



Minimally invasive surgery. Transforaminal lumbar interbody fusion. Argument of position study group vertebral surgery Latin America

Cirugía de mínima invasión. Fusión intersomática lumbar transforaminal. Argumento de posición grupo de estudio cirugía vertebral Latinoamérica

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Abstract

Introduction: minimally invasive spine surgery (MISS) has had an exponential development in the last two decades, offering wide intra-surgical and post-surgical benefits compared to open techniques; The MIS-TLIF technique is a recent alternative that involves a paramedian approach, tubular retractor and microscope or endoscope, which gives us the possibility of performing a transforaminal interbody fusion with adequate release of the neural and foraminal canals, all through a single approach «Over-the-top». **Objective:** to discuss and generate recommendations on the MIS-TLIF, focusing on technical and news to unify criteria and establish a current panorama of competence for spine physicians in training. **Material and methods:** through a consensus and the criteria of 3 spine surgeons who are experts in minimally invasive surgery using relevant search criteria with MIS-TLIF, which stood out: definition, techniques, benefits, complications, material resources and training for surgeons in training, in the Google scholar, PubMed search engines in English and Spanish from 2000 to 2021. **Results:** 16 steps could be identified and created sequentially as a support for surgeons in minimally invasive training, demonstrating the versatility and easy diffusion of MIS-TLIF always with the training of an experienced spine surgeon. **Conclusion:** the MIS-TLIF technique is a versatile surgery that should be diffused in all training centers for spine surgery since it allows us to perform interbody fusions and decompressions from T12 to S1 with positive impact recovery in the short and medium postoperative period term compared to open techniques.

Keywords: posterior lumbar interbody fusion, transforaminal lumbar interbody fusion, minimally invasive transforaminal lumbar interbody fusion, pedicle screw techniques, degenerative disc disease.

Resumen

Introducción: la cirugía de columna mínimamente invasiva (MISS) ha tenido un desarrollo exponencial en las últimas dos décadas, ofreciendo amplios beneficios intraquirúrgicos y postquirúrgicos comparado con las técnicas abiertas; la técnica MIS-TLIF es una alternativa reciente que implica un abordaje paramediano, retractor tubular y microscopio o endoscopio, la cual nos da la posibilidad de realizar una fusión intersomática transforaminal con adecuada liberación de canal neural y foraminal, todo a través de un abordaje único Over-the-top. **Objetivo:** discutir y generar recomendaciones sobre la MIS-TLIF enfocado en actualidades y técnicas para unificar criterios y establecer un panorama actual sobre la competencia para los médicos en formación especialistas en columna. **Material y métodos:** mediante un consenso y el criterio de tres cirujanos de columna vertebral expertos en cirugía de mínima invasión, usando motores de búsqueda relevantes a MIS-TLIF: definición, técnicas, beneficios, complicaciones, recursos materiales y entrenamiento para cirujanos en formación, en los buscadores Google Scholar, PubMed en idioma inglés y español desde el año 2000 a 2021. **Resultados:** se pudieron identificar y crear de manera secuencial 16 pasos a modo de apoyo a los cirujanos en entrenamiento de mínima invasión; demostrando la versatilidad y la fácil difusión de MIS-TLIF siempre con el adiestramiento de un cirujano con experiencia. **Conclusión:** la técnica MIS-TLIF es una cirugía versátil que debe ser difundida en todos los centros de entrenamiento para cirugía de columna vertebral, ya que nos permite realizar fusiones intersomáticas

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y descompresiones desde T12 a S1 con impacto positivo en la recuperación postquirúrgica a corto y mediano plazo comparado con técnicas abiertas.

Palabras clave: fusión intersomática lumbar posterior, fusión intersomática lumbar transforaminal, fusión intersomática lumbar transforaminal mínimamente invasiva, técnicas de tornillos pediculares, enfermedad discal degenerativa.

Introduction

Minimally invasive spine surgery (MISS) is a set of techniques and procedures that depend on technology, reduces local surgical tissue damage and systemic stress, which allows an early return of function with better results than traditional techniques (AOSpine MISS Curriculum Task Force, May 3, 2018; Singapore), for this, the group of experts at AOSpine recommends training always guided by a Senior surgeon, based on a structured and gradual study plan, from basic, advanced and master, always keeping in mind the professional and ethical approach with the following concepts: objective (optimized patient selection), technology (optimal combination of approach, visualization, navigation, instrumentation, and biological augmentation), technique (microsurgery, neural protection, decompression, stabilization), training (simulation, observation, mentoring), and testing of limits (MISS for deformity, robotics).^{1,2} Taking into consideration the above, the general objective was set for the authors to update MISS-TLIF in definition and techniques, in the search engines Google scholar, PubMed in English and Spanish from 2000 to 2021 that help the diffusion and easy step-by-step understanding, writing down 16 crucial points in the authors' experience that will help surgeons in training at all spine centers.

MISS surgery education

Access to MISS in Latin America is difficult due to the implants costs, accessibility to surgical microscopes, and, more importantly, face-to-face educational opportunities in formal surgical teaching programs with a specialized «orthopedic and neurosurgical» approach are scarce.^{3,4}

Advantages of the MIS-TLIF technique (minimal surgery-transforaminal lumbar interbody fusion)

Spine anatomical knowledge, the type of instrumentation material, knowing the specific surgical

indication for each patient and recognizing the surgeon's experience are indicators of good post-surgical results;⁵ in this way, we can divide the advantages into intraoperative, short-term and medium-term.

Intraoperatively, it is possible to significantly reduce bleeding, decrease surgical times, reduce the consumption of intraoperative anesthetics, which secondarily leads to a low consumption of postoperative opioids, having an earlier mobilization of the patient.^{6,7}

In the short term, we can mention results that show that an adequate discectomy and placement of the intersomatic cage translates into sufficient indirect decompression for the nerve roots, in addition, as an alternative, a direct decompression can be performed unilaterally «Over-the-top» with the help of a tubular retractor⁸ (Figure 1), achieving decompression of the central canal and a foraminal level, which we can corroborate in radiographic and magnetic resonance studies.^{9,10}

As it is a technique of less than 2 decades of development, at the moment, the literature reports follow-up results ranging from 1 to 5 years post-surgery. In some studies with similar results comparing with

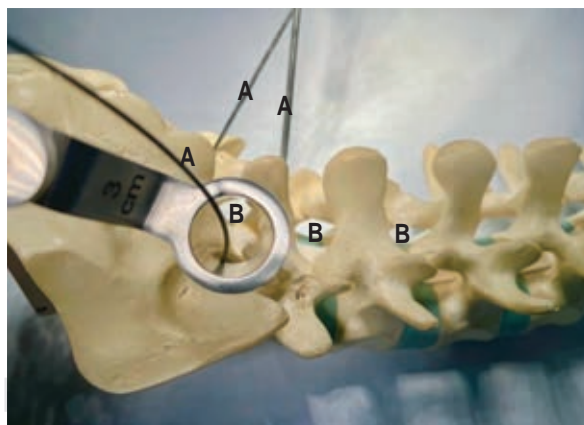


Figure 1: Contralateral inclination of the surgical table, as well as oblique positioning of the tubular separator, to be able to visualize the central and contralateral area of the spinal canal and in this way perform an adequate contralateral foraminal release, always keeping in mind the pedicle guide and the nerve structures. **A)** Pedicle guides. **B)** Spinal space and contralateral foramen.

open TLIF, evaluating fusion and complications,¹¹⁻¹⁴ it is concluded in favor that as it is an intermuscular approach, it respects the insertions, as well as the nerve pathways, it causes less muscle atrophy and, in some cases, an increase in paravertebral musculature when compared to open methods;^{15,16} some studies, evaluating the function and connection with the patient's level of anxiety and satisfaction, suggest a possible trend in favor of the MIS-TLIF technique for ODI (Oswestry Disability Index), leg pain VAS (Visual Analog Scale of pain) and back pain VAS, this expressed in psychological analysis of the patient before the idea of a MISS procedure.^{17,18}

Learning curve

For an adequate practice of MIS-TLIF, one must have a clear knowledge of the technique, as well as the complications that may occur in the short and long term. The learning curve can take up to 2 years or an average of more than 30 MISS surgeries to have results comparable to a Senior surgeon;¹⁹ the transpedicular screw placement technique is fundamental, both for open surgery and for the percutaneous technique; where an intracanal safety margin of less than 2 mm is allowed with a learning curve of 70-80 correctly placed screws,^{20,21} for this, the AOSpine study group suggests methodically 20 safety steps for placement with the percutaneous technique;²² Knowledge of the technique, surgical planning, use of lead attachments, placement lateral to the image intensifier and far from the surgeon's beam generator, result in less exposure to radiation, resulting in a lower risk of developing cancer or cataracts, which is the main concern of the apprentice surgeon.^{23,24}

Complications

Incorrect diagnosis and surgical indication translate into complications and technical difficulties, which, in some cases, can cause radiculopathy ipsilateral or contralateral to the approach, this secondary to a sagittal and coronal imbalance due to the lateral and posterior positioning of the intersomatic box even in the 5% of cases.²⁵ Cage subsidence is associated with elevated BMI (body mass index), paravertebral muscle injury, implant characteristics such as size greater than 12 mm, titanium-coated PEEK (Poly-ether-ether-ketone) and a combination of grafts types.²⁶ In addition, the use of

postoperative spinal orthosis to prevent complications of instability and increase the percentage of fusion is not indicated, since it has been discovered that it does not influence superiority to non-use, but it does increase muscle atrophy, which, in certain patients, can be counterproductive.²⁷

Objective: the general objective of this consensus was to discuss and generate recommendations on the MIS-TLIF, focusing on technical news, unifying criteria, establishing a current panorama of competence for spine physicians in training, as well as sequentially recommending the key steps for a surgery with a high success rate in the authors' experience.

Material and methods

It is carried out by consensus of the spine surgery department of the minimally invasive surgery concentration center, which brings together a Neurosurgeon member of Task Force MISS AO Spine, a Neurosurgeon certified by Bremen Germany Klinikum Bremen Mitte University of Goettingen, both with More than 15 years of experience in endoscopic and minimally invasive surgery, as well as an AO Spine Certified Spine Surgeon, with training in minimally invasive and endoscopy at the same institution. 2 face-to-face meetings and 4 virtual meetings were held in which relevant topics were defined as search criteria with MIS-TLIF, which stood out: definition, techniques, benefits, complications, material resources and training for surgeons in training, in the Google scholar, PubMed search engines in English and Spanish from 2000 to 2021 with the keywords: lumbar spine fusion; posterior lumbar interbody fusion, transforaminal lumbar interbody fusion; minimally invasive transforaminal lumbar interbody fusion, pedicle screw techniques, degenerative disc disease; spine; selecting relevant information for the authors, according to the level of evidence and type of article, having 30 articles from level 2 to 4 of evidence.

Results

Based on the scientific evidence presented and the experience of the authors as an aid to the surgeon in training, the following is suggested:

1. Adequate positioning of the patient on the operating table with the abdomen free to reduce bleeding due to abdominal pressure.

2. Fluoroscopic marking of the levels to be instrumented and decompressed (*Figure 2*).
3. Make a skin and fascia approach of 2.5 cm to allow the passage of each percutaneous screw.
4. Starting from the contralateral side to the decompression, the entry point is located and the Jamshidi needle trocar is placed until the beginning of the vertebral body passing the guide for the screw until the middle third of the vertebral body with the use of a fluoroscope.²²
5. Place the screws on the contralateral side to the decompression, without placing the bar.
6. On the ipsilateral side according to the level to intervene, place the guide of the caudal pedicle of the level to intervene.
7. Place the tubular retractor in a medial and superior position with reference to the pedicle guide, this allows to be observed at all time the superior and inferior laminae, the limit of the articular facet and the screw entry point, achieving in this way an adequate three-

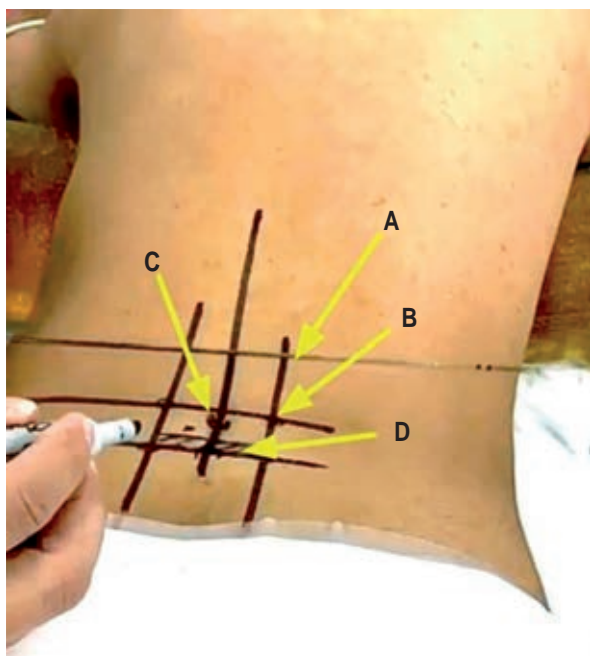


Figure 2: Skin marking with a fluoroscope help. **A)** Metallic guide for marking approach and orientation lines. **B)** Intersection point indicating the pedicle line and entry point for placement of the pedicle screw. **C)** Spinous process of the upper level to intervene. **D)** The ideal area is marked for placement of the tubular retractor located superior to the inferior pedicle line and inferior to the spinous process of the superior vertebra.

- dimensional orientation of the nerve structures to decompress (*Figure 3*).
8. To position the surgical microscope at the correct angle to visualize the structures to be resected and decompressed.
9. Perform soft tissue resection to expose the border of the superior lamina, inferior lamina, and articular facet at its internal and external border.
10. With the use of a drill and irrigation, remove the edges of the lamina until the ligamentum flavum insertion, then gradually remove the articular facet with the use of a drill and Kerrison forceps starting from medial to lateral, always keeping in mind the three-dimensional orientation of the nervosa root and the lateral border of the dural sac (*Figure 4*).
11. Change the angle of the tubular retractor and the contralateral oblique surgical table to perform superior decompression if it is necessary (*Figure 1*).
12. Return the table to the original position, retract the dural sac and root always through the shoulder to avoid laceration due to traction and continue exposing the intersomatic disc, taking care to first perform hemostasis with bipolar cautery of each vessel to avoid hemorrhage.
13. After discectomy and hemostasis, the intersomatic cage is placed in an anterior and central position with the use of a fluoroscope, this allows better correction of sagittal balance and less risk of subsidence.
14. Remove the tubular retractor and place ipsilateral screws with the percutaneous technique described in step 4.
15. Place lateral bars and secure the system, as well as take final fluoroscopic images.
16. Confirm hemostasis and close fascia and skin.

Discussion

The description in the literature of multiple surgical approaches for the treatment of the same pathology requires us to know the advantages and disadvantages of each one, the adequate selection of the patient, the economic and material resources of our work area, as well as to recognize the surgical capacity of the surgeon to perform it and be able to minimize complications.^{28,29} As Hussain¹²⁸ mentions, the adequate selection of the previously assessed patient and depending on their clinical condition is the crucial step to perform a successful minimally invasive surgery, therefore, we must individualize each case

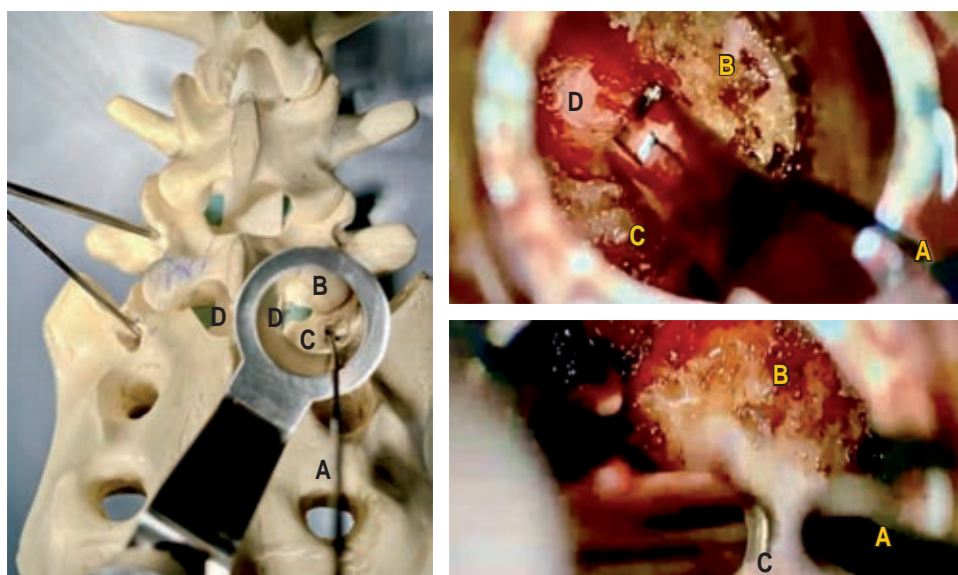


Figure 3:

Placement of a tubular separator at the right L5-S1 level, using the pedicle guide as a reference. **A)** Pedicle guide through a tubular separator allows us a better three-dimensional orientation. **B)** Lamina-facet junction of superior vertebra. **C)** Lamina-facet junction of inferior vertebra. **D)** *Ligamentum flavum* area.

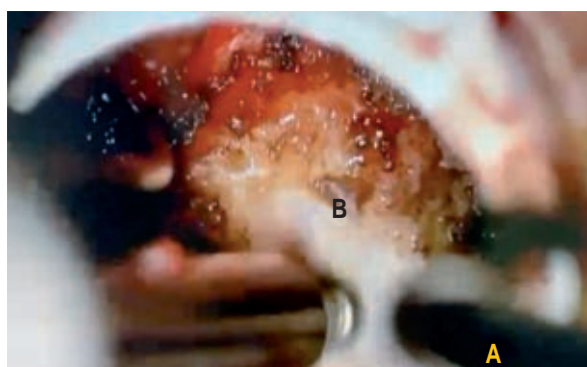


Figure 4: Using the pedicle guide as a reference, always work in the upper and lateral bone area until you find the edge of the *Ligamentum flavum* and thus achieve fast and safe decompression. **A)** Pedicle guide. **B)** Safe bone zone.

taking into account their comorbidities and, in this way, carry out adequate pre-surgical planning to achieve interbody fusion with the highest probability of success with the correct approach and the lowest possible risk, as its indicated by Mobbs RJ.²⁹

Based on the above, it is necessary to define that the MIS-TLIF technique should consider the characteristics and criteria proposed by some authors in the latest systematic review of the literature, which are: 1. Percutaneous screw placement by paramedian approach, 2. use of tubular retractor, 3. use of microscope or endoscope for visual aid; and in this way, we will be able to have higher quality studies in the short

and long term.³⁰ Thus obtaining scientific evidence that justifies the widespread use of the MIS-TLIF technique as it is a reproducible technique with a lower learning curve as part of the competencies of a spine surgeon, regardless of the geographical region where is located.

Conclusion

Knowledge of the anatomy, biomechanics, neurological clinic and surgical treatment of spinal pathologies have to be carried out gradually, always with the accompaniment of an experienced surgeon, this reduces the risk of complications, with favorable results. The MIS-TLIF technique is a versatile surgery that should be diffused in all training centers for spine surgery, since it allows us to perform interbody fusions and decompressions from T12 to S1 with positive impact recovery in the short and medium postoperative period. term compared to open techniques.

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Conflict of interests

The authors have no conflict of interest with this publication.