ENDOSCOPIC INTERLAMINAR DISCECTOMY. USE OF SWINE CADAVERS AS A TRAINING MODEL

DISCECTOMIA INTERLAMINAR ENDOSCÓPICA. USO DE CADÁVERES DE SUÍNOS COMO MODELO DE TREINAMENTO

DISCECTOMÍA INTERLAMINAR ENDOSCÓPICA. USO DE CADÁVERES DE CERDOS COMO MODELO DE ENTRENAMIENTO

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ABSTRACT

Objective: To analyze the possibility of using cadavers of pigs for training in endoscopic interlaminar discectomy. Methods: Five young pigs were used. The necessary instruments and equipment were used, and the endoscopic transforaminal and interlaminar percutaneous approach was performed at the L7-S1 level. A specialist surgeon performed the procedure. The points of entry, needle angulation, and subjective technical difficulties indicated by the surgeon were analyzed. Results: The mean weight of pigs was 42.2 kg. The posterolateral (transforaminal) entry point was, on average, 6.28 cm from the midline at an angulation of 32.8°. The posterior (interlaminar) entry point was on average 1.82 cm. Full-endoscopic interlaminar discectomy was possible in all animals of the sample. The structures described in the literature were visible endoscopically in 100% of the models. Conclusions: The demonstrated benefits and increased indications of endoscopic lumbar surgery created the need to establish safer and more efficient training processes. The authors raise the possibility of using experimental models to develop technical skills in endoscopy via interlaminar approach. The use of teaching tools such as animal models constitutes a new learning technique and give more confidence to surgeons. The use of cadavers of pigs, obtained according to ethics, avoids the use of human cadavers, and minimizes the development of the learning curve on patients.

Keywords: Education, continuing; Minimally invasive surgical procedures; Diskectomy; Endoscopy; Swine; Ethics.

RESUMO

Objetivo: Analisar a viabilidade técnica da utilização de cadáveres de suínos para a formação em discotomia interlaminar endoscópica. Métodos: Cinco jovens porcos foram tomados. Usando o conjunto de instrumentos e os equipamentos necessários, foi feita uma abordagem transforaminal percutânea e uma interlaminar endoscópica no nível L7-S1. O procedimento cirúrgico foi realizado por um cirurgião especialista. Pontos de entrada foram analisados, a angulação da agulha e as dificuldades técnicas subjetivas indicados pelo cirurgião. Resultados: O peso médio dos cadáveres de suínos empregados foi de 42,2 Kg. O ponto de entrada transforaminal foi em média de 6,28 centímetros da linha média em um ângulo de 32,8°. O ponto de entrada interlaminar, em média, foi de 1,82 centímetros. O discotomia completamente endoscópica por abordagem interlaminar foi tecnicamente viável em todos signo animal. As estruturas descritas na literatura foram visíveis endoscopicamente em 100% dos modelos. Conclusões: Os benefícios comprovados e indícios crescentes de cirurgia endoscópica criou a necessidade de estabelecer processos mais seguros e eficientes treino. Os autores levantam a possibilidade de utilizar modelos experimentais para o desenvolvimento de competências técnicas na abordagem interlaminar completamente endoscópico. O uso de ferramentas de ensino, tais como modelos experimentais, fornece para o processo de aprendizagem de novas técnicas e permite que os cirurgiões alcançar mais confiança. O uso de carcaças de suínos, feitas eticamente, evita o uso de cadáveres humanos e minimiza o desenvolvimento da curva de aprendizagem em pacientes.

Descritores: Educação continuada; Procedimentos cirúrgicos minimamente invasivos; Discotomia; Endoscopia; Suínos, Ética.

RESUMEN

Objetivo: Analizar la posibilidad de emplear cadáveres de cerdos para entrenamiento en la discectomía interlaminar endoscópica. Métodos: Se tomaron cinco cerdos jóvenes. Empleando el instrumental y el equipamiento necesario, se realizó un abordaje endoscópico percutáneo transforaminal y interlaminar en el nivel L7-S1. La técnica quirúrgica fue realizada por un cirujano experto. Se analizaron los puntos de ingreso, la angulación de la aguja y las dificultades técnicas subjetivas indicadas por el cirujano. Resultados: El peso promedio de los cadáveres de cerdos fue de 42,2 Kg. El punto de ingreso posterolateral (transforaminal) estuvo en promedio a 6,28 cm de la línea media con una angulación de 32,8°. El punto de ingreso posterior (interlaminar) en promedio fue 1,82 cm. La discectomía interlaminar completamente endoscópica fue posible en todos los animales de la muestra. Las estructuras descritas en la literatura fueron endoscópicamente visibles en el 100% de los modelos. Conclusiones: Los beneficios demostrados y el aumento de las indicaciones de la cirugía endoscópica lumbar crean la necesidad de establecer procesos de entrenamiento más seguros y eficientes. Los autores plantean la posibilidad de emplear modelos experimentales para desarrollar habilidades técnicas en la endoscopia por abordaje interlaminar. El

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uso de herramientas educativas como modelos de animales es una nueva técnica de aprendizaje y proporciona más confianza para los cirujanos. La utilización de cadáveres de cerdos, obtenidos de manera ética, evita el uso de cadáveres humanos y minimiza el desarrollo de la curva de aprendizaje sobre pacientes.

Descriptores: Educación continua; Procedimientos quirúrgicos mínimamente invasivos; Discectomía; Endoscopia; Porcinos; Ética.

INTRODUCTION

In recent years, the treatment of back pain has been positively impacted by advances in minimally invasive surgery, conferring a position of relevance to this type of technique in medical practice,[1-3] and allowing its benefits to be offered to more patients. Within the broad spectrum of minimally invasive procedures, there is a group of surgical techniques that are performed via endoscopic approaches.[4-6] Endoscopic surgery of the spine allows, through the use of lenses, cameras, and other special equipment,[7,8] the visualization of structures and the treatment of degenerative pathologies like disc herniation, central and foraminal stenosis, facet joint cysts, and epidural hematoma[2,6,7-14] in the different vertebral segments: cervical, thoracic, and lumbar.[5,15,16]

One of the most recently described procedures is the percutaneous full-endoscopic interlaminar discectomy (PFEILD), indicated in the treatment of disc herniation at the L5 – S1 level, and an interesting alternative to avoid the technical difficulties associated with the transforaminal approach at this level.[17,18] The PFEILD was described in the same year (2006), but in different locations, by Choi et al.[19] and Ruetten et al.,[20] and its surgical principle in the case of herniated discs, the resection of the fragments of the disc (contained, extruded, migrated or not, sequestrated, at the central or foraminal level) that are compressing the nerve structures at the L5-S1 level causing lumbar and/or radicular pain. The satisfactory outcomes of the technique, with reported improvement rates above 80%,[21-27] are contrasted with the significant challenge of a difficult and relatively long learning curve and the potential for complications related to the lack of technical experience,[28,29] since in PFEILD, as in most minimally invasive procedures, the clinical results are closely linked to previous training.[30-32]

In this sense, it is important to note that the technology revolution in recent years has not only changed medicine and surgery, but also medical education, and in particular, how surgical skills are acquired.[33] These new ideas have allowed us to reevaluate the "Halstedian" concept of teaching in surgery (see – do – teach),[34] and have given it a predominant role in training accomplished outside of the operating room, that is to say to procedures simulated in training centers.[35,36] Additionally, surgical simulation has been supported by the results of recent studies that have demonstrated that its implementation can reduce the time of the learning curve for certain endoscopic techniques.[29,36-40]

Surgical simulation is based on the use of high-fidelity teaching tools. i.e., simulators that offer a high degree of realism for the training that is intended to be imparted.[41-43] Although human cadavers continue to be the gold standard in surgical training processes,[44-46] their use is linked to extensive infrastructure and logistics requirements, which make it costly and of limited availability. For this reason, experimental model cadavers constitute an interesting alternative that must certainly be used within a framework of ethical and responsible use, recognizing their true potential and analyzing their comparative anatomy. These factors will allow us to use these simulators as tools that contribute to the endoscopic spine surgery learning curve and allow better clinical results when performing PFEILD in human patients.

The objective of this study is to describe the experience of using experimental models in PFEILD training and to define the comparative anatomical parameters of the technique using pig cadavers as a tool to teach surgical skills.

METHODS

The complete cadavers of five pigs of the Landrace breed, obtained commercially from a meat processing plant and whose reasons for death were not related to the study proposal, were used. The procedures were performed at facilities specially designed for training processes (Centro Latinoamericano de Investigación y Entrenamiento en Cirugía de Mínima Invasión, Bogotá - Colombia) with equipment used exclusively for training and research of the institution. The complete Vertebris (Richard Wolf GmbH, Germany) equipment solution for performing videoendoscopy and the lumbar instrument set were used, with the Trigger Flex system (Elliquence LLC, NYC) as the radiofrequency energy source.

The animals were placed in a prone (external) position with lumbar support in order to completely align the spine. (Figure 1) The surgical technique used in the models consisted of the insertion of an epidural needle at level L7-S1 (analogous to level L5-S1), in order to perform discography and staining under fluoroscopic control. (Figure 2) The site of entry for the PFEILD approach was then established, achieved by anchoring the tip of the dilator over the spinolaminar junction, (Figure 3) confirming the position with the C-arm. At this point, an incision was made in the skin and the muscular tissue was dissected with the help of the same dilator until the vertebral body could be felt. Once the dilator was in position, the cannula was passed above it with the endoscope through it. (Figure 4) With the endoscope in the intervertebral space, endoscopic identification of the structures, (Figure 5) the release of the ligamentum flavum, and the discectomy using punch and radiofrequency were performed, (Figure 6) until the dural sac, the nerve root, and the axilla could be visualized. (Figure 7)

All the procedures were performed by a surgeon specializing in the technique (JGR) accompanied by a veterinarian with knowledge of the technique and the anatomy of the model (GOA). In order to establish and report the anatomical references of the disc entry, both for discography and for the discectomy, the data for the distance between the midline and the point of entry of the epidural needle in the posterolateral or transforaminal approach (TFA) to the L7-S1 intervertebral space, as well as the angulation of the needle (AN) in relation to the horizontal plane were recorded. (Figure 2) Finally, the distance was measured between the midline and the point of entry of the dilator in the posterior or interlaminar approach (ILA). (Figure 3)

Figure 1. Position of the experimental model.

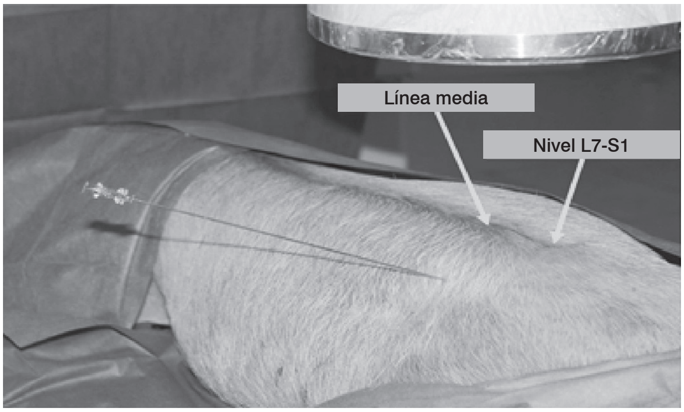

Figure 2. Transforaminal percutaneous entry.

Figure 3. Interlaminar entry.

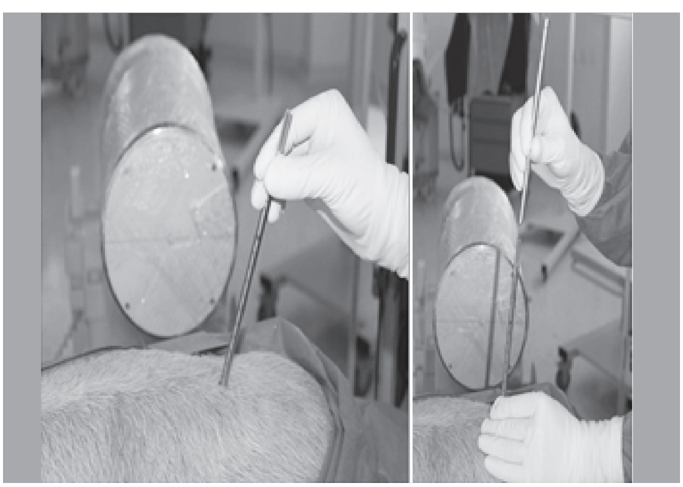

Figure 4. Placement of the dilator and the cannula.

Statistical analysis was conducted using the R 3.1.1 software for Windows, in which the measures of central tendency and ranges of the variables were determined, as well as the Pearson correlation coefficient between the variables of weight and the distance of the posterolateral and posterior entry point.

RESULTS

Of the five models used, three were females and two were males. Their average weight was 42.4 kg (SD=2.35), with a range of 5.8 (minimum 39.8, maximum 45.6).

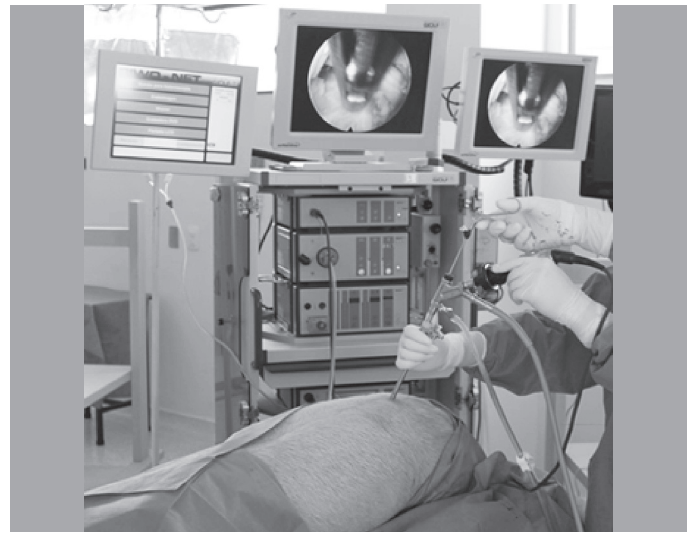

Figure 5. Endoscopic interlaminar discectomy.

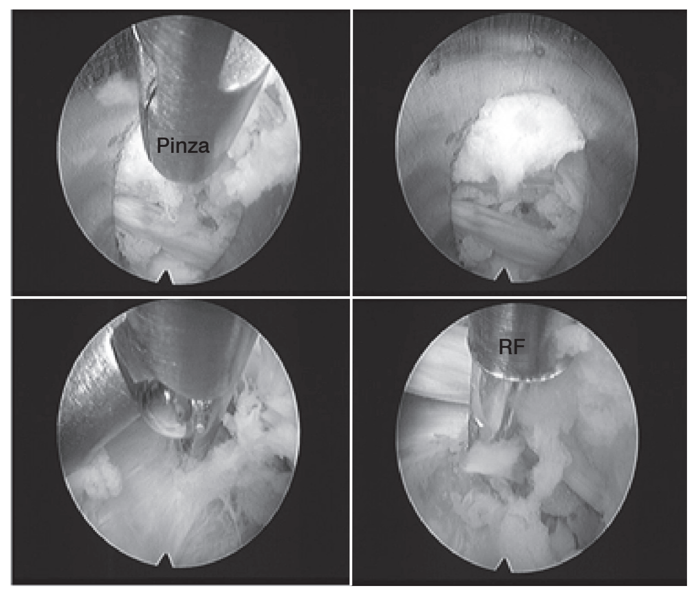

Figure 6. Endoscopic view of the structures and endoscopic interlaminar procedures. Above left: resection of the ligamentum flavum; above right: ligamentum flavum, dural sac, and nerve root; below left: mechanical discectomy with forceps; below right: thermal discectomy with radiofrequency.

With respect to the point of entry of the posterolateral approach to the L7-S1 space, we obtained an average TFA of 6.28 cm (SD=0.54), with an angle of entry of an average of 32.8° (SD=3.11) in relation to the horizontal plane. This approach was more technically demanding for the surgeon, particularly in the animal of the lowest weight (39.8 Kg), a female with a higher tibial crest. Likewise, in the posterior approach, the value of the ILA averaged 1.82 cm (SD=0.40). (Figure 8)

The PFEILD was performed without major technical issues in the five models. All the procedures of the surgical protocol (discography, resection of the ligamentum flavum, and discectomy) were able to be performed with the instruments used. Similarly, all the structures of the interlaminar endoscopic anatomy (ligamentum flavum, dural sac, and nerve root) were clearly visualized in all the animals.

Finally, the Pearson correlation coefficient between the variables of weight and TFA was 0.94. The same coefficient for weight and the ILA was 0.59.

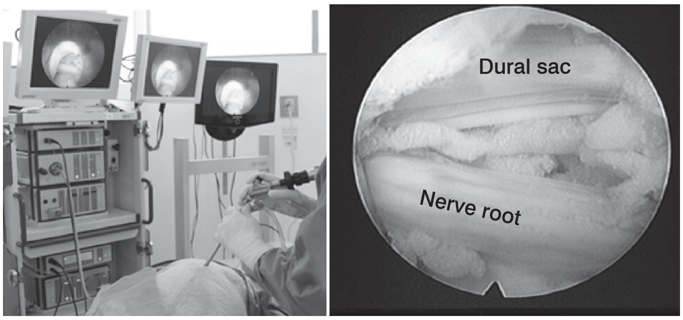

Figure 7. External and endoscopic views of the interlaminar endoscopy in pig cadavers.

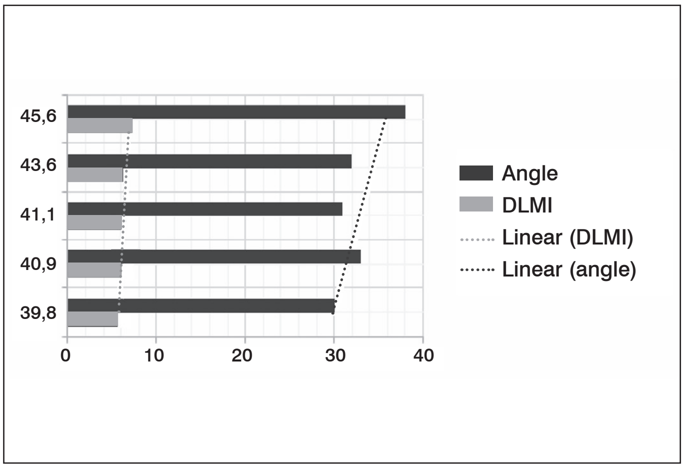

Figure 8. Comparative graph of the weights of the models and the respective angles and distances of entry in the TFA.

DISCUSSION

The disc fragmentectomy at level L5 – S1 via a full-endoscopic interlaminar approach is a minimally invasive procedure that yields results similar to those obtained using conventional techniques, but with the great advantage of respecting adjacent anatomical structures and offering benefits such as the use of local anesthesia, reduced hospital stays, and fewer possibilities of complications.[23] It is a safe and reproducible technique that enables the achievement of adequate decompression of central and foraminal herniations present in segment L5 – S1.[17-26] However, it is considered a technically demanding procedure with a long learning curve.[28-31]

The results obtained in this sample allowed us to confirm that the full-endoscopic interlaminar technique is perfectly reproducible in pig cadavers, making these models a teaching tool for the development of technical skills in the first stages of training for the procedure. Adding these findings to the results obtained by other researchers who have shown improvements in endoscopic technique skills in surgeons who have trained using animals,[47,48] it would be possible to develop training methods for the specific skills of the technique that could lead to a reduction of the time and number of patients necessary to complete the learning curve more quickly.

Among the advantages of the use of pig cadavers as a learning tool, besides the possibility of minimizing the use of patients to achieve technical ability, we highlight the reduced dependence on human cadavers, with the operational difficulties that their use implies; the ethical advantages of using a highly available tool, since pig cadavers can be obtained from any certified meat processing plant; and the fact that the cause of death of these animals was not directly related to the proposal, their use is understood as an "alternative method"[49] and does not imply the need for an animal ethics committee.[50]

In terms of the technical difficulties of this type of procedure, it is important to note that percutaneous entry at level L7-S1, in the opinion of the specialist surgeon, was demanding. This may be an advantage to the extent that, if entry is achieved at this level in pig cadavers, it would theoretically be easier to perform percutaneous entry at level L5-S1 in human patients. Additionally, the fact that there is no bleeding could make recognition of the anatomical structures more difficult, particularly for surgeons who are not familiarized with endoscopic interlaminar anatomy.

Statistical analysis provides data for establishing a training protocol and, thus, some early indications for the student. Similarly, the strong linear association between both posterolateral and posterior entry points and weight could indicate that, in cases of using larger animals, the approaches should be more distant from the midline.

To the authors' knowledge, there is no other study that reports the use of pigs in an endoscopic interlaminar procedure. However, values obtained in the transforaminal approach in other four-legged animals (dog), and with a similar lumbar spinal disposition, were similar, with a distance of 4.6 (SD=1.06) from the point of entry to the midline reported in an animal of 32 kg.[51] Taking into account that the models used in this study were larger, the results are comparable and they also demonstrate the positive correlation between weight and distance from the midline. Among the study limitations is the fact that the study used animals without the pathology, minimizing the effect of the staining of the discs. This factor could make clear differentiation of the disc difficult, in light of the epidural fat and the posterior longitudinal ligament.

Finally, the authors think it is important to implement studies to verify the real contribution of this type of simulation tool in the development of specific technical skills and their potential for reducing the number of patients needed to complete the learning curve and minimizing associated complications.

CONCLUSIONS

Surgical simulation has proved to make a real contribution to training processes and the acquisition of manual skills by surgeons in training. The use of animal cadavers can be a useful tool with a high degree of realism. The pig cadavers obtained in an ethical way act as an anatomical simulation that is technically valid for performing PFEILD. It is important to continue to develop training models that use simulations and to validate their effective contribution to the learning curves of spine surgeons.

All authors declare no potential conflict of interest related to this article.

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