INTRODUCTION

In 1982, Harms and Rolinger suggested placing bone graft and titanium mesh in the intersomatic space, with distraction using prior transpedicular instrumentation through the direct transforaminal route; this approach could be completed by exposing the ipsilateral foramén, with minimal retraction of the thecal sac. The approach was called transforaminal lumbar interbody fusion (TLIF) and offers an alternative to posterior lumbar interbody fusion (PLIF), with the intention of achieving a circumferential fusion with minimal risk to the neural structures and avoiding the need for two separate surgical procedures.\(^1\)\(^-\)\(^3\) Minimally invasive TLIF (MI-TLIF) was described for the first time by Foley et al, in 2003.\(^4\) This approach is less traumatic; it has more rapid recovery compared with conventional open TLIF, and the more lateral exposure of the intersomatic space allows less manipulation of neural elements, preserves the posterior tension band, and reduces injury to the paraspinal muscles.\(^1\)\(^-\)\(^2\)\(^5\)\(^6\) The indications of MI-TLIF are: refractory mechanical low back pain, radicular pain associated with spondylolisthesis grade 1 and 2, degenerative disc disease, and recurrent disc herniation.\(^1\)\(^-\)\(^5\) However a weakness of the technique is the lack of microanatomical orientation, because the standard anatomical landmarks are not visible and it is technically difficult to work through a small surgical access incision.\(^1\) The perioperative time is longer than for conventional open TLIF, and exposure to radiation during surgery is higher.\(^2\) The aim of this work was to define the most relevant microanatomical landmarks of microsurgical target in the MI-TLIF; facet joint complex.

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MATERIAL AND METHODS

We carried out an observational study during MI-TLIF procedures; L4-L5 intersomatic left side levels were photographed under a microscope and edited in the OSX program (1983-2015, Apple Inc.). We then compared these with diagrams and anatomical models in order to show the microsurgical landmarks used by the Senior author (JASS) for access to the lumbar interbody space through the foramen during the MI-TLIF technique. All the surgeries were performed by the Senior author (JASS), assisted by the Principal author (JQO). The study was approved by the Soriano Institute of Minimally Invasive Spine Surgery (UQO012015ISCCM1)

PROCEDURE

The patient was placed in the prone position on a radiolucent operating table. Conventional fluoroscopy was performed to locate the radiological landmarks in MI-TLIF, in order to make the incision and accesses for placement of the percutaneous pedicle screws. We then started performing true shots with the C-arm. Working by the antero-posterior route, the upper endplate of the adjacent vertebral body and the upper endplate of the underlying vertebral body of the segment to be fused must be aligned, and in a true lateral shot with the C-arm, the surgical vector of the approach will be the intersomatic space (L4-L5, in this case). We then performed a longitudinal incision in the skin between 1.7 to 2 cm in most cases, dissecting the subcutaneous tissue, thoracolumbar fascia, subfascicular tissue and common muscle fascia by planes, until the boundary between the longissimus and iliocostalis muscles was visualized. Subsequently, blunt dissection was done, using the index finger to feel and identify the facet joint (L4-L5 left, in this case). The tubular retractors were then placed progressively, until the last retractor was positioned and fixed to the surgical table.

Then microscopic stage then began, with the aim of performing the transforaminal decompression, preparing the interbody space, and inserting the bone graft and interbody cage.

MICROSURGICAL LANDMARKS

The first microscopic image that we see through the tubular retractor is the remains of adjacent tissue to the facet joint; these can be easily coagulated and removed with disc forceps. We must subsequently define the limits of drilling, which will enable us to access the foramen from an angled posterolateral tubular approach. The upper microsurgical limit is the apex of the superior articular process; which is the most cephalic point of the superior articular process of the underlying vertebral body of the segment to be fused. The lower limit is the transverse-facet junction, which is at the same height as the inferior pedicle of the segment to be fused. Its intraoperative recognition is critical to avoid transgressing the upper limit of the inferior pedicle where will the inferior screw will be inserted. (Figure 1) The medial limit of the microsurgical transforaminal access is the articular cleft, which it is generally visible when the adjacent facet joint tissue is removed. (Figures 2 and 3) Having located the three microanatomical landmarks, it is completed by drilling the lateral facetectomy of the segment to be fused, to reach the intervertebral disc safely and perform microdiscectomy, with preparation of the endplate, and placement of bone graft and intersomatic cage. Finally, the percutaneous pedicle screws and rod are inserted, correcting the lordosis if required.

DISCUSSION

In 1982 Harms and Rolinger developed the open technique of transforaminal lumbar interbody fusion as an alternative to PLIF. Foley et al., in 2003, described a minimally invasive technique for performing the same approach. However the technique has progressed at the same time of technological developments, and has advantages such as fusion of the three spinal segments, better visualization of the lateral interbody space, and the ability to prepare the intervertebral space through a unilateral approach, with less retraction of the thecal sac, preserving the posterior tension band and ensuring minimal paraspinal muscle transgression. Comparing the length of hospital stay, intraoperative bleeding, and perioperative use of narcotics between the MI-TLIF versus conventional open TLIF, the first has better results. The MI-TLIF is more cost-effective compared to open TLIF in the long term. The fusion rate at one year is similar for both techniques.
Figure 3. a) Surgical photo after drilling left articular process of L5. The traversing root and exiting root are observed medially and laterally in surgical field. b) The intervertebral disc is reached through the Kambin’s triangle; limited access to the intervertebral disc through Kambin’s triangle (red dotted triangle), model. Blue: drilling area in the L5 lateral facet. Yellow: neural elements. Safe access to the foramen is achieved when drilling the upper facet and entering the secure area within Kambin’s triangle, bounded by two catheti and a hypotenuse; the medial cathetus is the dural sac and traversing root, the lower cathetus is the intervertebral disc, and the hypotenuse is the exit root of the segment to be fused. The drilling of the upper facet is combined with the laterality and angulation of tubular access, minimizing the drilling of the medial posterior arch. Minimally invasive techniques have been limited due to insufficient exposure area compared to open surgery of the spine, a situation that becomes less important when there is a specific and defined surgical target, as proposed in this work. The reasons why young spine surgeons often choose conventional open TLIF over MI-TLIF are: (1) a long learning curve, (2) prolonged surgical time compared to open surgery, (3) the difficulty of managing bilateral symptoms using a unilateral approach, and (4) the fact that MI-TLIF involves longer radiation exposure than conventional lumbar fusion. However there are numerous reasons to choose MI-TLIF over conventional open TLIF: shorter recovery times and return to normal activity, cosmetic improvement, decreased postoperative pain, decreased hospitalization times, reduced dependence on postoperative pain relief, and less intraoperative bleeding. In addition, pathological changes in the paraspinal muscles after open surgery are well documented, and have been associated with poor outcome.

CONCLUSIONS

MI-TLIF is a technical challenge, especially during the time the surgeon takes to become familiar with the technique. This approach requires deep knowledge of microanatomy and microsurgery, and has long learning curve. The microsurgical landmarks proposed in this paper provide guidance and security when entering the foramen during the microscopic stage of MI-TLIF.

All authors declare no potential conflict of interest concerning this article.