, methods of facet joint block without help of visualization should not used uncritically.

We are of the opinion that further investigations are necessary to research safety and effectiveness of facet joint block procedures without help of visualization systems.

REFERENCES

1. Carter OD, Haynes SG. Prevalence rates for scoliosis in US adults: results from the first National Health and Nutrition Examination Survey. Int J Epidemiol. 1987; 16(4): 537–544.
2. Mooney V, Robertson J. The facet syndrome. Clin Orthop Relat Res. 1976; (115): 149–156.
3. Carrera GF. Lumbar facet joint injection in low back pain and sciatica: description of technique. Radiology. 1980; 137(3): 661–664. doi: 10.1148/radiology.137.3.6449716.
4. Sehgal N, Shah RV, McKenzie-Brown AM, Everett CR. Diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: a systematic review of evidence. Pain Physician. 2005; 8(2): 211–224.
5. Fritz J, Niemeyer T, Clasen S, Wiskirchen J, Tepe G, Kastler B, Nagele T, Konig CW, Claussen CD, Pereira PL. Management of chronic low back pain: rationales, principles, and targets of

imaging-guided spinal injections. Radiographics. 2007; 27(6): 1751–1771. doi: 10.1148/rg.276065509.

6. Tilscher H, Eder M. Infiltrationstherapie Therapeutische Lokalanästhesie. 4th ed. Maudrich: Vienna, 2007.
7. Weinschenk S, Kupke T. Handbuch der Neuraltherapie. Elsevier, 2011.
8. Cobb J. The American Academy of orthopedic surgeons instructional course lectures. Edwards, Ann Arbor, 1948.
9. Webster N. An American Dictionary of the English language: Exhibiting the origin, orthography, pronunciation, and definition of words. 3rd ed. S. Converse: New York, 1980.
10. Windisch G, Ulz H, Feigl G. Reliability of Tuffier's line evaluated on cadaver specimens. Surg Radiol Anat. 2009; 31(8): 627–630. doi: 10.1007/s00276-009-0493-z.