

Anterior cervical subtotal decompression combined with bone grafting and titanium plate internal fixation for treatment of cervical spondylotic myelopathy in 118 patients*

Shu Dong-ping, He Min, Liu Shi-liang

Abstract

BACKGROUND: Anterior decompression and internal fixation for treatment of cervical spondylotic myelopathy has been widely accepted. However, there are few clinical case reports regarding this.

OBJECTIVE: To investigate the curative efficacy of anterior cervical decompression combined with bone grafting and titanium plate internal fixation in treatment of cervical spondylotic myelopathy.

METHODS: A total of 118 patients with cervical spondylotic myelopathy who underwent anterior cervical subtotal vertebrectomy, iliac bone grafting (or bone grafting with titanium cage) and anterior locking titanium plate internal fixation at the Department of Orthopedics, Huang Gang Central Hospital of Hubei Province between January 2001 and August 2007 were retrospectively analyzed. According to the X-ray photographs taken before, immediately after surgery and during postoperative follow-up periods, Cobb's angle, anterior vertebral height and posterior vertebral height of fused segments. Bone graft fusion was evaluated. Neurological function was assessed according to Japanese Orthopaedic Association (JOA) scores.

RESULTS: During the follow-up period (6-32 months, mean 19 months), three patients presented with slight titanium mesh sinking, and no fragmentation or loosening during internal fixation was observed in all patients, with a final bone fusion rate of 100%. JOA scores obtained immediately after surgery and during last follow-up were significantly greater compared with those obtained prior to surgery ($P < 0.05$). The excellent and good rate of neurological function recovery during the last follow-up was 86.2%. After surgery, sagittal Cobb's angle, anterior and posterior vertebral heights of fused segments were significantly improved ($P < 0.05$). These findings indicate that anterior cervical subtotal decompression combined with bone grafting and titanium plate internal fixation for treatment of cervical spondylotic myelopathy can thoroughly decompress, effectively correct cervical vertebrae malformation, and achieve stable bone fusion and reconstruction, with satisfactory clinical efficacy.

Department of Orthopedics, Huang Gang Central Hospital of Hubei Province, Huanggang 438000, Hubei Province, China

Shu Dong-ping★, Master, Attending physician, Department of Orthopedics, Huang Gang Central Hospital of Hubei Province, Huanggang 438000, Hubei Province, China shudongping919@hotmail.com

INTRODUCTION

Anterior decompression and internal fixation has been widely accepted for treatment for cervical spondylotic myelopathy owing to its advantages including thorough anterior decompression and reliable clinical efficacy^[1]. However, clinical case reports are few. The present study retrospectively reported 118 patients with cervical spondylotic myelopathy who underwent anterior cervical subtotal vertebrectomy, iliac bone grafting (or bone grafting with titanium cage) and anterior locking titanium plate internal fixation and demonstrated satisfactory clinical efficacy of this surgery as revealed by 6-32 months of follow-ups.

SUBJECTS AND METHODS

Design

A retrospective case analysis.

Time and setting

This study was performed at the Department of Orthopedics, Huang Gang Central Hospital of Hubei Province between January 2001 and August 2007.

Subjects

A total of 118 patients with cervical spondylotic myelopathy who underwent anterior cervical subtotal vertebrectomy, iliac bone grafting (or bone grafting

with titanium cage) and anterior locking titanium plate internal fixation at the Department of Orthopedics, Huang Gang Central Hospital of Hubei Province between January 2001 and August 2007 were included in this study. These patients, consisting of 62 males and 56 females, were aged 57.2 (range, 41-72) years old. The course of disease was averaged 25.6 (range, 3.0-71.5) years. Among these patients, 101 suffered from intermittent claudication, 57 from urination and defecation disturbance to different degrees, and 4 from paraplegia. Prior to surgery, X-ray CT and MRI examinations were performed. CT revealed posterior longitudinal ligament calcification in 87 patients and ligamentum flavum calcification in 76 patients. MRI demonstrated that all patients had intervertebral disk herniation (Figure 1) and 39 patients presented with signal changes of cervical cord in compressed segments. All patients participated in surgery voluntarily and signed written informed consent. All surgical procedures were in accordance with the *Administrative Regulations on Medical Institution*, formulated by the State Council of the People's Republic of China^[2].

Inclusion criteria

Patients who exhibited positive Hoffmann sign, positive Babinski sign, disturbances of somatic sensation, tendon hyperreflexia, and lesions involving two intervertebral spaces, and were subjected to cervical total vertebrectomy and subtotal decompression.

Correspondence to: Liu Shi-liang, Master, Chief physician, Department of Orthopedics, Huang Gang Central Hospital of Hubei Province, Huanggang 438000, Hubei Province, China lsh1701130@sina.com

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Exclusion criteria

Patients who had motor neuron diseases (clinically presenting with four-limb incomplete paralysis to different degrees and generally increased muscular tension).

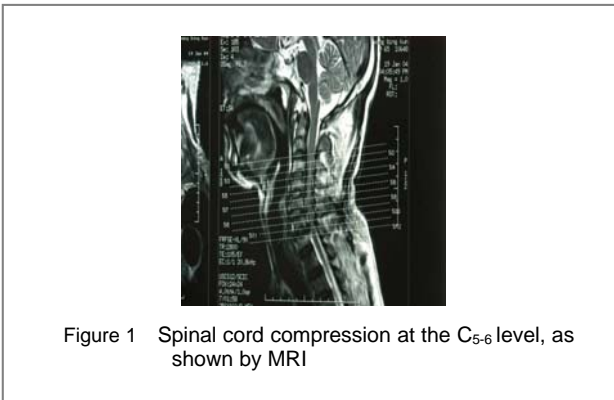
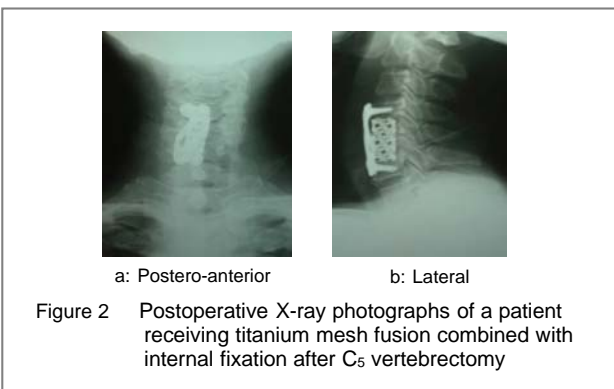


Figure 1 Spinal cord compression at the C₅₋₆ level, as shown by MRI

Methods

Surgical procedures

Following general anesthesia and intubation, patients were asked to lie in a dorsal position. Through an oblique incision made along the anterior margin of the left sternocleidomastoid or a transverse incision made at the anterior neck, the esophagus and the trachea were bluntly separated along the artery sheath till the anterior region of the cervical vertebra. Taking bilateral longus colli as safety lines, anterior cervical subtotal vertebrectomy and decompression were performed to expose the intervertebral space of diseased cervical vertebrae that needed to decompress, as well as the superior and inferior cervical vertebrae. The superior and inferior intervertebral disc tissue was first discarded through the use of curette and superior, and inferior vertebral cartilage end plate and bone spurs were thoroughly removed. Decompression was performed in the cervical vertebrae that needed to decompress through the use of drill, gouge forceps, and curette. Bone spurs and calcified posterior longitudinal ligament protruding into the vertebral canal were carefully managed. Under the assistance of Casper bracer, 38 patients underwent grafting of autogeneic iliac bone and 80 patients received grafting titanium mesh filled with small blocks of autogeneic bone (Figure 2). The length of iliac bone block and titanium mesh should be 1.0–2.0 mm longer than bone slot. Prior to implanting titanium plate of sufficient length into the cervical vertebra, two screws at the diagonal positions of the titanium plate should be installed to the superior and inferior cervical vertebrae, respectively. The implanted titanium plate (Bayer, Germany) was equipped with locking screws and made of titanium alloy.



a: Postero-anterior b: Lateral

Figure 2 Postoperative X-ray photographs of a patient receiving titanium mesh fusion combined with internal fixation after C₅ vertebrectomy

Assessment on neurological functions

According to Japanese Orthopaedic Association (JOA) scores^[3], patients were graded prior to, immediately after surgery and during the last follow-up. Neurological function recovery rate in the last follow-up was calculated. Neurological function recovery rate = (Postoperative scores or last follow-up scores–preoperative scores)/(17–preoperative scores) ×100%. Neurological function recovery rate was ranked as excellent (≥75%), good (50%–74%), fair (25%–49%), and poor (≤24%).

Imaging evaluation

According to the X-ray photographs taken before, immediately after surgery and during postoperative follow-up periods, fragmentation and displacement of titanium mesh and titanium plate as well as bone fusion were observed. Sagittal Cobb's angle (lateral projection) and anterior and posterior vertebral heights of fused segments were measured.

Main outcome measures

Neurological function recovery rate and imaging findings.

Design, enforcement and evaluation

Liu Shi-liang designed this study and all authors participated in study enforcement. Blind method evaluation was used.

Statistical analysis

All measurement data (paired as prior to and immediately after surgery, immediately after surgery and follow-ups) were statistically processed using SPSS 13.0 software. Paired *t* test was used, and a level of *P* < 0.05 was considered statistically significant.

RESULTS

Quantitative analysis of subjects

All initial 118 patients provided preoperative and postoperative data and were successfully followed up for average 19 (range, 6–32) months.

Intraoperative and postoperative general information

The surgery was averaged 120 (range, 90–150) minutes. During and after surgery, no death, infection or recurrent laryngeal nerve injury was observed.

Neurological functions assessment

JOA scores increased from preoperative (9.1±2.4) scores to (15.5±1.4) scores 1 week after surgery and (15.7±1.5) scores during the last follow-up. Paired *t* test results revealed that there was significant difference in JOA scores between prior to and immediately after surgery (*P* < 0.05). There was no significant difference in JOA scores between immediately after surgery and last follow-up (*P* > 0.05). A total of 68 patients acquired excellent neurological function recovery, 31 good, 15 fair and 4 poor, with an excellent and good rate of 86.2%.

Imaging results

Cobb's angle, anterior and posterior vertebral heights prior to

and immediately after surgery and during the follow-up period are shown in Table 1. Cobb's angle, anterior and posterior vertebral heights were significantly improved after surgery compared with prior to surgery ($P < 0.05$). There was no significant difference in above-mentioned indices between immediately after surgery and last follow-up ($P > 0.05$).

Table 1 Cobb's angle, anterior and posterior vertebral heights prior to and immediately after surgery and during last follow-up ($\bar{x} \pm s, n=118$)

| Time point | Cobb's angle (°) | Anterior vertebral height (mm) | Posterior vertebral height (mm) |
|----------------|----------------------|--------------------------------|---------------------------------|
| Preoperative | 7.8±1.8 | 48.3±3.6 | 44.6±1.8 |
| Postoperative | 9.1±2.1 ^a | 49.9±2.3 ^a | 46.0±2.6 ^a |
| Last follow-up | 8.8±2.3 ^a | 49.7±3.2 ^a | 45.8±6.5 ^a |

^a $P < 0.05$, vs. preoperative results

Adverse events

During follow-up periods, three patients presented with slight titanium mesh sinking within 1 month after surgery, but which was not managed for absence of obvious neurological function impairments and fused 3 months later. No bone graft abscission, cervical vertebra collapse, or titanium plate or screws fragmentation was observed during the follow-up periods. Bone fusion was observed in all patients. With exception of three patients that had no obvious neurological function recovery due to severe cervical cord injury attacking 6 months ago, the remainders (115 patients) attained neurological function recovery to different degrees.

DISCUSSION

Anterior cervical subtotal vertebrectomy and bone graft fusion internal fixation is a common surgery for treatment of intervertebral disc protrusion and cervical spondylotic myelopathy. Anterior cervical decompression is generally performed by to remove the ventral pressure to spinal cord. It is characterized by direct thorough decompression and little interference to spinal cord, which prevents secondary injury and is conducive to the neurological function recovery under relatively normal physiological environment. Conventional decompression range includes intervertebral disc tissue and bone spurs. In addition, peripheral erosion during slot opening in the cervical vertebra can enlarge decompression range. In addition to direct removal of ventral pressure to spinal cord, anterior cervical subtotal vertebrectomy and bone graft fusion internal fixation can make titanium mesh or iliac bone grafts fused and fixed, allowing for re-stabilization of diseased segments^[4]. Simple anterior decompression and bone grafting easily result in many adverse events due to poor stabilization in particular for many segment surgery, including bone graft loosening and displacement, low bone graft fusion rate, loss of intervertebral space height and trachelokyphosis. In contrast, immediate stability provided by steel plate internal fixation can retrieve the drawbacks above mentioned. Jin *et al*^[5] reported that any patients who are involved in subtotal or total vertebrectomy and bone graft fusion can choose anterior cervical internal fixation.

Evidence exists that application of anterior cervical steel plate leads to a 92%–100% bone graft fusion rate for one segment of

lesions and a 70%–100% fusion rate for two or more segments of lesions^[6-7]. Anterior cervical steel plate shows the following several biological characteristics: first, strong supporting function increases the stability of diseased segments, reduces the movement between bone grafts and end plate, and enhances fusion rate. Second, reducing complications of intervertebral grafts, such as preventing from graft prolapsed. Third, preventing from trachelokyphosis and keeping the balance of cervical vertebra in the sagittal level. Steel plate pre-curved with certain radian can attach to the cervical vertebra, which improves the physiological curvature of cervical vertebra, reduces the arm of force, optimizes stress transduction, and enhances stability and fixation force^[8], providing good local mechanics for improvement in neurological function after surgery.

Anterior cervical steel plate obviously reduces complications, but a series of other complications appear, including screw loosening and prolapse, internal fixation fragmentation, and injury to esophagus and peripheral tissue caused by the screws prolapsed from the steel plate. For multi-segment anterior cervical discectomy and fusion, anterior locking plate can greatly enhance the stability of bone grafts, effectively maintain the physical curvature of cervical vertebra, and prevent intervertebral height loss and the mechanical transduction abnormality among adjacent segments^[9-11]. The anterior locking titanium plate used in the present study exhibits the following characteristics: first, integrated structure can effectively prevent screw withdrawal. Second, in the flexion and extension positions of cervical vertebra, there are tension band and supporting effects, the stability of cervical vertebra in fixed segments is strengthened and the fusion rate of bone grafts is increased. Third, the fixation screws do not penetrate the posterior border of the vertebral body. Fourth, internal fixation system equipped with locking screws are made of titanium or titanium alloy, with good histocompatibility and tolerance to corrosion and produce small influence on postoperative magnetic resonance imaging. Fifth, the tapered worm in the nail-tail and the inner ring in the steel plate form pressurized caging; screw direction can be adjusted, with the characteristics of one-screw multi-direction fixation, which allows increased fixation range.

Caution should be taken during and after anterior cervical decompression combined with bone grafting and titanium plate internal fixation. First, thorough decompression is the key to surgery. During slot opening to decompress, attention should be paid to the bone spurs in the posterior border of the vertebral body, in particular full examination of the corner of the slot opened. In addition, caution should be taken to resect the posterior longitudinal ligament. In the present study, 23 patients showed suspected intervertebral disc-caused pressure under the complete posterior longitudinal ligament; 79 patients demonstrated thickened posterior longitudinal ligament to different degrees, and 35 patients presented local calcification or ossification in the posterior longitudinal ligament, resulting in pressure to the dura mater. Therefore, the key to ensure the curative efficacy of the surgery is to resect the posterior longitudinal ligament in the corresponding segments to be decompressed as possible^[12]. Second, this surgery reserves bony end plate above and below the bone slot, prevents titanium mesh collapse into the vertebral body, and effectively maintains the height of fused segments. At the same time, the intervertebral disc tissue and cartilage end plate not thoroughly

removed would influence the environment of bone grafting. Therefore, caution should be taken to manage the superior and inferior ends of the intervertebral body. Our experience is that with the assistance of C-arm X-ray machine, the superior and inferior end plates are treated under the condition of slot opening based on precise contrast with the superior and inferior borders of the intervertebral body prior to decompression. Third, superior laryngeal nerve injury is commonly induced by intraoperative electric coagulation burning and long-time bracing. Great vessel and esophagus injury is commonly induced by improper intraoperative pulling and hooking or excessive bracing force. Spinal cord injury and Horner's syndrome should be also avoided, which are induced by unclear anatomical relationship and careless manipulation. After surgery, cervical vertebra should be protected by avoiding long-term bending over desk working and sleep with high pillow. Neck support should be used within postoperative 6-8 weeks. This study is a retrospective, controlled case analysis. Anterior cervical subtotal decompression combined with bone grafting and locking plate internal fixation for treatment of cervical spondylotic myelopathy can thoroughly decompress and achieve stable bone fusion and reconstruction, with satisfactory clinical efficacy. This surgery is safe and reliable. But precise long-term curative efficacy needs further investigation for limited case numbers and various follow-up periods.

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颈椎前路钢板置入内固定并减压植骨治疗脊髓型颈椎病 118 例*

舒冬平, 何敏, 刘仕良(湖北省黄冈市中心医院骨科, 湖北省黄冈市 438000)

舒冬平★, 男, 1979年生, 湖北省黄冈市人, 汉族, 2008年南华大学毕业, 硕士, 主治医师, 主要从事脊柱外科方面的研究。

通讯作者: 刘仕良, 硕士, 主任医师, 湖北省黄冈市中心医院骨科, 湖北省黄冈市 438000。

摘要

背景: 目前应用前路减压内固定方法治疗脊髓型颈椎病得到了普遍认可, 但大宗病例的临床报告并不常见。

目的: 探讨颈椎前路减压植骨结合锁定钛板内固定治疗脊髓型颈椎病的疗效。

方法: 回顾性分析了 2001-01/2007-08 于黄冈市中心医院骨科行前路椎体次全切减压、取肋骨植骨或钛网植骨结合前路锁定钛板固定治疗的 118 例脊髓型颈椎病患者。根据术前、术后即刻及术后随访颈椎标准侧位 X 射线片, 测量融合节段前凸 Cobb 角、融合节段椎体前缘高度及后缘高度, 并评估植骨融合情况; JOA 标准评价神经功能。

结果与结论: 随访期间(6-32 个月, 平均 19

个月)3 例出现钛网轻度沉降, 所有病例无内固定断裂、松动, 末次随访骨融合率为 100%。与术前比较, 术后即刻及末次随访时患者的 JOA 评分明显增高($P < 0.05$), 术后末次随访优良率为 86.2%; 术后 Cobb 角、融合节段椎体前缘高度及后缘高度值也较术前明显改善($P < 0.05$)。说明前路次全切减压植骨锁定钛板内固定治疗脊髓型颈椎病, 既能彻底减压又能有效矫正颈椎畸形, 坚固骨融合重建稳定, 临床效果满意。

关键词: 颈椎; 锁定钛板; 次全切减压; 脊髓型颈椎病; 前路钢板置入

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来自本文课题的更多信息——

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文章的倚倚或不足: 文章的随访时间不是很长; 病例均为单节段减压病例, 无法完全说明多节段脊髓型颈椎病的情况。

提供临床借鉴的意义: 充分认识脊髓型颈椎病手术治疗的必要性, 通过大宗病例说明前路减压锁定钛板内固定的疗效并探讨术中术后并发症。