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Cervical corpectomy reconstruction with titanium mesh cage and anterior plating

Reconstrucción con corpectomía cervical mediante jaula de malla de titanio y placa anterior

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ABSTRACT. **Introduction:** cervical spondylosis is a disorder that is characterized by cervical and shoulder pain as the main symptoms. In some cases, it presents with myelopathy, which causes important functional disability in the adult population. There have been many surgical techniques described for treatment, with anterior cervical discectomy and fusion being the gold-standard. Studies have shown that using a cervical mesh as anterior support during a corpectomy allows for a wider decompression than other techniques; this surgical treatment comes with controversy as cage subsidence remains the greatest limitation. **Objective:** to evaluate the surgical results of cervical anterior decompression with titanium cage and anterior fixation plate; establish if there is a correlation of subsidence with poor functional outcomes. **Material and methods:** retrospective, observational and descriptive study at a tertiary level institution. The study sample was completed up to n = 126, from January 2008 to August 2011. Review clinical and radiological files of 126 patients, had at least 18-month follow-up. **Results:** sixty-five male patients (52%) were included. Age was 44 years to 84 years with an average of 66.03 years. Subsidence was present in 112/126 (88.88%) of cases. In 75 (61%) cases, subsidence was present in the inferior platform and the

RESUMEN. Introducción: la espondilosis cervical es un trastorno caracterizado por cervicalgia y dolor de hombro asociado. En algunos casos, puede presentar mielopatía, causa principal de discapacidad funcional en la población adulta. Se han descrito diversas técnicas quirúrgicas como tratamiento, siendo la discectomía cervical anterior con fusión vertebral el estándar de oro quirúrgico. En diversos estudios se ha encontrado que usar una malla cervical como soporte anterior al realizar una corpectomía permite tener mejor descompresión cervical en comparación con otras técnicas; sin embargo, este tratamiento es controversial ya que el colapso del implante es la limitación más importante del mismo. **Objetivo:** evaluar los resultados quirúrgicos de la descompresión cervical anterior con jaula de titanio y placa de fijación anterior; establecer si existe una correlación entre el hundimiento (subsidence) y malos resultados funcionales. **Material y métodos:** estudio retrospectivo, observacional y descriptivo en una institución de nivel terciario. Se completó la muestra del estudio hasta n = 126, de enero de 2008 a agosto de 2011. Se revisaron los expedientes clínicos y radiológicos de 126 pacientes con al menos 18 meses de seguimiento. **Resultados:** incluimos 65 pacientes (52%) hombres. La edad fue de 44 años a 84 años con un promedio de 66.03 años. El hundimiento estuvo

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rest in the superior one. In the group with mild subsidence (1-3 mm), the median was 1.88 mm and in the severe group (> 3 mm) was 5.87 mm. Functional improvement according to the Nurik scale was statistically significant (p = 0.001) between preoperative and final examinations. Postoperative complications occurred in 39 patients (30.9%). Loosening was the most common complication (15.8%), followed by odynophagia (4.7%). **Conclusions:** over time, mesh subsidence caused the loss of lordosis, leading to rectification, kyphosis in some cases and losing the sagittal balance without clinical significance in its interpretation. Bone fusion was unsatisfactory and the implant makes radiological evaluation difficult, being overvalued at the time of outpatient follow-up. We emphasize that improvements must be made to the implants in order to avoid subsidence and to improve the degree of consolidation.

Keywords: corpectomy, cervical myelopathy, cervical spondylosis, treatment, titanium mesh cage, subsidence.

presente en 112/126 (88.88%) de los casos. En 75 (61%) casos, el hundimiento estuvo presente en la plataforma inferior y en el resto en la superior. En el grupo con hundimiento leve (1-3 mm), la mediana fue de 1.88 mm y en el grupo grave (> 3 mm) fue de 5.87 mm. La mejoría funcional según la escala de Nurick fue estadísticamente significativa (p = 0.001) entre los exámenes preoperatorio y final. Las complicaciones posoperatorias ocurrieron en 39 pacientes (30.9%). El aflojamiento fue la complicación más común (15.8%), seguido de odinofagia (4.7%). **Conclusiones:** con el tiempo, el hundimiento de la malla ocasionó la pérdida de lordosis, llevando a rectificación, cifosis en algunos casos y pérdida del equilibrio sagital sin significancia clínica en su interpretación. La fusión ósea fue insatisfactoria y el implante dificulta la evaluación radiológica, siendo sobrevalorada al momento del seguimiento ambulatorio. Se enfatiza que deben realizarse mejoras en los implantes para evitar el hundimiento y mejorar el grado de consolidación.

Palabras clave: corpectomía, mielopatía cervical, espondilosis cervical, tratamiento, jaula de malla de titanio, hundimiento (subsidence).

Abbreviations:
ACCF = anterior cervical corpectomy and fusion
ACDF = anterior cervical discectomy and fusion

Introduction

Cervical spondylosis is a disorder involving the intervertebral discs, vertebrae and joints associated with degenerative changes of aging or secondary to trauma. The main symptom is cervical pain often associated with shoulder pain.[1,2,3] A considerable number of patients have cervical spondylosis; however, these patients are asymptomatic.[3] Penning et al. showed that a concentric compression of the spinal cord resulted in upper motor neuron signs when the spinal conduct transverse ratio is decreased by 30% or less than 60 mm.[2,4]

Myelopathy due to cervical spondylosis is the principal cause of functional disability in the adult population. International efforts have attempted to search for a suitable treatment for this pathology.[5] Multiple surgical treatments, currently available, have been standardized over time.[6]

Although anterior cervical discectomy with fusion has been the gold standard for cervical stenosis, other techniques have been described for treatment of multilevel disease under the premise that the use of an implant decreases morbidity because it does not require graft havesting.[7,8,9,10] For this reason, using a cervical mesh as anterior support when performing a corpectomy has the advantage of allowing a wider decompression than a two level discectomy, and using the same corpectomy bone tissue as a graft.[11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27]

Treatment continues to be controversial because cage subsidence remains the greatest limitation of this procedure.[28] A question that remains is if subsidence could be related to spine stability compromise or poor functional outcomes?

International literature has reported results on the treatment of cervical stenosis using multi-level corpectomy and placement of a titanium mesh cages plus anterior fixation plates, with variable results among authors.[11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32] The purposes of this study are to evaluate the surgical results of cervical anterior decompression with titanium cage and anterior fixation plate at a tertiary level institution; to identify the presence of mesh subsidence, and to establish if there is a correlation of subsidence with poor functional outcomes.

Although we know, both anterior cervical discectomy and fusion (ACDF) and one or two-level anterior cervical corpectomy and fusion (ACCF) provided satisfactory clinical outcomes and fusion rates for cervical spondylotic myelopathy (CSM). However, adjacent two-level ACDF was associated with shorter hospital stays, less blood loss, shorter operative times, fewer differences in segmental height and greater improvement in segmental lordotic curvature. In most cases where either surgical method could be selected, two-level ACDF may be a worthwhile alternative to corpectomy for treating cervical myelopathy. This is particularly true in cases of ossification of the posterior ligament, retropulsion of the vertebral body, or cervical kyphosis, among other reasons.[31]

Material and methods

We conducted a retrospective study of the clinical files of patients with cervical stenosis that were surgically treated with cervical corpectomy, anterior support with rigid titanium mesh cage and anterior fixation plate (Medtronic-Sofamor Danek Group, Memphis, TN and Depuy Synthes Codman, Berkshire, UK), at a spine surgery service of a tertiary level institution, from January 2008 to August 2011, both genders. This study was approved by the Investigation Committee. Information was obtained from the programming registry of the spine surgery service and from the Automated Hospital Information System (AHIS). We verified the correspondence between diagnosis at hospital admittance and discharge to avoid duplication in the registries. Complete electronic radiological results were recorded and patients had been evaluated by two specialized spine surgeons, not related to this study, and followed for a minimum of 18 months. We estimated a study size according to a prevalence of 1.6% per 100,000 inhabitants,[11] with a maximum error of 2% and a confidence level of 90% giving us a size of 107 patients, but we decided to include 126 patients.

We analyzed gender variables, Nurick scale, subsidence at corpectomy levels, cervical lordosis, fusion rate and degree, surgical time, bleeding, and complications.

Surgical technique

Surgeries were performed by four senior surgeons from the spine surgery service of our hospital, with standardized technique, with previous signature of an informed consent. General anesthesia was used for all procedures. Patients were placed in the supine position with neck extension and traction of the shoulders supported by foot padding. A conventional approach was used with a transverse incision under radiographic control at the confirmed level. Resection of the necessary discs was undertaken with partial corpectomy, preserving the lateral margins up to the posterior longitudinal ligament. Ligament resection was always carried out. All cartilage was removed from the surfaces of the cephalic and caudal vertebral bodies up to the level of the subchondral bleeding bone. The titanium mesh cage was measured and filled with autologous bone taken from the excised vertebra and placed under distraction through Harms rods. Finally, an anterior plate was placed, molded in lordosis with respect to the level of fixation. After the surgical procedure, all patients wore a Philadelphia cervical collar for eight weeks.

Follow-up evaluation

For follow-up, x-rays were taken in the anteroposterior (AP) and lateral position of the cervical spine on the first postoperative day and at 45 days and again at three, five, 12 and 18 months. Subsidence of the mesh cages was evaluated by comparing their position and distance from the platforms with x-rays from the first postoperative day. All cases of subsidence were divided into a mild group (1 to 3 mm) and a severe group (> 3 mm). Fusion was observed in the midportion of the cephalic and caudal adjacent platforms in the mesh cage as described by Eck et al.[33] Anterior fusion was graded as 1) definite, with obvious trabeculations apparent crossing vertebral end plates; 2) probable, with intact graft and no lucencies but without full remodeling and incorporation; 3) probably not, with graft intact but with definite lucency apparent at the top or bottom of the graft; 4) no, with resorption of bone graft; or 5) could not be assessed. Likewise, sagittal alignment was checked by measuring the Cobb angle at the same time. When any doubt existed, computed tomography (CAT scan) was requested to verify the diagnosis. Two surgeons who were not part of the surgical team performed a neurological and functional assessment using the Nurick functional rating scale.

Statistical analysis

Descriptive statistics were performed by estimating frequencies, percentages, mean, median, range and standard deviations. Comparison test of measures of related groups and paired t test were used for normally distributed variables. The parametric alternative used was the Wilcoxon test for signed ranks; $p < 0.05$ was accepted as statistically significant for all tests. Statistical packages Excel and SPSS v. 15 were used *(Figure 1)*.

Results

There were 126 patients included in the study: 65 (52%) males and 61 (48%) females. There were no patients lost to follow-up. Minimum age was 44 years and maximum age was 84 years with an average of 66.03 ± 10.571 years.

Corpectomy at one level was done in 95 (75.3%) patients (C5, 48 cases, C4, 35 cases, C6, 12 cases); two levels on 25 (19.8%) patients (C4 and C6, 13 cases, C5 and C6, eight cases, C6 and C7, four cases); and six (4.7%) patients with three levels (C4-C5-C6). Surgical time was recorded as a minimum of 70 minutes and maximum of 420 min (median 178.62 min ± 69.884). Days of hospital stay was minimum four days and maximum of 11 days (median 6.79 days ± 2.077).

In 121 patients graft from the removed vertebra was used and only five patients had autologous graft combined with bone matrix. Consolidation was divided into five grades. Four patients were evaluated as grade I (3.17%), 17 (13.49%) grade II, 54 (42.85%) grade III, grade IV in 37 patients (29.36%) and grade V in 14 patients (11.11%). Subsidence was present in 112/126 (88.88%) of cases. In 75 (61%) cases, subsidence was present in the inferior platform and the remainder in the superior. The initial subsidence was more important in the posterior portion of the platform and began in the first month, reaching its

maximal subsidence at six months, consistent with the time of complete fusion diagnosis. In the group with mild subsidence (1-3 mm) the median was 1.88 mm and in the severe group (> 3mm) was 5.87 mm.

Minimal presurgical lordosis was 2º and maximum was 54º (median 16º). Minimum immediate postsurgical lordosis was 2º and maximum was 51º (median 15º). During the final follow-up, minimum postoperative lordosis was 0º with a maximum of 43º and a median of 10º. There is a statistically significant result with respect to postsurgical lordosis vs. lordosis at final follow-up (p = 0.002) as shown in *Table 1*.

Functional improvement according to the Nurik scale is reported with a statistically significant difference (p = 0.001) comparing the preoperative examination with the final examination. However, there is no relationship with regard to subsidence and degree of segmental and total lordosis (p = 0.50) nor subsidence and Nurick scale at final follow up (p = 0.71).

Postoperative complications occurred in 39 patients (30.9%). Loosening was the most common complication in 20 cases (15.8%) cases followed by odynophagia in six cases (4.7%), dysphagia in six cases (4.7%), hematoma in four cases (3.1%) and soft tissue infection in three cases (2.3%). There was only one case with fracture of the C5 body at the time of pin placement. Preoperative bleeding was a minimum of 80 ml and maximum of 1,500 ml (average 200 ml). In all cases there was no relationship between the levels, surgical time or grade of subsidence.

Table 1: Radiograph and clinical outcomes of patients N = 126.

	Z	p
Presurgical lordosis - last follow-up lordosis	−3.151	0.002
Immediate postsurgical subsidence - last follow-up subsidence	−4.418	0.001
Presurgical Nurick - Nurick at last follow-up	−3.464	0.001

Wilcoxon signed ranks test.

Discussion

According to their studies, Kepler et al.,[7] Acosta et al.,[10] and Nakase[32] reported fusions ranging from 98.5 to 100% of the cases. These are studies with a population of between 23 and 30 patients. Our results do not match with what was reported by these authors radiographically as we found lower rates of fusion (taking into consideration grades I and II with 17.3%). This may be due to a larger population or because they were sometimes evaluated only radiographically and not aided by CAT scan. Furthermore, results by Wang et al.[16] describe an 80% rate of fusion at

Figure 1: A 55-year-old male presented with gait difficulties and progressive sensory and motor deficit in the upper extremities. **A)** Pre-operative anteroposterior and lateral X-ray films with multiple segment disc narrowing without cervical spine instability. **B)** Sagittal T2-weighted image with anterior and posterior spinal cord compression at C3-C7 level. **C)** Post-operative anteroposterior and lateral X-ray films showed C4 and c6 corpectomy with titanium mesh reconstruction and anterior plate; enlarged spinal canal and perfect lordotic curvature maintained by pre-bending of the plate.

three levels and excellent results in fusions at one level. However, these authors do not use any classification to determine the degree of fusion and use the Odom criteria as a pre- and postoperative evaluation.

We found an 88.88% of subsidence in our population and definite fusion just in 16.66% of our patients. We used fusion grade described by Eck et al,[33] and found that our rate of fusion was unsatisfactory and the implant made radiological evaluation difficult, being over-evaluated at the time of outpatient follow-up. Although different classifications have been used to determine the consolidation in patient's post-spinal surgery, the ideal imaging method and classification has not been described to corroborate fusion. When implants such as mesh are used, visualization of bone graft integration is difficult. But in 2012, Selby[34] concluded that the routine use of CAT should be individualized due to the risk of ionizing radiation. In those patients with a satisfactory postoperative evaluation, plain x-ray is sufficient. A protocol for using CAT should be established just for those patients in whom there is reasonable doubt of malunion.

Chen[28] concluded that subsidence is a common phenomenon after anterior cervical corpectomy and that the only risk factor for a severe subsidence is the number of levels in which the corpectomy is performed. We found no statistical significance in this item during our study; nevertheless, our sample size is smaller than his. We found important information regarding the loss of lordosis ($p = 0.002$). However, there is no relationship with regard to subsidence and degree of segmental and total lordosis ($p = 0.50$) nor subsidence and Nurick scale at final follow up ($p = 0.71$). This leads us to believe that although subsidence of the mesh is a common phenomenon there is no correlation with poor functional outcome, at least at 18-month follow-up. We acknowledge the risks of bias of a retrospective study. This is being taken into consideration for further investigations as well as long term outcome measures of our patients.

In the first multicenter, prospective, comparative study from the Spine CORe Study Group suggests that both single-level and two-level Anterior Cervical Corpectomy and Fusion can achieve similar improvements at two years. Their results demonstrate that both procedures are effective and durable. Therefore, we know that both the survival and clinical outcomes are not affected by the procedure when indicated correctly.[35]

Conclusions

Although the «gold standard» for treating cervical stenosis is anterior discectomy and fusion, the use of titanium mesh cages[3,5,16] began in 1986 as part of the therapeutic arsenal in cervical stenosis. Twenty-four years later the ideal treatment for this pathology has not yet been defined due to the contradictory information reported in the literature.

Subsidence of the titanium mesh is a common phenomenon after corpectomy. Over time, mesh subsidence causes the loss of lordosis, rectification, including kyphosis in some cases and losing the sagittal balance. Our study shows there is no correlation between this loss of lordosis with any clinical symptom or poor functional outcome, at least at 18-month follow-up. Anterior cervical corpectomy and fusion with titanium mesh cage is a safe and effective surgical treatment for cervical degenerative diseases; nevertheless, we emphasize that there are improvements that can still be made to implants in order to avoid subsidence and to improve the degree of consolidation.

It is reasonable that other factors, such as radiographic characteristics and patient symptoms, may influence patient selection for these procedures over the others.

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