Cervical disc prosthesis replacement and interbody fusion — a comparative study

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Received: 13 September 2006 / Revised: 26 September 2006 / Accepted: 27 September 2006 / Published online: 16 December 2006
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Abstract The purpose of this paper is to compare the new functional intervertebral cervical disc prosthesis replacement and the classical interbody fusion operation, including the clinical effect and maintenance of the stability and segmental motion of cervical vertebrae. Twenty-four patients with single C5-6 intervertebral disk hernias were specifically selected and divided randomly into two groups: One group underwent artificial cervical disc replacement and the other group received interbody fusion. All patients were followed up and evaluated. The operation time for the single disc replacement was (130 ± 50) minutes and interbody fusion was (105 ± 53) minutes. Neurological or vascular complications were not observed during or after operation. There was no prosthesis subsidence or extrusion. The JOA score of the group with prosthesis replacement increased from an average of 8.6 to 15.8. The JOA score of the group with interbody fusion increased from an average of 9 to 16.2. The clinical effect and the ROM of the adjacent space of the two groups showed no statistical difference. The short follow-up time does not support the advantage of the cervical disc prosthesis. The clinical effect and the maintenance of the function of the motion of the intervertebral space are no better than the interbody fusion. At least 5 years of follow-up is needed to assess the long-term functionality of the prosthesis and the influence on adjacent levels.

Résumé L'objectif de ce travail est de comparer les prothèses discales, cervicales à la classique arthrodèse

intercorporeale, en analysant les aspects cliniques, la stabilité et la mobilité des vertèbres cervicales. 24 patients ayant présenté une hernie discale c5 c6 ont été sélectionnés et séparés en deux groupes randomisés. Un groupe a bénéficié d'une prothèse discale et l'autre groupe d'une arthrodèse intercorporeale. Tous les patients ont été suivis et évalués. Résultats : le temps opératoire pour la prothèse discale a été de 50 à 130 minutes et le temps opératoire de l'arthrodèse de 53 à 105 minutes. Aucune complication neurologique ou vasculaire n'a été observée après les interventions. Le score JOA dans le groupe des prothèses a évolué de 8.6 à 15.8 et dans le groupe des arthrodèses de 9 à 16.2. la symptomatologie clinique et la mobilité des espaces inter vertébraux adjacents à l'intervention chirurgicale ne montrent pas de différence statistique. En conclusion : ce suivi à court terme ne permet pas de mettre en évidence un avantage à la prothèse discale cervicale. Les résultats fonctionnels et la mobilité ne sont pas supérieurs à ceux d'une arthrodèse intercorporeale. Il faudra au moins cinq ans de suivi avant de mettre en évidence une éventuelle fonctionnalité à long terme des prothèses et leur influence bénéfique au niveau des espaces adjacents à l'intervention si tant est qu'il y en ait.

Introduction

Anterior cervical decompression and interbody fusion with an internal fixation device have been the classic treatment for the cervical spondylosis, but the operation can result in the accelerated degeneration of the adjacent space. An artificial cervical intervertebral disc can maintain the motion of the intervertebral space and theoretically slow down the degeneration of the adjacent space, allowing the

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physiological curvatures and range of motion of cervical vertebrae to be restored to the greatest extent. Nevertheless, it has not been clinically proven. Twenty-four patients with C5-6 intervertebral disk hernias were divided into two groups at random: one group received prosthesis replacement and another group received interbody fusion. All the patients were followed up to compare the difference of the two methods.

Materials and methods

Patient information

Twenty-four patients, 17 males and 7 females, had an intervertebral disk hernia of C5-6 (Fig. 1). These patients were selected specifically and divided into two groups, in order to compare them statistically. The average age was 42 years old, ranging from 24 to 53. The course of disease ranged from 3 months to 4 years, with an average of 18 months. The average follow-up time was 17 months, ranging from 10 to 35 months. All patients received systemic expectant treatment before operation, but the clinical symptoms worsened gradually.

Fig. 1 The MRI appearance of intervertebral disk hernia of C5-6

Fig. 2 The lateral X-ray appearance of intervertebral disk hernia of C5-6 after cervical disc prosthesis replacement

Operation method

In this operation, the patient was supine. The same common anterior cervical approach was adopted to expose the intervertebral disc, removing the affirmed intervertebral disc, pulpy nucleus and annulus fibrosus, and the soft tissue inside it completely. Next we erased the cartilage terminal plate with the appropriate device, maintaining the bony integrity of the body of vertebra. Then we propped open, burnished, and measured the height intervertebral space. An artificial intervertebral cervical disc prosthesis (Figs. 2 and 3) of suitable size was later embedded.

Anterior cervical discectomy decompression and interbody fusion exposed the protruded intervertebral disc, removing it completely to decompress the spinal cord. Afterwards, the uncovertebral joint was processed at the same time to decompress the nerve root. Iliac bone was taken to graft intervertebral space. The appropriate internal fixation device was chosen to fix the grafted bone. A drainage tube was removed after two days. The stitches were removed at 7 days. Cervical support was used for 4–6 weeks. All the patients were rechecked with an X-ray after 1 week, 3 months, 6 months and one year.

Fig. 3 The A-P X-ray representation of intervertebral disk hernia of C5-6 after cervical disc prosthesis replacement

Results

The JOA score after operation: The average JOA score before operation of the prosthesis replacement was 8.6. The average score after operation was 15.8; the rate of improvement was 70%. The average JOA score before operation of interbody fusion was 9. The average score after operation was 16.2; the rate of improvement is 72%, and there was no statistical difference between the improvement rates of the two groups.

The range of motion of the adjacent space and the operational space before and after operation were improved. Dynamic lateral position X-ray was used to determine the ROM of the intervertebral space. The average ROM of the adjacent space before the operation of the group of interbody fusion was $11.9^{\circ} \pm 5.8^{\circ}$ and $11.4^{\circ} \pm 4.9^{\circ}$ after the operation. The average ROM of the adjacent space before operation of the group of prosthesis replacement is $12.8^{\circ} \pm 5.7^{\circ}$ and $11.2^{\circ} \pm 3.9^{\circ}$ after the operation. A t-test was performed on the two groups, $P > 0.05$. There was no statistical difference.

The improvement of signs and symptoms: According to the degree of alleviation of the clinical symptom and the

improvement of the spinal compression, the results of the two methods were evaluated, according to the Odom standard. In the prosthesis replacement patients, the clinical effect of six cases was excellent, three cases good, three cases fair. The rate of excellent and good was 75%. In the group of interbody fusion, clinical effect of seven cases was excellent, three cases good, and two cases fair. The rate of excellent and good was 83%. The two groups were compared with the t-test, $P > 0.05$. There was no statistical difference between the two groups.

Discussion

Treatment of cervical disc herniation with anterior cervical decompression and interbody fusion with internal fixation device has been the classic method, but the fusion can result in the loss of range of motion of cervical vertebra, which causes the accelerated degeneration of the adjacent cervical disc. It can protrude against the spinal cord or the nerve root can be compressed, making a second operation necessary. The problem has caught the attention of many surgeons. Hilibrand found that after anterior decompression and interbody fusion more than 2.9% of adjacent intervertebral discs degenerate [8]. So doctors are exploring how to avoid these complications after anterior inter-body fusion and how to maintain the curvature and range of motion of cervical intervertebral discs.

Artificial intervertebral cervical disc prosthesis replacement, especially the successful application of artificial lumbar intervertebral disc prosthesis, is a new technique based on the principles of artificial joints, such as knee and hip prostheses. The arthroplasty of the cervical intervertebral disc can restore and maintain the height of intervertebral space. This yields excellent progress in treating the disease of intervertebral discs. If the clinical effect of artificial cervical intervertebral disc prosthesis can be proved to achieve or surpass the effect of anterior decompression and interbody fusion, a new standard to treat the disease of intervertebral discs will be achieved [2], but the artificial cervical intervertebral disc prosthesis is expensive and follow up is short so whether it can prevent the degeneration of adjacent intervertebral space is a question that requires further research. The indications for operation and the handling of complications are still in the process of evaluation.

Anterior cervical discectomy decompression in combination with interbody fusion with a grafted bone is a classic method for treating cervical spondylosis. Artificial cervical intervertebral disc replacement showed no advantage. Firstly, there was no difference in the improvement of clinical effect and the function of spinal cord. This is because the clinical effect of the cervical spondylosis

caused by cervical intervertebral disk hernia is dependent on complete decompression. The preoperative symptoms will surely be significantly relieved as long as the compression factor was completely removed. The clinical effect has little relationship with prosthesis replacement or interbody fusion [7], as far as the degeneration of the adjacent space, as there is little difference between the two methods. This is because after the artificial cervical intervertebral disc replacement, the normal mode of activity of the intervertebral space actually cannot be restored. In particular, the transient axis of rotation when the cervical vertebrae are in motion is very difficult to restore. In some sense, it is impossible because after artificial cervical intervertebral disc replacement, the motion of cervical vertebra is still in a condition of instability. It can also result in the accelerated degeneration of adjacent intervertebral space in the follow-up at on average 14 months [4]. The change of height of adjacent intervertebral space of two groups made no statistical difference. As for pain, the amount of cervical discomfort in disc replacement was greater than that of the group of interbody fusion. There was statistical difference in the two groups. In the follow-up at on average 14 months, there is no statistical difference in the degeneration of the adjacent space. The percentage of cervical discomfort of prosthetic replacement is higher than that of interbody fusion. Some of the patients who received prosthesis replacement had pain in the neck. Foreign body sensation of the cervical region is related to the inappropriate choice of the size of the prosthesis. Moreover, after prosthetic replacement, the activity of the prosthesis and adjacent space is out of step, which can cause discomfort [1].

Artificial cervical intervertebral disc prosthesis does not show obvious advantage in the follow-up. The time of the follow-up is short. Longer follow-up is needed to determine if there is some advantage of artificial cervical intervertebral disc prosthesis compared with interbody fusion. At the same time, it has its own complications as a kind of artificial joint, such as prosthesis wear and aseptic loosening.

Goffin first reported treating cervical spondylotic radiculopathy with artificial cervical intervertebral disc prosthesis in 2002. The rate of satisfaction after a follow up of 12 months is 85%–90%. Some authors who studied the artificial cervical intervertebral disc prosthesis found that the clinical effect of artificial cervical intervertebral disc prosthesis is satisfactory, but it must be mentioned that the clinical effect is mostly determined by the complete decompression and the recovery of the function of the spinal cord. The early clinical effect does not have much

relationship with artificial cervical intervertebral disc replacement [5].

Sekhon reported that seven patients of cervical spondylotic myelopathy were treated with artificial cervical intervertebral disc replacement. He performed a follow-up at 17 months after operation. In the course of the follow-up, there is no subsidence or shifting of the prosthesis. According to Odom's score system, five patients gained excellent effect, the other two were good, with all the surgical space restored ROM to some extent, but the physiological curve of cervical vertebrae of four patients was lost. At the same time, artificial cervical intervertebral disc replacement could not help to improve the symptom of spinal compression. More than five years is needed to discover whether the design of artificial cervical intervertebral disc prostheses is consistent with the biomechanics of cervical vertebra.

The surgical indications for artificial cervical intervertebral disc replacement must be strictly controlled. Serious osteoporosis, obvious instability of cervical vertebra, trauma, tumour and infection of cervical vertebra are all contraindications for artificial cervical intervertebral disc replacement [3]. If an osteoporotic patient receives artificial cervical intervertebral disc replacement, the possibility of prosthesis subsidence will increase significantly [6].

In the follow-up of 14 months, the artificial cervical intervertebral disc replacement did not show any statistical advantage compared with interbody fusion with bone graft. Longer follow up is needed.

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