Digital anatomical position of the “point” in cervical vertebra fixed-point rotatory technique**★**

Yuan Yuan-xing[1], Wan Lei[2], Li Yi-kai[3], Chen Jing[3]

Abstract

BACKGROUND: Although the fixed-point cervical vertebra rotating reduction has a notable treatment effect, yet it has not been deeply studied in the medical field. Some clinical surgeons feel difficult to make an accurate control on the power and rotatory joint position while operating, even results in iatrogenic injury.

OBJECTIVE: To discuss the action mechanism of rotatory technique based on the central rotatory point of cervical vertebra fixed-point rotatory technique.

METHODS: Samples were scanned through a 64-row spiral CT working platform at 1-mm layer distance. The picture’s profilogram data were extracted from the image processing functional module in PHILIPS MEDICAL SYSTEMS, and then the three-dimensional structure of the upper cervical vertebra was reconstructed and displayed. Taking the axis spinous process peak (point A), odontoid process vertical axes (point B), and the midpoint (point C) of their link as the rotating axes (the rotating central point in simulation), spherical system on each point was set up. The intersection angle of the links between the axis’ spinous process peak and the lower jaw, and between the odontoid process vertical axes and the lower jaw before and after rotation were all measured.

RESULTS AND CONCLUSION: While applying fixed-point rotation of the cervical spine, the rotatory centre is the vertical axle center of the odontoid process, rather than the handy axis spinous process peak. The rotatory angle of the axle centre is larger than the observation angle. A new concept of fixed-axis rotation should be accepted and its principle should be comprehended in order to appropriately apply the cervical rotatory technique.

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INTRODUCTION

In the 1970s, Feng has innovatively proposed the cervical spine rotatory technique in buckling position, including the fixed-point cervical vertebra rotating reposition technique[1-2]. Then various kinds of cervical spine rotatory techniques appear, clinical application indications also increase, and many massage schools innovate, which all enrich and develop the rotatory technique. However, these newly-appeared techniques are all about cervical spine rotation and are basically the same as Feng’s fixed-point cervical vertebra rotating reposition technique. Although fixed-point cervical vertebra rotating reposition technique has a notable treatment effect, yet it has not been deeply studied in the medical field. For example, where is the exact anatomical position of that “fixed-point”? What’s its space relation with those abnormal anatomical positions such as spinous process and small joint? How does the maximum pull or draw power at handedness has an effect on the fixed-point? In general, when there is a clicking sound, the operation should be stopped or the angle of rotatory should not be enlarged. But how to judge whether the angel is suitable? The medical field has not have explanations to the above questions yet[3-4]. Therefore, some doctors feel difficult to make an accurate control on the power and rotatory joint position while operating, this uncertainty sometimes even results in iatrogenic injury.

This research is to investigate the mechanism underlying fixed-point cervical spine rotatory technique. It is based on series studies of cervical spine rotatory technique[5-10]. Using computerized three-dimensional (3D) reconstruction techniques, it is able to make an analog simulation of fixed-point cervical vertebra rotatory on a spinous process malposition corpse specimen. The anatomical position on the 3D models was directly judged and calculated after rotation.

MATERIALS AND METHODS

Design

A measurement of medical image at 3D simulation design.

Time and setting

The experiments were performed from June 2007 to June 2010 at Anatomy Department, Southern Medical University, China.

Materials

A cervical vertebra specimen (C_{0-4}) was taken from a male adult corpse. CT-scan confirmed axis spinous process malposition (the peak points towards 5 o’clock position) and excluded other anatomical abnormality. The parenchyma such as muscle was eliminated. Cervical vertebra ligament and joint capsule of each segment were retained. Then the specimens were embed and fixed.

Methods

Establishment of cervical vertebra 3D models

Specimens were scanned through a 64-row spiral CT working platform, at 1 mm layer distance. The images were preprocessed with spiral CT platform to remove the false image of the embedded metal base. The scan outcome was saved as DICOM grey scale image (Figure 1). The picture’s profilogram data were extracted from the image processing functional module in PHILIPS MEDICAL SYSTEMS, and then

3D structure of the upper cervical vertebra was reconstructed and displayed.

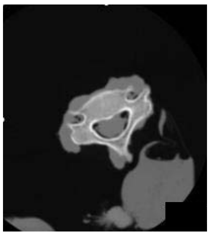


Figure 1 CT plain film of spinous processes deviation of axis

Analog simulation of cervical vertebra fixed-point rotatory technique

This experiment is facilitated with P4 3.0 GHz hyper-threading CPU, 1GDDR533 random access memory and 6800GT double 128MPCIE accelerated graphics card, operated through the powerful image processing module in PHILIPS MEDICAL SYSTEMS. It can exclude other bone models except for the atlantoaxial model, to directly observe and judge the relative change of anatomical position during the atlantoaxial Rotation. This experiment takes the axis spinous process peak (point A), odontoid process vertical axes (point B), and the midpoint (point C) of their link as the rotating axes (the rotating central point in simulation), then spherical system on each point was set up. The atlas kept rotating around each original point on the horizontal plane with ROTATE operation and Boolean calculation. The image outcomes from different rotating points were observed and collected.

Main outcome measures

(1) Link between the axis’ spinous process peak and the lower jaw before rotatory and after rotatory, the intersection angle of these two link lines; (2) Link between the odontoid process vertical axes and the lower jaw before rotatory and after rotatory, the intersection angle of these two link lines.

RESULTS

Comparison of the outcomes after cervical vertebra fixed-point rotation around different original points

After the fixed rotation around different original points, the outcomes are shown in Figure 2 (point A), Figure 3 (point B) and Figure 4 (point C). Comparison of these images found that, the fixed rotation centering both point A and point C would be bogged down soon after a small-angle (less than 15°) rotation, because the atlas lateral mass is obstructed by odontoid process. Due to the atlantoaxial subluxation, a decrease of vertebral canal volume can be observed from the vertical position of axle. This indicated that the spinal tissues may be under pressure. Unlike point A and point C rotation, point B fixed rotation works well: spinous process malposition recovers well, the vertebral canal is clear and unobstructed at the vertical position of axle. This showed no hint of spinal cord pressure caused by bone.

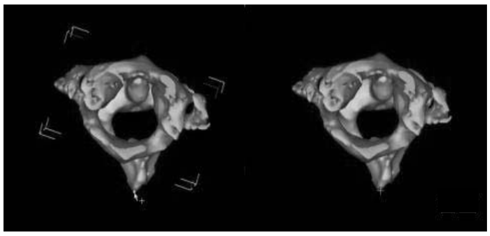


Figure 2 Comparison of the rotation based on spinnacle of axis spinous process

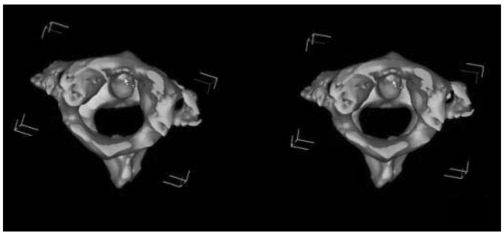


Figure 3 Comparison of the rotation based on the point of odontoid process center

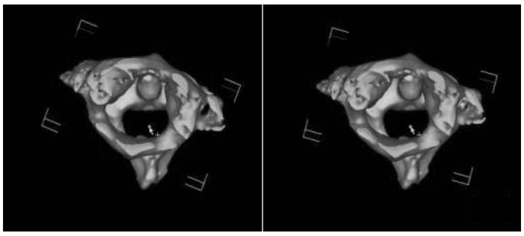


Figure 4 Comparison of the rotation based on midpoint of axis spinous process and odontoid process center

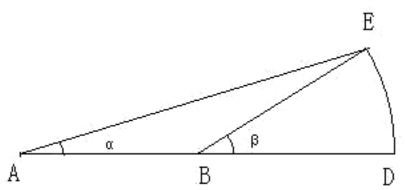
DISCUSSION

Determination and clinical significance of 3D anatomical position of the fixed-point rotatory central point

Since Feng’s first introduction to the cervical spine rotatory technique in the 1970s, many rotatory techniques have been developed based on it and gained wide clinical application. However, looking into various medical documents, there is little discussion on the key element, the exact “point” of fixed rotation. The study of the “point” has not been brought to the forefront. As to this “point”, even Feng himself does not have a detailed explanation on its dimensional anatomical position and its clinical significance. Usually the study and application of this technique are based on a vague concept. Some doctors even take the handy application point, that is, the lower cervical vertebra spinous process peak, as the origin rotatory point (compulsive rotatory point) and narrowly operate on the patient. Such operation achieves poor effect, even it may lead to iatrogenic injury[11-14]. This experiment compared the outcomes based on different original rotatory points and came to a conclusion: the odontoid process vertical axes central point is the right rotatory central point. This confirmation of 3D anatomical position has the following clinical significance: the odontoid process vertical axes central point is also the rotatory axle centre of normal atlantoaxial complex, this is not a coincidence. No matter which kind of rotatory technique is applied, it should apply to the abnormal position according to the natural physiological law and make the best use of the circumstances. The treatment couldn’t be achieved through violating the body mechanism. It follows that, as to different cervical vertebra segments, the fixed rotatory central points should fall on their normal physiological rotatory axes central point.

The correlation between the operator’s observation angle and the real axis rotatory angle

While applying the atlantoaxial fixed-point rotatory technique, the operators should use a thumb to hold out against the axis spinous process peak, and the other hand to hold the patient’s lower jaw (there will be different positions according to the operation requirement). Link between the axis spinous process peak and the lower jaw before and after rotation (AD, AE) was observed, then the intersection angle of these two link lines was measured. This angle is the observation angle (angle α), its angular dimension can be measured by eyes. Link between the odontoid process vertical axes and the lower jaw before and after rotation (BD=BE=R) was observed, then the intersection angle of these two link lines was measured. This angle is the axes rotatory angle (angle β), it can not be observed by the operators (Figure 5). According to the triangle principle, angle β is always larger than angle α, this reminds the operator not to rely on the observation angle, to avoid the risk of over rotatory. Their relation can be seen from the following equations:



A: Spinnacle of axis spinous process; B: Odontoid process center; D: Submaxilla before rotatory; E: Submaxilla after rotatory; α: The angle observed; β: The angle of rotation

Figure 5 Schematic layout of atlantoaxial rotatory

Equation 1: $AE^2=(AD-R)^2+R^{2}-2g(AD-R)gRg\cos(\pi-\beta)$

Equation 2: $\sin\alpha/\sin(\pi-\beta)=R/AE$

A discussion on the action mechanism underlying cervical vertebra fixed-point rotatory

Using the fixed-point rotatory technique to treat cervical vertebra disease, it is generally acknowledged that its possible mechanisms are as followed: to set correct the malposed spinous process and to release the incarceration of facet joint, so that the spinous process returns to its normal anatomical or compensatory position, and the vertebral column reconstructs its interior and exterior balance[15-21]. These will relieve or eliminate the stimulation, pressure and stretch to relative tissues, improve circulation and clear up aseptic inflammation, and then the clinical symptom is relieved or eliminated[15-21].

This hypothesis reflects the general understanding to the mechanism underlying cervical vertebra fixed-point rotatory technique. However, many details still remain unclear, related studies and demonstrations are insufficient. Now, based on the outcome of this experiment and series studies of cervical vertebra rotatory techniques, two conclusions can be made as follows. (1) Both the handy points and the thumb’s push-and-pull power have their clinical significance: Generally, cervical vertebra rotates once at each of the left and the right, to resume the normal arrangement order of the cervical vertebra spinous process. No matter handy thumb or unhandy thumb, their application point is the same, so they can both be called handy application point. Although the push-and-pull power is significantly different between handy thumb and unhandy thumb (P < 0.05)[6], their mechanism are both to stabilize the rotatory central point *via* application of a force. Using the thumb to push the spinous process, the maximum power of the left thumb is 4.727±1.037 kg and that right thumb is 6.420±1.329 kg. Statistical analysis showed that, there was no direct relationship between the push-and-pull power and the clicking sound. According to this experiment, the thumb’s push-and-pull power is aimed not to make the cervical vertebra spinous process return to its normal position by force. Actually it is the rotated upper vertebral body and the muscle soft tissues that generate pressure to the rotatory axes, and this pressure passes through the hypostasis vertebral body, so it needs the thumb’s push-and-pull power to work against it. (2) The correlation of clicking sound with the resetting of abnormal spinous process and facet joint: Clinically, the clicking sound is a message indicating that the application should be stopped. It is thought that the clicking sound shows the rotatory angle has come to an extreme. In this experiment, the cervical vertebra always rotated around the physiological rotatory centre. This centre is corresponding in space to the pending abnormal spinous process and facet joint, that is, the resetting of spinous process and facet joint should be operated around the physiological rotatory centre[22-30]. Only then the spinous process can return to its normal position, the facet joint incarceration can be resolved, and the resetting clicking sound appears. If the rotatory centre has been shifted, the resetting clicking sound will not appear. According to previous experiments, there are many other causes accounted for the appearance of clicking sound, therefore the converse negative proposition of this conclusion is not identically true.

The concept, principle and clinical significance of fixed-axle rotatory technique

Based on the above discussions, we propose a concept of cervical vertebra fixed-axle rotatory technique. In accordance with the bio-dynamics principle, cervical vertebra rotation is a complicated coupling movement. Inside this movement, there must exist a line (or the false extension) that is stock-still[12-20]. The “point” in the fixed-point rotatory theory is simply the intersection point between instant rotatory axis and two-dimensional plane. Therefore, the fixed axle rotatory is more scientific than the fixed-point rotatory in illustrating the anatomical features and operation key points. It has three principles: Firstly, the rotation should be applied around the physiological rotatory axis. Secondly, the resetting depends on the rotatory angle, not the power dimension. Thirdly, the observation angle is smaller than the axis rotatory angle, so the operator should establish an axis-based thinking pattern. Clinically, the cervical vertebra fixed-axel rotatory technique is not a singular specific technique, it is a new thinking pattern based on cervical vertebra rotatory and vertebral column rotatory technique. Moreover, it should also coordinate with other kinds of rotatory techniques. Its general application mechanism is to relax muscle tissue (together with other techniques), to stabilize the physiological rotatory axis (work on the application point to stabilize the axle), and to restore the body to normal anatomical position by rotating (depends on angle). Because the observation angle is smaller than the axis rotatory angle, when making judgment on the treatment effect, the operator should be very careful not to extend the angle blindly to avoid any iatrogenic injury. The cervical vertebra fixed axel rotatory principles lay emphasis on the operator’s anatomic and bio-dynamic knowledge and requires the operator to master the rotatory axis of different kinds of rotatory techniques. Thus, the principles have covered the clinical operating key points of various rotatory techniques. Before operation, the operator should establish in mind a hypothetical axis going through the patient’s rotating segments, observe and make judgement according to the axis rotating angle. Working along with other rotatory techniques, further studies on the fixed axel rotatory technique may make up the drawback of them.

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颈椎定点旋转手法“点”的数字化解剖*★

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摘要

背景：虽然颈椎定点旋转复位手法效果显著，但其机制一直缺乏深入的研究。临床上对所要实施的推拿力和旋转节段无法做到精确控制，有时会造成手法的医源性损伤。

目的：从颈椎定点旋转手法旋转中心点的角度分析旋转手法的作用途径。

方法：在 64 排螺旋 CT 工作平台扫描标本，层距 1 mm。在 PHILIPS MEDICAL SYSTEMS 图像处理功能模块中提取图片中轮廓线数据，进行上颈椎三维结构重建和图像显示。取枢椎棘突顶点(A 点)、齿突垂直轴心(B 点)以及两者之间连线的中点(C 点)为旋转轴心(模拟中的旋转中心点)，分别以各点为原点建立球坐标系。观察枢椎棘突顶点与下颌尖旋转前后的连线夹角，以及齿突垂直轴心与下颌尖旋转前后的连线夹角。

结果与结论：做定点手法旋转时其中心并非是施术者利手作用的枢椎棘突顶点，而是枢椎齿突垂直轴心；实际轴心旋转角>术者观察角。提示应建立颈椎定轴旋转的新概念，并掌握颈椎定轴旋转手法的原则，以指导临床正确应用脊柱旋转类手法。

关键词：颈椎；定轴旋转；手法；复位；三维重建

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来自本文课题的更多信息--

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作者贡献：实验设计者为万磊，实施者为袁元杏、陈静，评估者为李义凯；手法操作均经过正规培训，采用双盲法评估。

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伦理批准：实验按临床医学伦理标准实施。

本文创新性：2011-04 以“fixed axle rotatory technique”检索 PUBMED 数据库，未检索到相关文献。20 世纪 70 年代冯天有创新性地提出了在屈曲位下的脊柱旋转手法，虽然颈椎定点旋转复位手法治疗效果显著，但是学界对于其一直缺乏深入的研究。文章对颈椎定点旋转手法进行仿真模拟，在三维模型上直接对旋转后解剖位置的变化进行判断和计算，以此探讨颈椎定点旋转手法的作用机制，并提出了颈椎定轴旋转手法的概念。创新性特点：①提出了 fixed axle rotatory technique 手法。②得出了术者观察角与实际轴心旋转角的关系。③总结颈椎定轴旋转手法的原则及临床意义。