Endoscopic microsurgery in herniated cervical discs

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The purpose of this study was to make public our results using endoscopic microsurgery in herniated cervical discs. This technique allows us to avoid complications due to conventional exposure, as is the case in traditional approaches. This study was carried out from January 1991 to January 1998. One hundred and seventy-one patients should have undergone traditional surgery for 296 herniated cervical discs. They were, instead, treated by using endoscopic microsurgical techniques. In 273 herniations the surgical procedure was performed by a paramidline right anterior approach, and in 23 herniations by a paramidline posterior approach, with a working sleeve of 4.6 mm outer diameter in both cases. In the anterior approach the tube was firmly placed against the anterior longitudinal ligament and the edge of the anterior part of the vertebral bodies. The neurovascular structures were placed lateral to the working sleeve and the visceral structures were placed medial to the working sleeve. Then, under endoscopic coaxial control, removal of the herniated part was performed, through the intervertebral discs, with microsurgical instruments. In the posterior approach, the tube was placed instead between the inferior and superior lamina, then under the nerve root up to the herniation, which was removed. This posterior approach was used only in the lateral disc herniations. There were no incidents or major complications following these operations. After one month the success rate was 94.7%, after three months 95.9%, after six months 96.4% and after one year 97%. There were no cases of relapse during the follow-up period of these patients. This study suggests that for herniated cervical discs, the endoscopic microsurgical technique is an extremely advantageous and safe method. Moreover, longer follow-up periods and an increased number of patients treated with this procedure should further confirm the usefulness of this technique. [Neurol Res 1999; **21**: 31–38]

Keywords: Cervical vertebrae; intervertebral disk displacement; myelopathy; spine; neurosurgical treatment; endoscopy

INTRODUCTION

Cervical myelopathy and/or cervical radiculopathy caused by compressive lesions from herniated cervical disc has been surgically treated either by a posterior laminectomy or by an anterior approach with or without interbody fusion. The posterior approach was first described in 1950 by Spurling and Scoville[1] to treat primarily laterally displaced disc herniation. It has been used less frequently since the development of the anterior approach to the cervical spine[2–4]. Positioning the patient in the prone position, the complications associated with posterior approach include nerve root injury, particularly when more than one root is exposed, spinal cord injury secondary to cord retraction, particularly during transdural approach to a herniated disc, spinal instability, particularly when the facet joint is removed, and posterior muscle trauma and injury. For the past 30 years, the anterior approach has become very popular. Three common techniques of fusion are described by Cloward[2,5,6], Bailey and Badgley[3], and Smith and Robinson[4]. In Cloward's 1958 publication[2], he described his operative technique. The complications associated with the anterior approach include injuries to the spinal cord, the nerve roots[7,8], the vertebral artery, the sympathetic chain and the anterior soft tissue structures, such as the esophagus, carotid artery, trachea, recurrent laryngeal nerve and, very rarely, the thyroid gland. With the anterior approach at the C_7–T_1 level, injury to the dome of the parietal pleura of the lung with secondary pneumothorax is a possible risk. When fusion is performed, in the immediate post-operative period, graft extrusion should occur[9]. Pseudoarthrosis may be present after a one-segment fusion, but this does not necessarily preclude a good clinical outcome[10,11]. Other complications, typical of the fusion with autograft, are represented by the injury to the lateral femoral cutaneous nerve, hematoma, iliac wing fracture and post-operative wound infection[10,12]. When allograft is used to make the fusion, transmission of communicable diseases is possible.

When fusion is performed, the inevitable stresses applied to adjacent interspaces are present. This increases the probability of disc herniations and/or degenerative changes in the adjacent interspaces. Kyphotic deformity, developing long-term secondary to an anterior cervical discectomy with or without fusion, may be present. Scar tissue formation in the cervical spinal canal and/or in the foramina may develop in all the cervical spinal surgery and particularly in the posterior approach. Taking into consideration these

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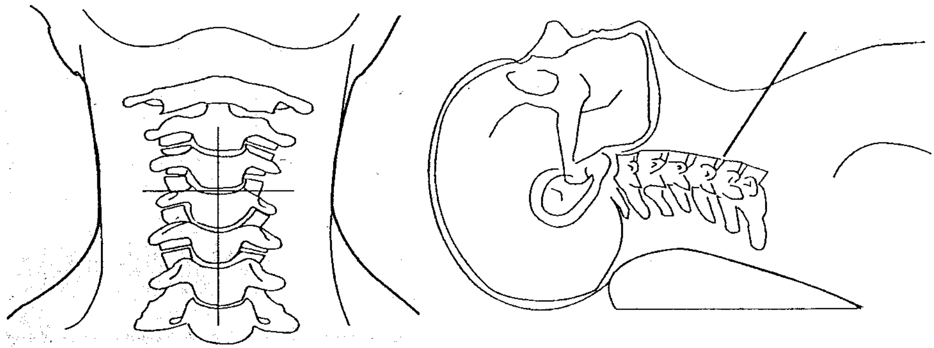

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Figure 1: During surgery, in the AA, the patient is placed in the supine position. **A:** Anterior part of the neck with an anterior posterior projection of the cervical spine; the midline and the level of the disc herniation has been drawn on the skin. **B:** Lateral view of the patient on the operating table. A pillow is placed under the patient's neck to maintain physiological cervical lordosis and the patient's face is kept straight. A blunt obturator can be seen firmly placed against the anterior longitudinal ligament and the edge of the anterior part of the adjacent vertebral bodies, at the appropriate intervertebral level

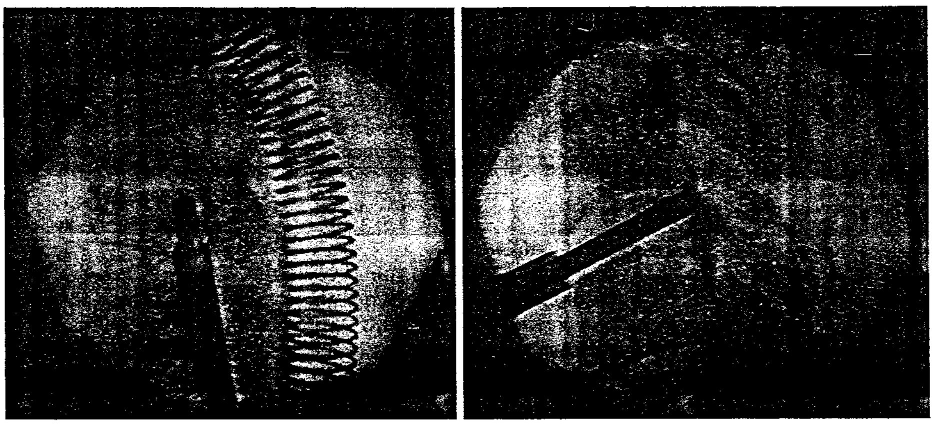

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Figure 2: A trephine is inserted in the working sleeve and carefully advanced in intervertebral space up to the herniation. In these fluoroscopic views it is possible to see **A:** an anterior posterior projection and **B:** a lateral projection of the cervical spine with the working sleeve and the trephine

complications and the outcomes in the open spinal surgery, we used 'closed' surgical techniques. With minimally invasive spinal neurosurgery the trauma for the patient in the surgical area is minimised, and consequently iatrogenic effects may be avoided[13]. These closed techniques took rise from the association of many different procedures used in neurosurgery. Stereotaxy was the first step towards minimally invasive neurosurgery. Subsequently, the introduction of the operating microscope permitted reduction of surgical field with consequent improvement of surgical techniques, to the patient's benefit. Furthermore, the development of 'neuroimaging methods' like CT and MRI, revolutionised neuroradiologic diagnostics, permitting precise surgical planning and three-dimensional programming. The use of the computer applied to surgery, the so called 'neuronavigator' has yielded high precision surgical techniques, and can be linked with very sophisticated control systems, such as intra-operative echography, intra-operative CT or intra-operative MRI, to achieve the optimum therapeutic effect with the minimum surgical trauma. More recently, endoscopes, i.e. optic instruments capable of transferring images from one place to another (from an area inside the body to the outside) and linked with microcamera systems, have been considerably improved and allowed the beginning of the

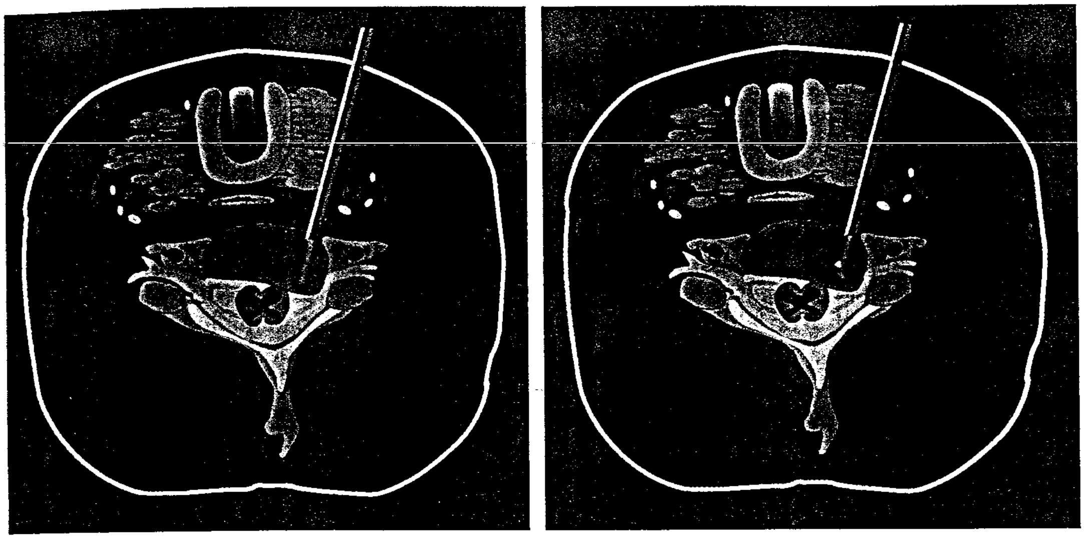

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Figure 3: Schematic drawings of the anatomy of the neck in axial section. **A:** A trephine inserted in the working sleeve up to the herniation. **B:** The microendoscopic canula inserted in the tube with an angled microforceps removing the herniated part

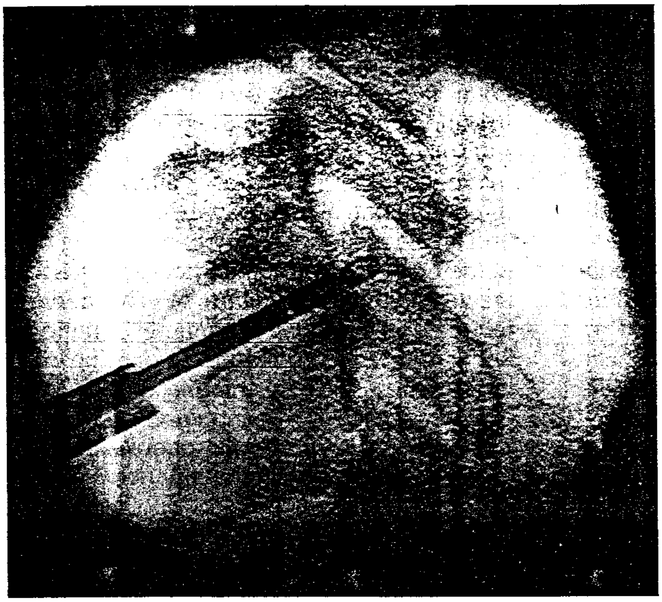

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Figure 4 A: Fluoroscopic view of microforceps removing the herniation. **B:** The microforceps in use

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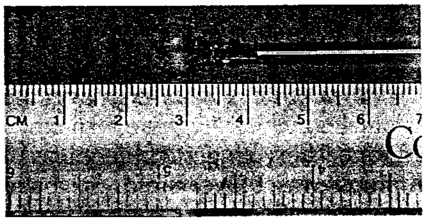

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Figure 5 A: Microscissors used to separate the dural sheath from the underlying herniated part and reactive adhesions. B: The microscissors in use

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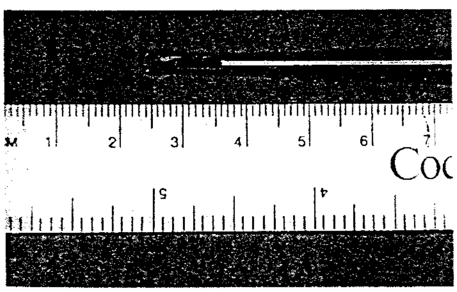

endoscopic microneurosurgery. Following this philosophy, keyhole surgery was developed. This technique enabled the surgeon to reach the surgical target through stereotaxic method, and perform the intervention by means of endoscopic systems using particular probes, the so-called 'working sleeves'[13]. Our personal experience in the field of keyhole neurosurgery began in 1989 and we introduced this technique in the cervical spine in January 1991, using either anterior approach or, less frequently, posterior approach[14]. Endoscopic microneurosurgery allows us to easily reach and expose the herniated part which can be removed with great facility, thus reducing the risk of complications. With this technique it is possible to avoid the formation of postoperative scar tissue and secondary iatrogenic events, such as vertebral instability. Therefore interbody fusion is not required and, thus, the patient is immediately mobilised after surgery.

MATERIALS AND METHODS

This study was carried out from January 1991 to January 1998. One hundred and seventy-one patients should have undergone traditional surgery for 296 herniated cervical discs. All patients had symptoms of cervical myelopathy and/or radiculopathy. They were, instead, treated by using the endoscopic microsurgical techniques. In 148 patients with 273 herniations, the surgical procedure was performed by a paramidline right anterior approach (AA), while in 23 patients with 23 herniations by a paramidline posterior approach (PA). Preoperatively all patients had plain films and magnetic resonance imaging (MRI) (*Figures 8A, 10A*) and the patients with bony changes had computed tomography (CT) scans (*Figure 9A*) with or without associated myelography (mielo-CT). Ninety-eight of these 171 patients were males, while 73 were females. Average age was 45 years. The youngest subject was 16-years-old and the oldest was 85-years-old. Six patients had four herniations, 27 patients had three, 53 patients had two, while 85 had only one herniation. The herniated cervical disc was at the C_2–C_3 level in four cases, at the C_3–C_4 level in 28 cases, at the C_4–C_5 level in 56 cases, at the C_5–C_6 level in 99 cases, at the C_6–C_7 level in 91 cases, and at the C_7–T_1 level in 18 cases. These surgical techniques were studied and practised over a long period of time on cadavers, before they were applied to patient care. When in cervical disc herniation there was failure of nonoperative management, progressive neurological deficit or myelopathy, operative intervention was considered: these patients were included in the present study. We used for the first time endoscopic microsurgery with posterior approach for far lateral disc herniation when there was no imbrication of adjacent lamina. We used endoscopic microsurgery with anterior approach in the other cases. In recent years we were inclined to use instead only anterior approach. In both techniques we administered prophylactic antibiotic treatment and surgery was performed under general endotracheal anesthesia, sometimes in neurolept analgesia with local anesthesia. In some cases, monitoring of the operation with somatosensory and motor evoke[d] potentials may be helpful. All the operative technique[s] must be followed carefully, step by step. The operatin[g] surgeon must be properly trained in these endoscopi[c] techniques. In the PA the patient is placed in the pron[e] position on the operating table with the neck slightl[y] flexed. Before making a skin incision, a lateral fluoro[-] scopic image should be obtained to verify the exac[t] intervertebral level. Then, a very small incision, less tha[n] 5 mm long, is made over the ligamentum flavum at th[e] correct vertebral space, in paramidline area. A blun[t] obturator is introduced first in dorsal fascia, and then, i[n] paraspinal muscles up to the ligamentum flavum[.] Successively the working sleeve is introduced an[d] guided by the blunt obturator until it reaches th[e] ligamentum flavum, which is passed using a sma[ll] trephine passing through the working sleeve. The[n] using a fine blunt instrument, palpation beneath th[e] nerve root is done from both above and below, und[er] endoscopic control, which is obtained by a microendo[-] scopic rigid or flexible canula, previously inserted in th[e] working canal. Bleeding from epidural veins can b[e] controlled with tiny cotton pledgets. During surger[y] irrigation and suction in the operating field are achieve[d] by suitable microinstruments. A bipolar coagulati[on] microelectrode must be available, if required. It [is] important not to cause pressure on the dural sheat[h] and great care is necessary in separating the dural slee[ve] of the nerve root from the underlying herniated disc a[nd] reactive adhesions (*Figure 5*). The nerve root is th[en] retracted superiorly (sometimes inferiorly), thus t[he] herniated part can be removed using different micr[o-] instruments, such as microforceps (*Figure 4*), micr[o-] scissors (*Figure 5*), microknives of different shap[e,] microprobes (*Figure 6*), microhooks, and microresecto[rs.] It is important to verify that the nerve root is complete[ly] decompressed and mobile by following the nerve ro[ot] out laterally and medially, using microhooks graduat[ed] in different ways (*Figure 6*) and suitable flexible or ri[gid] endoscope. In this phase, delicate movements a[re] required to avoid injury to the nerve root and to t[he] dural column. A drain is not necessary using endosco[pic] microsurgery. In the AA the patient is placed in t[he] supine position, a pillow is placed under the neck [to] maintain physiological cervical lordosis, and the p[a-] tient's face is kept straight (*Figure 1B*). The arms shou[ld] be placed at the side, pulled distally and held in place [to] facilitate positioning of the surgeon and obtaining int[ra-] operative fluoroscopic images. The midline and t[he] intervertebral level of the herniation are then drawn [on] the skin of the neck under fluoroscopic control (*Fig[ure] 1A*). A very small incision, less than five millimeters [is] made vertically at the correct intervertebral space, [on] the right side, about 15 mm from the midline. T[he] platysma muscle is also incised in the entire width of [the] skin incision. A blunt obturator (*Figure 1B*), is introdu[ced] through the skin and the platysma muscle. After incis[ion] of the pre-tracheal fascia, which is opened just ante[rior] to the sternocleidomastoid muscle, the subplatys[mal] dissection can be done. Using a blunt obturator, [the] strap muscles, the trachea and the esophagus

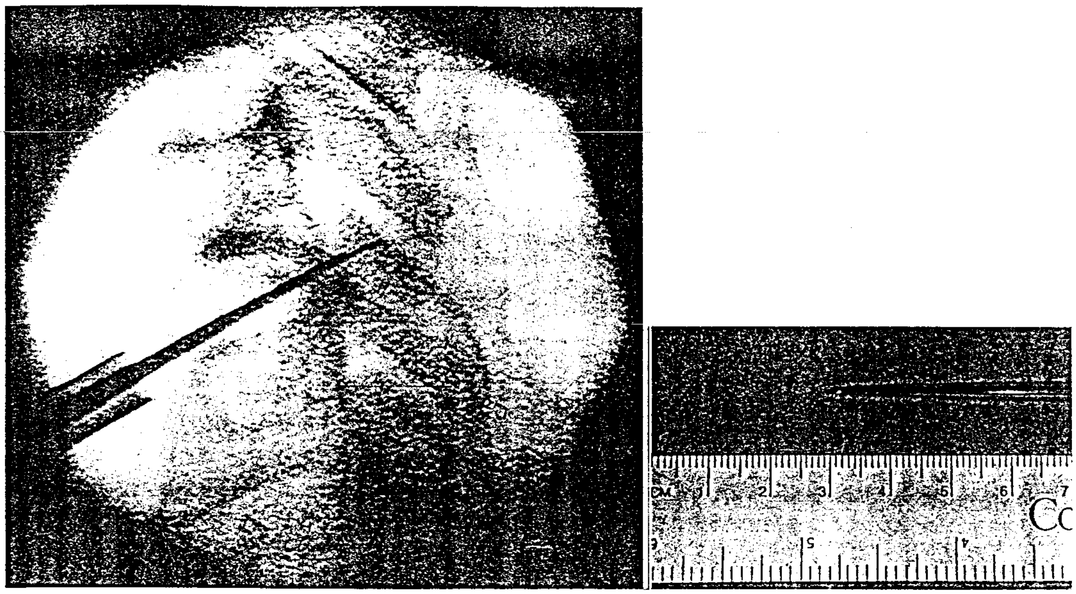

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Figure 6A: Fluoroscopic view of microprobe angled at 45 degrees used to verify that the nerve root and spinal cord are completely decompressed and mobile. In this phase, delicate movements are required to avoid injury to the spinal cord, the nerve root and the dural sheath. **B:** The microprobe in use

retracted medially, while carotid sheath is held laterally. The working sleeve is then introduced and guided by the blunt obturator until it reaches the prevertebral fascia, which is opened by a small microknive. At this point the working canal is placed against the anterior longitudinal ligament and the edge of the anterior part of the adjacent vertebral bodies. An appropriate sized trephine is inserted in the working sleeve and carefully advanced in intervertebral space up to the herniation (*Figures 2* and *3A*). Using a microendoscopic rigid or flexible canula for endoscopic control, the herniated part can be removed (*Figure 3B*). Many instruments may be used, such as various types of microforceps, for example upwards, downwards, straight (*Figure 4*), and flexible, several types of microknives, microscissors (*Figure 5*), microprobes (*Figure 6*) and microhooks, with different angulations, and various microresectors. During surgery, as well as PA, irrigation and suction in the operating field are necessary and a bipolar microelectrode must be available[13]. No conclusive evidence exists for removal of all osteophytes from the posterior part of vertebral body or for removal of the posterior longitudinal ligament[10,15–22]. We believe that it is important to remove only the part of the osteophytes which is compressing the nerve root and/or the spinal cord. A small and lengthened high-speed drill with diamond bit and curettes of different sizes and shapes, are used to remove osteophytes. The drain is not used. The patient can be up 20 h after surgery and be discharged within a day or two. He is placed in a cervical collar when he is not in bed, for four weeks after surgery. Activities are limited in the first weeks. There is a full resumption of activities, including work, within four weeks.

RESULTS

In this study we considered success as the disappearance or the improvement of patient's symptoms, such as myelopathy, radiculopathy or neck pain. In our study there were neither incidents during surgery, nor major complications following these operations. The period of follow-up ranged from 12 months to 84 months. Patients were examined one month, three months, six months and one year after surgery, and thereafter on a yearly basis. No patient experienced relapse following operation in this study period. After one month the success rate was 94.7% (162 of the 171 patients), after three months 95.9% (164 of 171), after six months 96.4% (165 of 171), after one year 97.0% (166 of 171) (*Figure 7*). We saw the same results after a period of longer than one year. In this study there were three patients with a large and lateral herniation compressing the vertebral artery. In these three patients the symptoms correlated with vertebral artery compression disappeared after surgery. In our series of patients disc space narrowing was not present in the subsequent radiographs of all the cases operated either with AA or PA. In the dynamic view radiographs, the mobility of cervical spine in flexion, extension and in lateral bending was completely preserved, as with previous surgery. Kyphotic changes were never noted in the time using this endoscopic microsurgery. The MRI and CT post-operative controls demonstrated a complete removal of the herniations (*Figures 8–10*).

DISCUSSION AND CONCLUSION

This study suggests that for herniated cervical discs, the endoscopic microsurgical technique is an extremely

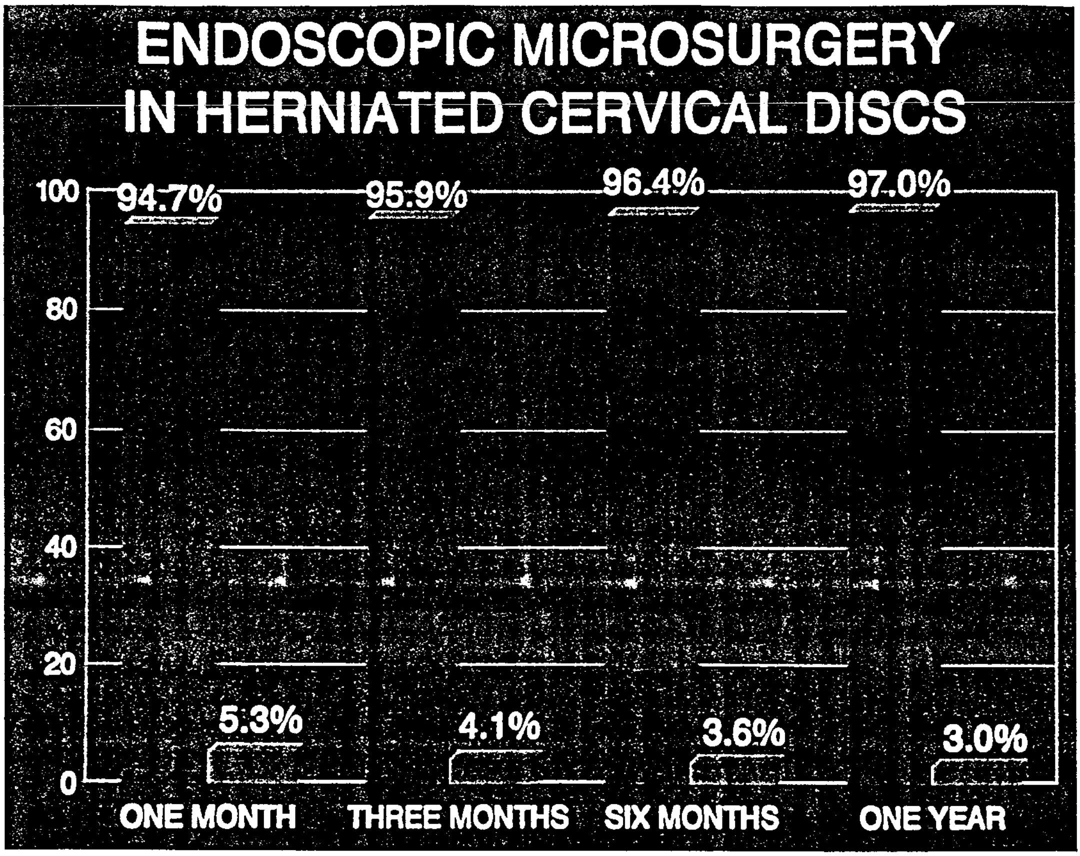

Figure 7: Changes over time in success rates (green) and failure rates (red) in the present study. After one month the success rate was 94.7% (162 of the 171 patients), after three months 95.9% (164 of 171), after six months 96.4% (165 of 171), after one year 97.0% (166 of 171). We saw the same results after periods of longer than one year

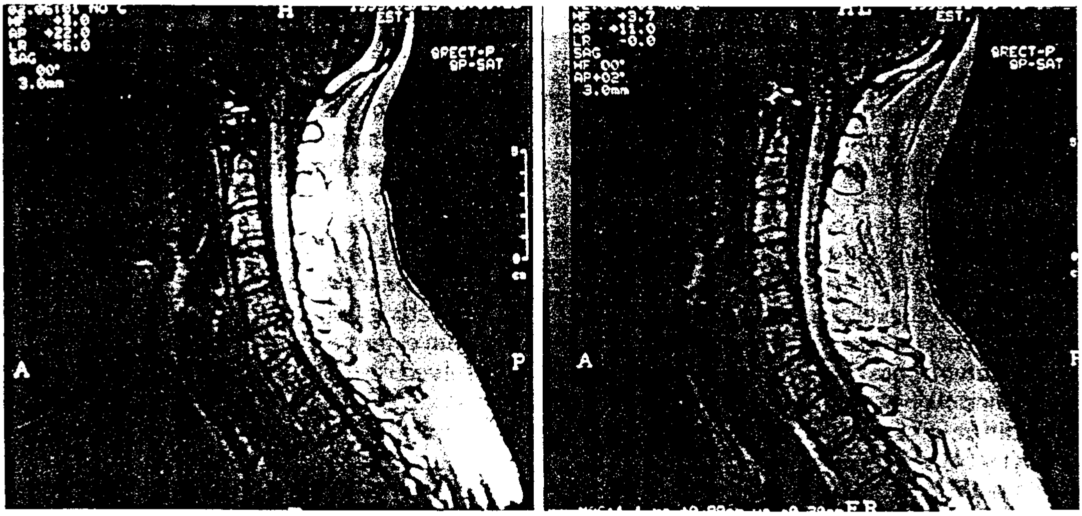

Figure 8 A: MRI view of a patient with a disc herniation at C_5–C_6 level. **B:** Post-operative MRI confirms a complete removal of the herniated part

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Figure 9 A: CT view of a patient with a disc herniation at C_5–C_6 level. B: Post-operative CT scan demonstrates a complete removal of the herniation

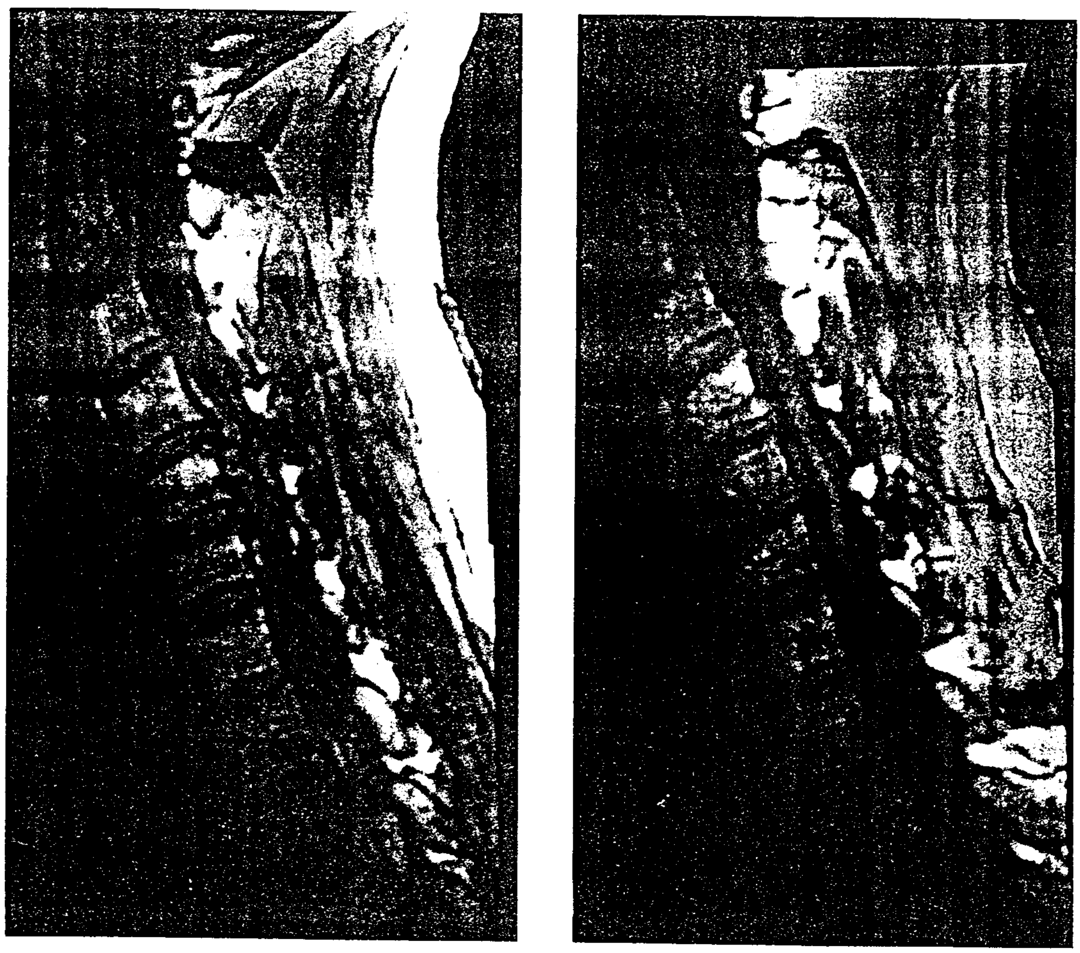

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Figure 10 A: MRI view of a patient with two large extruded fragments of disc herniation at the C_4–C_5 level and the C_5–C_6 level. B: Post-operative MRI shows a whole removal of the disc herniations advantageous and safe method[14,15]. The goal of this surgical technique was to achieve direct and effective anatomical decompression of the spinal cord and/or nerve root and/or vertebral artery, without fusion of the adjacent vertebral bodies and without post-operative immobilisation by maintenance of integral spinal stability. With this endoscopic technique it is possible to maintain a normal mobility of intervertebral space, avoiding the inevitable stresses applied to adjacent interspaces following fusion and the consequent secondary morbidity. Following this keyhole surgery, complications are very improbable and there are no iatrogenic changes secondary to the surgery. In all the patients we did not remove most of the disc in the intervertebral space, which maintains spinal stability. This technique allow us to operate on several levels of the cervical spine at the same time. The operation time of this endoscopic technique is significantly shorter than in the open traditional techniques. Average time in endoscopic microsurgery to perform a standard herniectomy was 25 min. Comprehensive training in this kind of surgery is necessary before performing operations. We think that continued development and improvement of instruments, longer follow-up periods and a greater number of patients treated, will further confirm this endoscopic microsurgical technique[14].

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