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Case Report

Effect of transcorporeal percutaneous endoscopic cervical discectomy on vertebral integrity

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Abstract: Objective: This study aimed to investigate the effect of transcorporeal percutaneous endoscopic cervical discectomy (TcPECD) for cervical spondylosis on vertebral integrity and potential complications due to bone defects by 3-D computed tomography (CT). Background: TcPECD can cause bone defects when a surgeon establishes a working channel in the vertebral body. The surgeon ensures surgical safety and improves surgical outcomes according to learning about potential surgical risks, such as the position of working channel, the site and degree of bone defects, the reasons of bleeding in vertebral body, and so on. Method: 1. The preoperative and postoperative VAS (visual analogue score), JOA (Japanese Orthopedics Association) score, muscle strength, and other characteristics of a patient with myeloid cervical spondylosis treated through TcPECD were evaluated 2. The CT of cervical vertebra before surgery and 3 days after surgery was examined, and the 3-D CT image was reconstructed. The location of bony passages, the location and degree of bone defects, the CT bone mineral density of each part of vertebral body, the location of foramina nutricium of venae basivertebrales were observed. Possible complications were analyzed. 3. We made a cylindrical guide with the diameter of the bone channel of the patient, simulated channel establishment, determined the channel position of the maximum reduction of bone defect, and then reached the objective of the operation. Result: 1. VAS score of the left upper limb: preoperative 7 points and postoperative 3 points, JOA score: preoperative 12 points and postoperative 15 points, and muscle strength of left upper limb: preoperative grade III and postoperative grade IV. 2. The columnar osseous channel with a diameter of 3.3 mm was from the left front to the upper left of the vertebral body of C6. The longest defect of the vertebral upper endplate was 7.87 mm, and the widest defect was 7.09 mm. The linear distance of the defect of apophyseal ring was 6.43 mm. The CT bone density in the junctional zone between the posterior part of the processus hamularis and apophyseal ring was the highest (1649.64 Hu). The vertebral vein plexus vallecula was located in the central region of the vertebral body. The bone loss (128.29 mm^3) of bone channel in patients was lower than those of the other parts of 3-D CT simulation. Conclusion: 1. TcPECD caused the bone defect of the vertebral body and might lead to the destruction of the lateral part of the upper endplate and the apophyseal ring.

Keywords: Cervical spondylopathy, anterior cervical approach, endoscope, 3-D CT, safety

Introduction

Combined with preoperative planning of 3-D CT, establishment of working channel near the affected side could lead to the following: reduction of the loss of bone mass and the destruction of the bone trabecular under the endplate; reduction of the narrowing of intervertebral space and the possibility of vertebra collapse; and long-term effect. 2. Free intervertebral disc herniation behind the vertebra and underneath the diseased intervertebral space was another appropriate indication of TcPECD. 3. Reduction or avoidance of injury to the vertebral venous sinus and the internal vertebral plexus in the central area of paries posterior of the vertebral body was necessary to avoid internal hemorrhage of the vertebral body during the operation and hematoma after the operation.

TcPECD [1-7], which establishes a working channel [8, 9] in the vertebral body to reach the prominent intervertebral disc and to decompress the spinal canal, is one of the minimally invasive methods used for the treatment of cervical spondylosis. However, this operation [10,

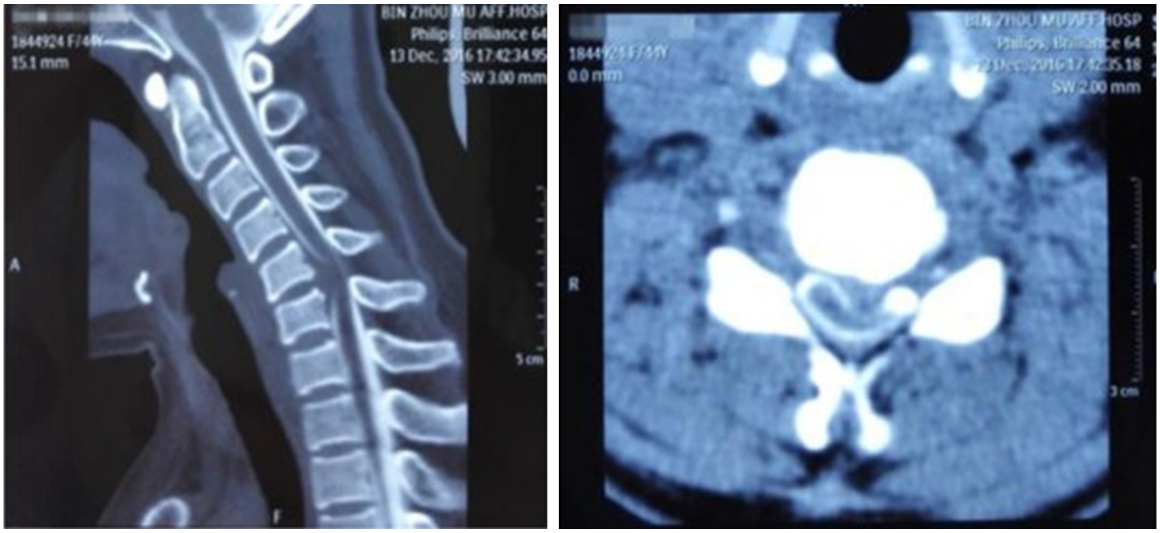

Figure 1. Preoperative CTM.

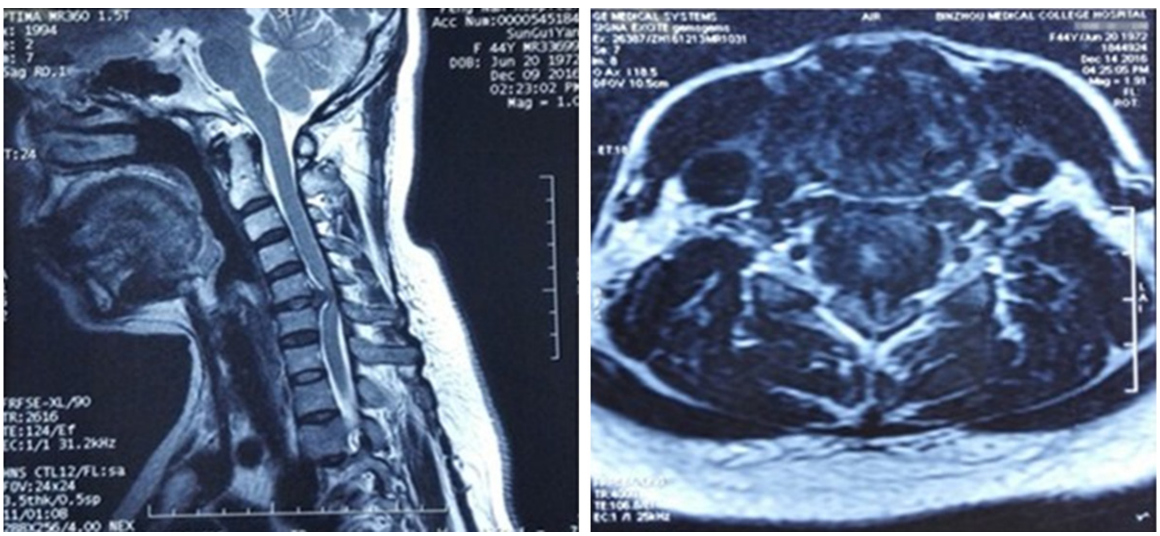

Figure 2. Preoperative MR.

11] inevitably leads to bone defect in the vertebral body. The location, degree, and potential complications of bone defects have not been thoroughly explored. This paper is based on a patient of cervical spondylotic myelopathy with TcPECD in our hospital. We observed the surgical path and the changes of the morphological structure of the vertebrae intuitively and omnidirectionally. We assessed the effect of bone defects on the integrity of the vertebral body and found a more reasonable channel position to ensure the safety and efficacy of the operation. The complications of the 3-D CT method were avoided.

Case report

A 44-year-old female patient complained of persistent blunt pain in her left upper limb and numbness and weakness in her arms and legs with no apparent cause in less than 8 months. The symptoms became more serious after activity and fatigue, and no relief was felt by the patient after rest. Thus, she went to a local hospital for a cervical magnetic resonance imaging examination, which revealed C5/C6 disc herniation and compression of dura mater spinalis. She was treated using a conservative treatment, such as acupuncture, and the symptoms

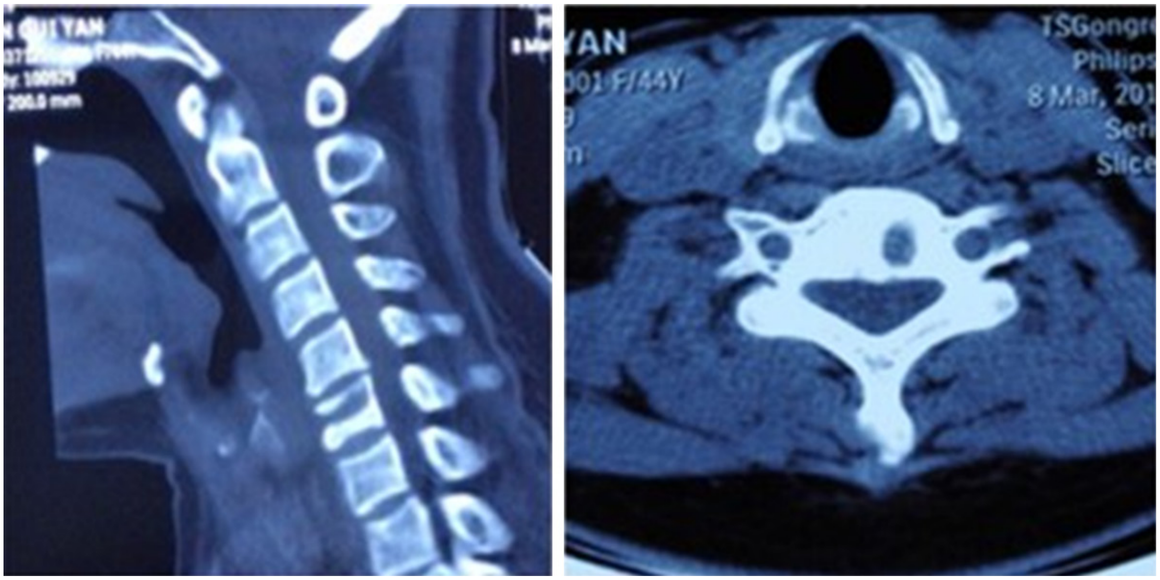

Figure 3. Postoperative CT.

were relieved. The pain of the left upper limb became more serious with left limb weakness and difficulty in walking in 7 days. Physical examination: The interspinous and paravertebral muscles were tender. The activity of cervical vertebra was limited in all directions. The feeling of the left thumb and index finger decreased. The muscle strength of the left brachial biceps and triceps was grade III. The right upper limbs were grade IV. The legs were grade IV. The Biceps and triceps reflex of arms were sthenia, and the knee and ankle reflex were active. The left Hoffmann sign (+), Babinski sign (+), Eaton sign (+), and Spurling sign (+). The VAS score of the left upper limb was 7, and the JOA score was 12 before the operation.

All laboratory tests showed no abnormality. The positive and lateral X-ray film of cervical vertebra showed degeneration of cervical vertebra. The CTM (scanning thickness was 0.625 mm) showed cervical kyphosis, and the C5/C6 intervertebral disc protruded toward left and rear and oppressed endorachis. The sagittal diameter of the corresponding horizontal vertebral canal was less than 10 mm. The MRI showed that the C5/C6 intervertebral disc protruded to the left and rear and oppressed the endorachis, the spinal canal stenosis at the same level, the compression of cervical spinal cord, and the T2 hyperlipidemia signal in the local cervical spinal cord (**Figures 1** and **2**).

TcPECD was planned after the doctor spoke with the patient and her family. After successful anesthesia, in the cervical neutral position, a transverse incision of about 0.6 cm at about 2 cm was made on the left side of the midline of the anterior cervical line (blunt separation). The positioning guide pin was inserted into the vertebral body of C6, and the puncture angle was adjusted. The operation confirmed that the transverse incision was located in the anterior part of the C6 vertebral body, from the left side to the left upper posterior part of the vertebral body. The frontal position was located on the left side of median deviation below the endplate level of C6 and the lateral position pointed to the upper edge of the vertebral body of C6. A needle expansion pipe was inserted into the vertebral body along the direction of the guide needle. The position of the vertebral body channel was marked with a bone wax marker stained by methylene blue. The work cannula expanded the soft tissue to the anterior wall of the vertebral body of the C6 step by step. Work annular tubes (8 mm in diameter) were installed, and the vertebral body of C6 was explored through endoscopy. The vertebral body of C6 working channel was established by a power drill, and a partial bone of the posterior wall of the vertebral body was cut off by a power drill and miniaturized bone nippers. The posterior mediastinum was exposed, and the nucleus pulposus of the intervertebral disc of C5/C6

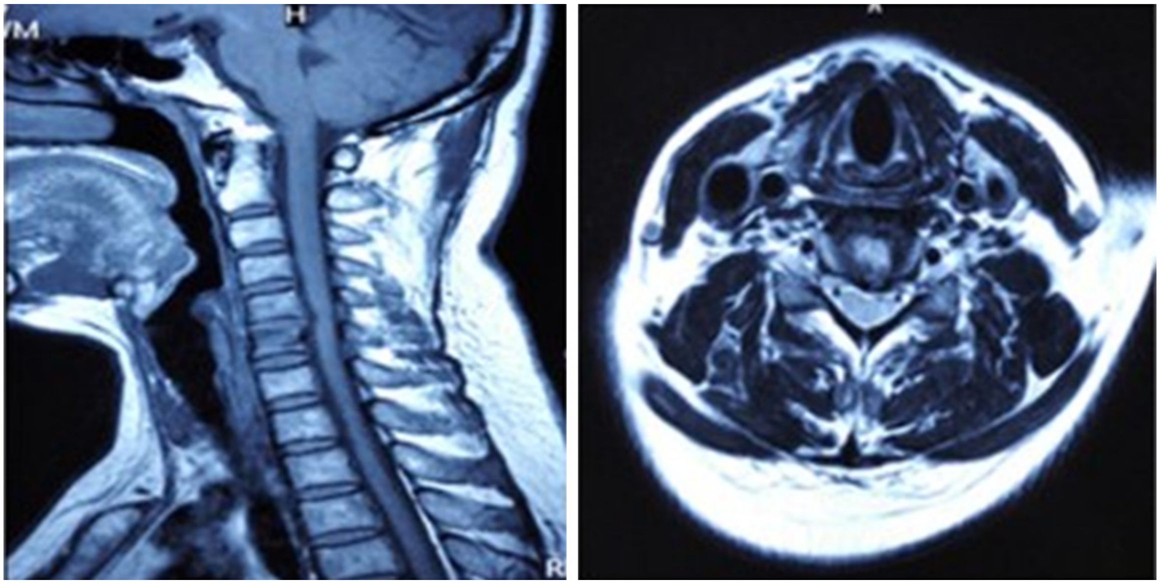

Figure 4. Postoperative MR.

was apparently removed. The left C6 nerve root and dura mater spinalis were oppressed. The nucleus pulposus was removed, and the spinal canal was decompressed. At the end of the operation, one drainage tube was retained. Then, the incision was sutured and bandaged by a surgical dressing.

The left upper limb muscle strength was grade IV, and the VAS score of the left upper limb was 3. The JOA score was 15, and the feeling of left thumb and index finger was apparently improved after the operation.

The cervical vertebra was subjected to CT (scanning thickness was 0.625 mm), and MRI examinations were performed 3 days after the operation (**Figures 3** and **4**). We obtained CT Dicom data before and after the operation, and the 3-D CT image of cervical vertebra by Mimics17.0 was reconstructed. The morphological changes of the vertebral body were observed. We made a cylindrical guide whose diameter was the same as that of the bone channel of the patient, and the work channel at different parts of the 3-D CT vertebral body before the operation was established. Loss of bone mass was examined by 3-Matic.

Discussion

Understanding the changes of the shape of the vertebral body and its structure before and after TcPECD by conventional CT and MRI was difficult. 3-D CT observed the shape and structural characteristics of the vertebral body, the location of the work channel, and the location and degree of the bone defects in 3-D space to provide evidence for evaluating the operative effect and to improve the operative method and operative safety.

Change of the morphological structure of cervical vertebra and its clinical significance before and after TcPECD

The 3-D CT showed (**Figure 5**) that the columnar osseous channel whose diameter was 3.3 mm was from the left front to the upper left of the vertebral body of C6. The anterior and posterior windows of the vertebral body were located on the left side of the middle line of the vertebral body. The longest defect of the anterior wall of the vertebral body was 4.8 mm, and its width was 7.80 mm. The longest defect of the posterior wall was 5.35 mm, and its width was 5.18 mm. The longest defect of the vertebral upper endplate was 7.87 mm, and the widest defect was 7.09 mm. The linear distance of the defect of the apophyseal ring was 6.43 mm. The CT bone density in the junctional zone between the posterior part of the processus hamularis and apophyseal ring was the highest (1649.64 Hu). Bone loss was 128.29 mm^3. In addition, bone loss in the vertebral body was the least, i.e., below the median of the vertebral

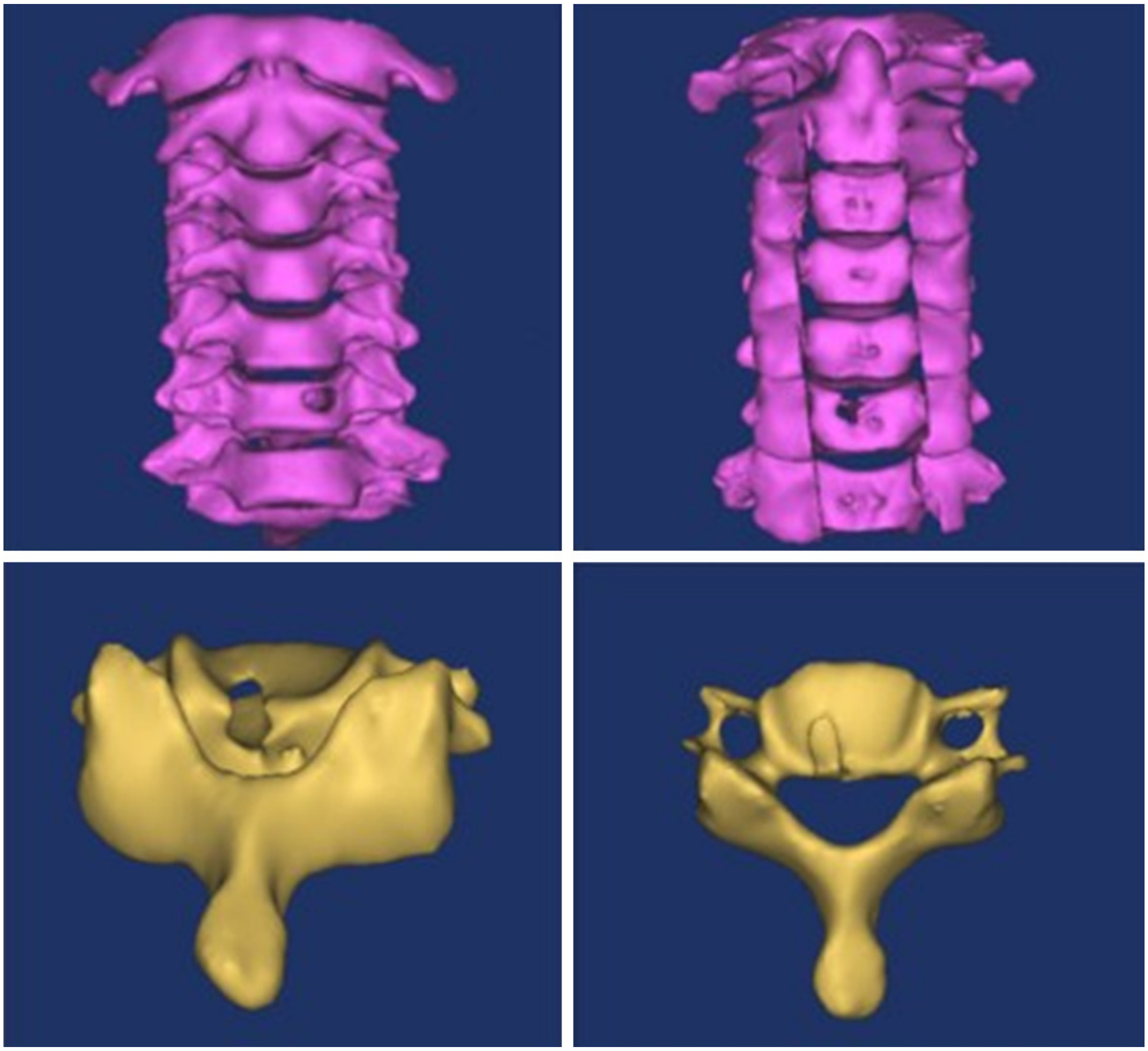

Figure 5. Postoperative the C6 vertebral body.

body (134.80 mm^3) and the contralateral channel (151.82 mm^3). The destruction of the trabecular bone below the endplate was minimal.

Biomechanical study found that endplate integrity was the key to maintain endplate stiffness and mechanical strength [12]. Intact vertebral column, cortical bone, and trabecular structure maintained the strength of the vertebral body. High strength leads to stronger compressive capacity. Pertinent literature [13] proved that cutting off the endplate could reduce the local stiffness and strength of the vertebral body, and the stiffness could decrease by more than 50% if the defect of the endplate was more than 2 mm. Foreign scholars [14] believed that the posterolateral area of the endplate was the strongest area for anti-settling capacity. The integrity of the trabecular bone below the endplate provided a significant stress resistance for the elastic changes of the endplate. The work channel in the vertebral body of this patient led to the integrity loss of the upper endplate, the burr ring, the trabeculae of the endplate, and the cortical bone of the anterior and posterior vertebral body. The stiffness, strength, compressive strength, and anti-settling capacity of the vertebral body were apparently reduced [15, 16]. We believe that combined with preoperative planning of 3-D CT, establishment of working channel near the affected side can reduce the loss of bone mass and the destruction of the bone trabecula under the endplate, can reduce the narrowing of the intervertebral space and the possibility of vertebra collapse, and can maintain a long-term effect.

Free intervertebral disc herniation behind the vertebra and underneath the diseased intervertebral space was another appropriate indication of TcPECD, which might reduce the possibility of damage to the upper endplate and the osseous protrusion.

Structural characteristics near the basivertebral foramen

From C3 to C7 segments, we observed the basivertebral vein impression whose shapes appeared like a crescent, a disc, and a horseshoe in the central posterior wall of the vertebral body. Most nutrient foramens of veins were connected with internal vertebral venous sinus at the posterior wall of the vertebral body. Intraoperative hemorrhage and postoperative hematoma were related to the rupture of venous sinus and the injury of venous plexus. Therefore, we should reduce or avoid these structural injuries when establishing working channels.

Main ideas

TcPECD causes defect of the vertebral body and may lead to the destruction of the lateral part of the upper endplate and the apophyseal ring. Combined with preoperative planning of 3-D CT, establishment of working channel near the affected side can reduce the loss of bone mass and the destruction of the bone trabecula under the endplate, can reduce the narrowing of intervertebral space and the possibility of the collapse of the vertebra, and can maintain a long-term effect.

Free intervertebral disc herniation behind the vertebra and underneath the diseased intervertebral space is another appropriate indication of TcPECD.

Reducing or avoiding the injury of the vertebral venous sinus and the internal vertebral plexus in the central area of paries posterior of the vertebral body is necessary to avoid the internal hemorrhage of the vertebral body during the operation and hematoma after the surgery.

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Disclosure of conflict of interest

None.

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