2. Benzel EC: Biomechanics of Spine Stabilization: Principles and Clinical Practice. New York: McGraw-Hill, 1995, pp 97-102.
3. Berg EE: The sternal-rib complex. A possible fourth column in thoracic spine fractures. Spine 1993; 18:1916-1919.
4. Bohlman HH, Zdeblick TA. Anterior excision of herniated thoracic discs. J Bone Joint Surg [Am] 1988; 70-A: 1038-47.
5. Denis F: The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine 1983; 8:817-831.
6. Dickman CA, Mican C. Multilevel anterior thoracic discectomies and anterior interbody fusion using a microsurgical thoracoscopic approach. J Neurosurg 1996; 84:104-109.
7. Krotenkov PV. Modified anterolateral extrapleural approach for thoracic disc herniation. J Russian American medical association 2006; 3(1):23. Available at: http://www.russiandoctors.org/journal/vol3/page23.pdf
8. Schlenk RP, Steward T, Benzel EC. The biomechanics of iatrogenic spinal destabilization and implant failure. Neurosurg Focus 2003; 15(3):21-32.
9. Wakefield AE, Steinmetz MP, Benzel EC. Biomechanics of thoracic discectomy. Neurosurg Focus 2001; 11 (3):45-52.
10. Yoganandan, N., Pintar, F., and Sances, A., Jr. Biomechanical investigations of the human thoracolumbar spine. SAE Trans. 1989; 97:676-684.

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**БИОМЕХАНИЧЕСКИЕ СВОЙСТВА ГРУДНОГО ОТДЕЛА ПОЗВОНОЧНИКА ПОСЛЕ ПЕРЕДНЕБОКОВОЙ МИНИМАЛЬНО ИНВАЗИВНОЙ ДИСКЭКТОМИИ**

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**АБСТРАКТ:**

*Понимание биомеханических свойств грудного отдела позвоночника и его костно-связочного аппарата важно для предупреждения потенциально деструктивного и дестабилизирующего эффекта оперативного вмешательства. В данной работе кратко рассмотрены биомеханические последствия переднебоковой дискэктомии при грыже грудного межпозвонкового диска, посредством модифицированного переднебокового экстраплеврального доступа, в свете биомеханических моделей позвоночника по Denis и Benzel.*

**Ключевые слова:**

*биомеханика, грыжа грудного межпозвонкового диска, переднебоковой экстраплевральный доступ, грудной отдел позвоночника, дискэктомия.*



**P.V.Krotenkov, A.M.Kiselev, O.V.Krotenkova*, J.W.D'souza***

# MICROSURGICAL EVALUATION OF MODIFIED ANTEROLATERAL EXTRAPLEURAL APPROACH FOR THORACIC DISK HERNIATION

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**ABSRTACT:**

*The management of thoracic disc herniation (TDH) has historically been prob-lematic, contradictory and technically demanding. We have modified the anterolateral extrapleural approach for the surgical treatment of TDH. The employed approach is minimally invasive, implies the use of an endoscope and requires no fusion and bone drafting. We used it for the treatment of 8 patients with symptomatic TDH. Postoperative results were favorable, and were accessed using ASIA/IMSOP classification. Our results suggest that modified anterolateral extrapleural approach (MALEA) may be a valuable option in the management of TDH.*

**Keywords**:

*anterolateral extrapleural approach, thoracic disc herniation, thoracic spine*

**Introduction**

The incidence of thoracic disc herniation (TDH) is being estimated at around 1 in 1 million. TDH is associated with significant morbidity and disability and its management has historically been prob-lematic and technically demanding [1-9]. Although some authors have shown conservative treatment of TDH to be effective, myelopathy is an absolute indication for the surgical treatment [5, 9]. Nowadays the standard surgical management of TDH is an anterolateral transpleural approach [2] or thoracoscopy [9], both of which, despite obvious advantages over posterolateral [1] and lateral approaches [3], have certain limitations. In order to excel our clinical results, we combined the advantages of traditional anterolateral transpleural approach and thoracoscopy, yielding modified anterolateral extrapleural approach

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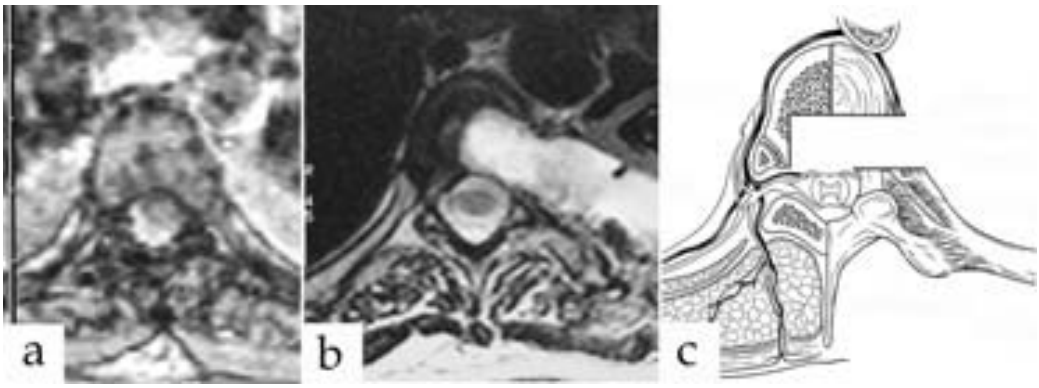


**Fig.1.** MRI of the thoracic spine and illustration of the MALEA.
**a** – Preoperative MRI shows massive centrolateral TDH at T6-7; **b** – postoperative MRI shows a channel created by excision of the TDH, disc and vertebral bodies at T6-7; **c** – illustration of the MALEA

(MALEA) for the surgical treatment of TDH. The employed approach is minimally invasive, implies the use of an endoscope and requires no fusion and bone drafting.

**Materials and methods**

Twenty fresh cadaver sessions, attempting middle and lower thoracic levels, were performed to determine microsurgical feasibility of the MALEA. Eight patients underwent MALEA removal of TDH. The group was comprised of five males and three females, ages 45–60. All patients had thoracic myelopathy presenting as walking difficulty, two had bladder dysfunction. Seven patients had single THD at levels ranged from T7 to T12, one had contiguous two-level TDH at T5-6 and T6-7. During the operation 6 patients were revealed with central or centrolateral location of herniation, 2 had lateral location.

The operation is performed with the patient under gen-eral anesthesia. The procedure is accomplished without entrance into the pleural cavity. The patient is placed in the lateral position; the side to be placed facing up is dictated by the abnormality. The artery of Adamkiewicz, which enters on the left side in 80% of cases, is a concern, but we believe we should have access to the side of greater cord compression. An axillary roll is placed, and the patient is positioned over the table break. The skin incision begins from 3 cm lateral to the midline and extends over the rib to the middle axillary line, for about 8-10 cm long. The skin incision is cephalad to the rib head to be resected. The skin incision is then deepened through the subcuta -neous tissues, latissimus dorsi, and serratus anterior mus-cles and is retracted with self-retaining retractors. The fascia immediately lateral to the erector spinae is divided along its length, and the muscle is dissected off the rib anterior to it, with the dissection proceeding medially to the transverse process. The periosteum over the rib is incised along its exposed length with cautery, stripped off the rib with elevators, and transected later-ally. Medially, sharp dissection is required to partially section the capsular ligament and to disarticulate the rib head. Unlike traditional anterior approaches, costotransverse ligament and transverse process is intentionally remained intact, maintaining noninvasive pattern of the approach. Neurovascular bundle under the rib is identified and followed medially. By blunt dissection, the parietal pleura, is separated from the ribs above and below and from the spinal column. The operating microscope is now used. With a high-speed drill the bony dissection is performed into the posterior 1 cm of the vertebral body adjacent to the disk, and a thin shell of the posterior cortex is kept intact to prevent epidural venous bleeding at this stage. Pedicle is remained intact. We remove the posterior one third of the disk and the posterior one third of the vertebral body adjacent to the disk (Fig 1. a, b, c). Thus, adequate room is created to allow inspection of the anterior face of the spinal canal. The thin, bony shell of the posterior cortex is dislodged anteriorly into the defect so created. The posterior longitudinal ligament is then in-cised and displaced anteriorly, both above and below the herniated disk. The endoscope is now used. The herniated disk and epidural sequestrated fragments are dislodged anteriorly and removed under control of endoscope, and the decompression is completed. The operative site is thoroughly irrigated, and the chest wound is closed in layers. Because the anterior and posterior columns remain intact, the middle column has been removed in part, and the spine is stable, fusion and bone grafting are not re-quired. Early ambulation and intensive spirometry are encouraged.

**Results**

No operative or postoperative complications were encountered with MALEA. Patients were evaluated with postoperative computed tomography and magnetic resonance imaging, which demonstrated the extent of the exposure and complete removal of TDH. Postoperative results were favorable, with a follow-up of 3 years and were accessed using ASIA/IMSOP classification. ASIA scores improved in all patients who had motor or sensory findings.

**Discussion**

Treatment of TDH includes both operative and nonoperative options. Surgical indications include progressive myelopa-thy, paralysis, or intractable pain that is refractory to nonoperative measures. The thoracic spine has several unique characteristics that create poten-tial risks during surgical manipulation. Despite the relatively small spinal cord size, the ratio of spinal cord to spinal canal is larger in the thoracic spine than in other areas. Additionally, the blood supply is more variable here with a particularly vulnerable region between T4 and T9, the wa-tershed zone. It has been demonstrated that lesions impacting on the spinal cord create compressive forces that are greatest at the point of contact and rapidly diminish with distance from the site of contact. These forces are zero at the opposite surface [2-6, 9]. Additionally, the forces result in axial tensions that are greatest on the surface opposite the site of compression. A reduction in these forces and tensions occurs only by direct removal of the lesion [9]. This is responsible for the poor results seen with laminectomy in the management of TDH and the reason for surgeons to adopt alternative surgical

approaches [1-4]. In 1958, Crafoord, used a modification of the lateral rhachotomy approach for a TDH [4]. Hulme, in 1960, utilized a lateral modified costotransversectomy [6]. In 1969, Perot and Munro reported using the transthoracic approach for disc excision [8]. In 1984, Maiman and Larson reported using the lateral extracavitary approach on 23 patients with TDH [7]. Since 1969, the thoracotomy approach has been used with greater frequency, until the early 1990s, when development of thoracoscopy for spinal surgery has provided new perspectives for the operative treatment of TDH [5].

MALEA has the several advantages over conventional approaches and thoracoscopy: 1) TDH frequently extrudes into the central area of the spinal canal, where the conventional posterior or transpedicular ap-proaches may not allow sufficient decompression. 2) It provides sufficient exposure to perform an extensive decompression of the spinal cord on the multiple levels, and the use of endoscope gives additional safety and visualization to the procedure. 3) Discectomy is performed with minimal osteoligamentous resection, anterior and posterior columns remained intact, and the spine remained stable, fusion, bone grafting or spinal instrumentation are not re-quired. 4) Microsurgical extrapleural approach eliminates the risk of postoperative pulmonary complications and injury to intercostal nerves, significantly reducing morbidity.

MALEA for the surgical treatment of TDH can provide satisfactory results without major complications and should be considered by surgeons experienced with both the conventional transthoracic approach as well as minimally invasive thoracoscopic surgery.

**References**

1. Arseni C, Nash F. Thoracic intervertebral disc protrusion: a clinical study. J Neurosurg 1960;17:418-30.
2. Bohlman HH, Zdeblick TA. Anterior excision of herniated thoracic discs. J Bone Joint Surg [Am] 1988;70-A: 1038-47.
3. Carson J, Gumpert J, Jefferson A. Diagnosis and treatment of thoracic intervertebral disc protrusions. J Neurol Neurosurg Psychiatry 1971;34:68-77.
4. Crafoord C, Hiertonn T, Lindblom K, Olsson SE. Spinal cord compression caused by a protruded thoracic disc: report of a case treated with anterolateral fenestration of the disc. Acta Orthop Scand 1958;28:103-7.
5. Dickman CA, Mican C: Multilevel anterior thoracic diskectomies and anterior interbody fusion using a microsurgical thoracoscopic approach. J Neurosurg 1996;84:104-109.
6. Hulme A. The surgical approach to thoracic intervertebral disc protrusions. J Neurol Neurusurg Psychiatry 1960; 23:133-7.
7. Maiman DJ, Larson SJ, Luck E, Elghatit A: Lateral extracavitary approach to the spine for thoracic disk herniation: Report of 23 cases. Neurosurgery 1984;41:178-182.
8. Perot PL, Munro DD. Transthoracic removal of midline thoracic disk protrusions causing spinal cord compression. J Neurosurg 1969;31:452-8.
9. Stillerman CB, Chen TC, Couldwell WT, Zhang W, Weiss MH. Experience in the surgical management of 82 symptomatic herniated thoracic discs and review of the literature. J Neurosurg. 1998;88(4):623-33.

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## МИКРОХИРУРГИЧЕСКОЕ ОБОСНОВАНИЕ МОДИФИЦИРОВАННОГО ПЕРЕДНЕБОКОВОГО ЭКСТРАПЛЕВРАЛЬНОГО ДОСТУПА ДЛЯ ЛЕЧЕНИЯ ГРЫЖ ГРУДНЫХ МЕЖПОЗВОНКОВЫХ ДИСКОВ

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**АБСТРАКТ:**

*Среди нейрохирургов нет единого мнения о выборе оптимального хирургического вмешательства для лечения грыж грудных межпозвонковых дисков, однако все отмечают технические труд-ности данных оперативных вмешательств. Мы модифицировали переднебоковой экстраплевральный доступ к грудному отделу позвоночника, сделав его миниинвазивным, не требующим корпородеза и использовали эндоскоп для лучшей визуализации и безопасности меннингорадикулолиза, применив его при лечении 8 пациентов с грыжами грудных межпозвонковых дисков. У всех пациентов, после оперативного лечения получены хорошие результаты, с регрессом неврологической симптоматики, оценивавшейся по шкале ASIA/IMSOP. Мы считаем, что модифицированный переднебоковой экстраплевральный доступ может быть ценной альтернативой для хирургического лечения грыж грудных межпозвонковых дисков.*

**Ключевые слова:**

*грыжа грудного межпозвонкового диска, переднебоковой экстраплевральный доступ, грудной отдел позвоночника*