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COMPARISON OF PSOAS MORPHOLOGY AND LUMBAR LORDOSIS IN DIFFERENT POSTURES

COMPARAÇÃO DA MORFOLOGIA DO PSOAS E LORDOSE LOMBAR EM DIFERENTES POSTURAS

COMPARACIÓN DE LA MORFOLOGÍA DEL PSOAS Y LA LORDOSE LUMBAR EN DIFERENTES POSTURAS

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ABSTRACT

Objective: To compare the interobserver reliability of measurements of psoas morphology and lumbar lordosis in different positions and to standardize the performance of magnetic resonance imaging in the prone and lateral positions. Methods: This is a cross-sectional study carried out with asymptomatic volunteers of both sexes, aged over 18 years, with no known pathological changes in the lumbar region. Magnetic resonance imaging of the lumbar spine was performed in the supine, right lateral decubitus and prone positions, obtaining images in T2-weighted sequences in the sagittal and axial planes. The distances were measured from the psoas to the vertebral plateau and from the psoas to the lumbar plexus. The exams were assessed by two independent, blinded orthopedists. Results: There was excellent agreement between the measurements of vertebral size (ICC=0.92), low agreement for plexus distance (ICC=0.63) and high agreement for the anterior margin (ICC=0.84). Conclusion: There was good reproducibility of 2 of the 3 measures proposed, suggesting that the technique in the lateral and prone positions is capable of generating quality images. ***Level of Evidence 3B; Prospective.***

Keywords: Magnetic Resonance ; Psoas Muscles; Patient Positioning.

RESUMO

Objetivo: Comparar a confiabilidade interobservador da mensuração da morfologia do psoas e lordose lombar nas diferentes posições e padronizar a realização do exame de ressonância magnética em posição prona e lateral. Métodos: Trata-se de um estudo transversal realizado com voluntários assintomáticos de ambos os sexos, maiores de 18 anos, sem alterações patológicas conhecidas na região lombar. Foi realizada ressonância magnética da coluna lombar na posição supina, decúbito lateral direito e prono, obtendo imagens nas sequências ponderadas em T2 nos planos sagital e axial. Foram medidas as distâncias do psoas até o platô vertebral e o plexo lombar. Os exames foram avaliados por dois ortopedistas independentes em caráter cego. Resultados: Houve ótima concordância entre as medições do tamanho da vértebra (ICC=0.92), baixa concordância para a distância do plexo (ICC = 0,63) e alta concordância para a margem anterior (ICC = 0,84). Conclusão: Houve boa reprodutibilidade das medidas propostas, sugerindo que a técnica em posição lateral e prona é capaz de gerar imagens de qualidade. ***Nível de Evidência 3B; Prospectivo.***

Descritores: *Ressonância Magnética; Músculos Psoas; Posicionamento do Paciente.*

RESUMEN

Objetivo: Comparar la fiabilidad interobservador de la medición de la morfología del psoas y la lordosis lumbar en diferentes posiciones y estandarizar la realización de la resonancia magnética en decúbito prono y lateral. Métodos: Se trata de un estudio transversal realizado con voluntarios asintomáticos de ambos sexos, mayores de 18 años, sin alteraciones patológicas conocidas en la región lumbar. Se realizó la resonancia magnética de la columna lumbar en decúbito supino, decúbito lateral derecho y prono, obteniendo imágenes en las secuencias potenciadas en T2 en los planos sagital y axial. Se midieron las distancias del psoas a la meseta vertebral y al plexo lumbar. Los exámenes fueron evaluados a ciegas por dos ortopedistas independientes. Resultados: Hubo una excelente concordancia entre las mediciones del tamaño de la vértebra (ICC = 0,92), una baja concordancia para la distancia del plexo (ICC = 0,63) y una alta concordancia para el margen anterior (ICC = 0,84). Conclusión: Hubo buena reproducibilidad de las medidas propuestas, lo que sugiere que la técnica en decúbito lateral y prono es capaz de generar imágenes de calidad. ***Nivel de evidencia 3B; Prospectivo.***

Descriptores*: Resonancia Magnética; Músculos Psoas; Posicionamiento del Paciente.*

Study conducted at the Spine Group of the Centro de Reabilitação e Readaptação Dr. Henrique Santillo (CRER – Goiânia/GO, Brazil).
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INTRODUCTION

Minimally invasive lateral lumbar interbody fusion (LLIF) has been increasingly used in the treatment of degenerative diseases and deformities of the lumbar spine. A transpsoas approach enables access to all the lumbar disks, except L5S1, allowing for the placement of cages with large surface area. This promotes high fusion rates and enables indirect decompression of neurological structures.[1,2]

This approach has some possible advantages in relation to the anterior approach, such as avoiding mobilization of the large vessels, the hypogastric plexus, the intestinal loops and the structures of the genitourinary system, and the fact that the procedure does not require access surgery. Unlike the posterior approach, it avoids denervation of paravertebral muscles and the retraction of neurological structures, which is often necessary for the placement of spacers in the intersomatic space in the anterior part of the vertebral body.[3-6]

However, like any other technique, LLIF has some disadvantages, such as the risk of damage to the lumbar plexus, especially at level L4L5. Other disadvantages are transient weakness of the psoas muscle, and the need to change decubitus to the prone position when arthrodesis needs to be complemented by the posterior approach.[3-6]

To optimize the transpsoas access, a new view of the lateral access was developed, this time with the patient in the prone position, known as the prone transpsoas technique (PTP). This new positioning allows for 360° arthrodesis to be performed in a single position, reducing the surgical time, as it is no longer necessary to change the patient's decubitus position. It also provides a gain in lumbar lordosis through patient positioning alone. Moreover, the patient positioning with hip extension allows for posterization of the psoas and lumbar plexus which, in theory, minimizes the risk of damaging these neurological structures.[7,8]

This study aims to compare the interobserver reliability of the measurements in the different positions, and to standardize magnetic resonance imaging performed in the prone and lateral positions.

METHODS

Study design and patient population

A cross-sectional, non-randomized, comparative study with asymptomatic volunteers. This study was approved by the Ethics Committee (CAE 40239820.0.0000.5078) and all the subjects signed an Informed Consent Form (ICF).

Inclusion and exclusion criteria

Volunteers without significant morphological alterations on external examination, or known pathologies in the lumbar region, were included in the study.

The exclusion criteria were any contraindication to the MRI (pacemaker, hearing prosthesis, aneurysm clip, metallic implant and defibrillator, or any deformity and/or anatomical variation detected in the MRI that would prevent the correct measurement of the target structures of the study.

MRI Protocol

Magnetic resonance imaging of the lumbar spine was performed at the Diagnostic Resources Center (*Centro de Recursos Diagnósticos* - CRD) in Goiânia, Goiás. All patients were submitted to a magnetic resonance examination of the lumbar spine using the same SIEMENS SPECTRA 3 TESLA device (Siemens Medical System, Inc., NJ, USA), supervised by an orthopedist (PPSF) and radiologic technologists of the service.

The patients were placed in the supine position, followed by the ventral and right lateral positions, using spine matrix coils (Siemens Medical System, Inc., NJ, USA) and flexible body coils (Siemens Medical System, Inc., NJ, USA). Sagittal and axial sequences, T2-weighted, were performed at each position. The following configuration parameters were used for the sagittal T2-weighted slices: repetition time (TR) 3520 ms, echo time (TE) 91 ms, and slice thickness of 4 mm. For the axial T2-weighted slices, the parameters were TR 7800 ms and TE 134 ms, with slice thickness of 4.5 mm.

During the first stage of the exam, axial and sagittal imaging sequences were performed in the supine position with the legs slightly flexed, a pillow under the head and a cushion under knees and legs (Figure 1A). In the second stage, the patient was placed in the prone position with the legs extended, using a flexible body coil over the lumbar region, a cushion under the knees and a pillow under the thorax, to improve lordosis and simulate the patient's position on the surgical table (Figure 1B). Finally, in the third stage, the patient was placed in right lateral decubitus, with the legs flexed 45° at the hips and 90° at the knees. A pillow was used under the head, and a flexible matrix coil on the lumbar region (Figure 1C).

Image analysis and morphometric parameters

The image analysis was performed by two experienced orthopedists, independently of each other, using the software program RadiAnt DICOM Viewer 2020.0 (Poznan, Poland). The exams were anonymized to ensure study blinding and the measurements were compared with each other to verify interobserver reliability.

The following measurements were evaluated (Figure 2):

1. Distance from the anterior margin in the left psoas muscle to the ventral portion of the vertebral plateau (DPsoas). The measurement was positive when it was anterior to the body and negative if it was posterior to the anterior margin of the body.
2. Distance from the nerves of the lumbar plexus to the posterior margin of the vertebral plateau (Nerve Distance – ND).
3. Size of the vertebral body in its anteroposterior (AP) axis.
4. Lumbar lordosis (LL), measurement of the upper plateau of L1 and the upper plateau of S1 (in degrees) (Figure 3A).
5. Lordosis between L4S1 (LL4S1), measurement of the upper plateau of L4 and the upper plateau of S1 (Figure 3B).

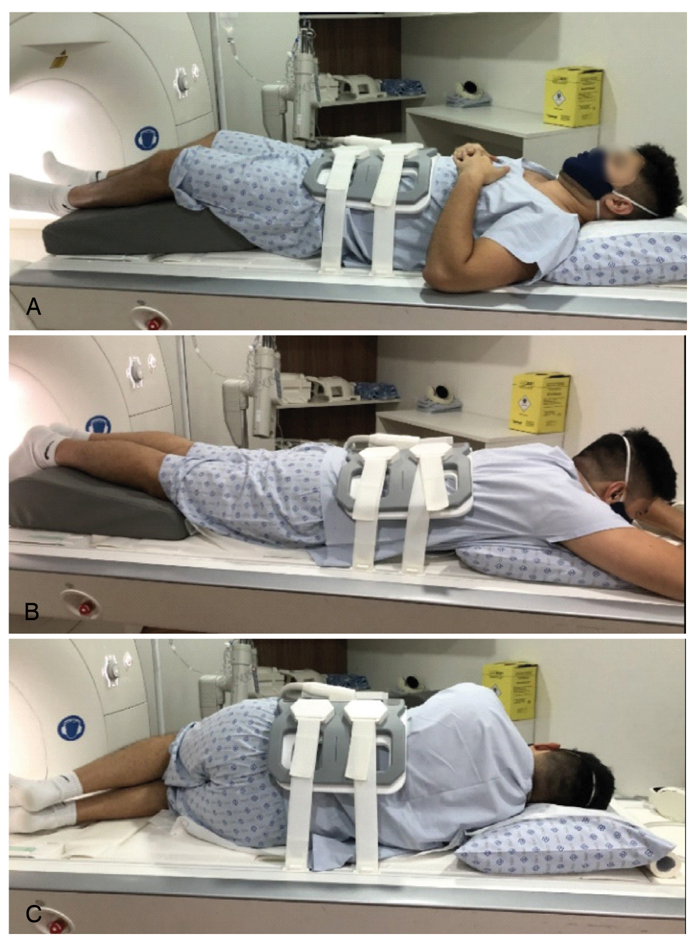

Figure 1. A. Patient in dorsal decubitus with a cushion below the knees to improve lumbar positioning. B. Patient in ventral decubitus with cushion under the legs and arms to ensure adequate lumbar lordosis for the exam. C. Patient in lateral decubitus with triple flexion of the legs.

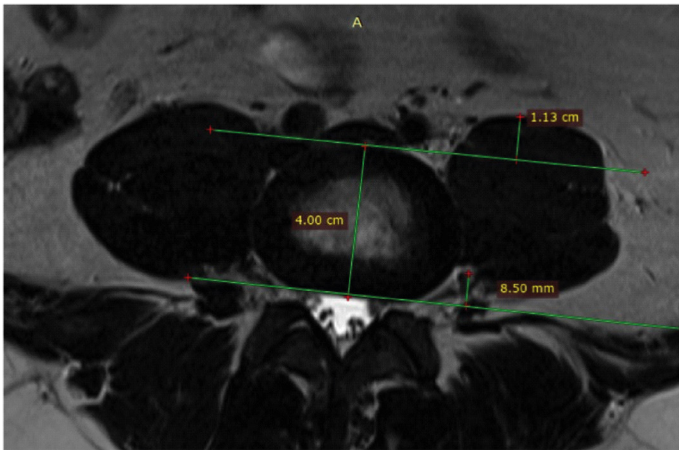

Figure 2. Measurements performed on the axial slice. 1: Size of the vertebral body; 2: Distance from the plexus of the vertebral body of the posterior margin; 3: Distance of the anterior margin of the psoas muscle from the anterior margin of the vertebrae.

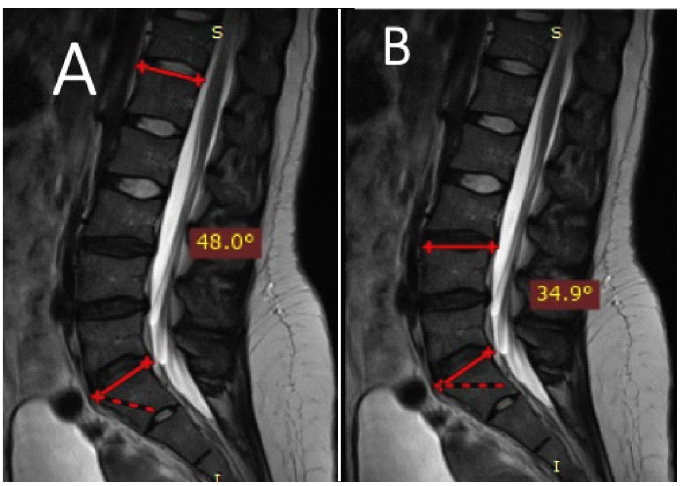

Figure 3. Measurements performed on the sagittal slice. 3a: Lumbar lordosis (LL); 3B: Lordosis L4S1 (LL4S1).

Statistical analysis

The data analysis was performed using the software program R. The student's T test was used to compare demographic data between sexes. Interobserver calculation was performed using the interclass correlation method (ICC) with a two-way mixed concordance model, with the help of the IRR package. Values lower than 0.05 were considered significant.

RESULTS

Thirty volunteers were submitted to an MRI of the lumbar spine: 16 men and 14 women, characterized in Table 1.

The interobserver analysis showed very high agreement between the measures of vertebra size (ICC=0.92) and between the anterior margin of the psoas and the anterior margin of the body (ICC=0.84). The plexus distance presented good concordance (ICC=0.63) (Table 2).

The LL in the supine position was 47.2° (42.0 to 52.4°), in the lateral position it was 46.5° (42.1 to 50.8°) and in prone position, 57.6° (54.1 to 61.2°). The LL4S1 in the supine position was 36.8° (33.7 to 39.8°), in the lateral position 36.9° (31.0 to 36.7°) and in the prone position 40.4° (37.8 to 43.0°).

During the exams, some difficulties were encountered related to the patient positioning. The long duration of the examination, due to the acquisition in three different positions, made it difficult for the participants to maintain a static position, increasing the

Table 1. Sample characterization.

		Mean (sd*)	Minimum	Maximum	P
Age	Women	42 (±17.32)	21	74	0.88
	Men	43 (±16.91)	25	78	
Weight	Women	66.43 (±12.03)	50	98	0.73
	Men	84.63 (±12.14)	65	105	
Height	Women	1.62 (±0.06)	1.50	1.75	0.12
	Men	1.77 (±0.07)	1.67	1.92	

* sd = standard deviation; p = student's T test, considering < 0.05.

Table 2. Intraclass correlation coefficient values of the interexaminer analysis and confidence interval.

Variable	95%-	ICC	95%+
Vertebra size	0.89	0.92	0.94
Plexus distance	0.38	0.63	0.77
Anterior Margin	0.8	0.84	0.88

artifacts on the image and the patient's level of stress. Also, in the lateral and ventral decubitus, as the spine was not firmly fixed to the coil, respiratory incursions generated motion artifacts, worsening the image quality. Five volunteers were required to repeat the examinations.

Another difficulty was the use of flexible body matrix coil in lateral decubitus in patients with a wider pelvis. In these patients, the gantry of the device was not compatible with the lateral diameter of the patient and the flexible coil. As a result, it was not possible to use the flexible coil with six patients in lateral decubitus.

DISCUSSION

The minimally invasive lateral transpsoas approach to the lumbar spine (LLIF) has become increasingly used in the treatment of degenerative pathologies and lumbar spine deformities.[1] However, it has some limitations, such as risk of damage to the lumbar plexus and the need to change decubitus position in cases that require complementation with a posterior approach.[3-6] To optimize the transpsoas technique, the PTP technique was developed, aimed at minimizing the surgical time without the need to change decubitus, improving LL with the positioning, posteriorizing the lumbar plexus, and minimizing the risks of neurological damage.[8,9]

Magnetic resonance imaging is an optimum tool for anatomical characterization of the vertebral spine, as it affords excellent visualization of the soft parts, including muscles and nerves.[10]

Buckland et al.,[11] report that the psoas muscle and lumbar plexus shift more anteriorly in seated MRIs when compared to the supine position, due to lordosis correction. This effect was even more frequently observed in the more distal intervertebral discs. Zhang et al.,[12] also evaluated the behavior of the anatomical structures using MRI in the supine and lateral positions, but with emphasis on the anterior approach to the psoas muscle. They demonstrated that the corridor between the psoas muscle and the aorta decreases in the supine position, probably due to anteriorization of the psoas muscle in the lateral position. This study demonstrates the mobility of the muscle according to the patient's position and corroborates the idea that surgical planning with the patient in the supine position may not be as accurate.

Regarding the difficulties in performing MRIs in positions other than the dorsal position, we can list the following: the long duration of the exams, which meant patients were unable to maintain the same position for the required time, and the difficulty of performing resonance exams in lateral decubitus in patients with wide pelvises, due to difficulties in positioning the flexible coil.

The main limitation of this study was the difficulty positioning patients in the MRI equipment, a challenge that was dealt with by elaborating a clear protocol for patient positioning.

CONCLUSION

Performing magnetic resonance imaging with the patient in lateral decubitus or the prone position is safe and feasible, despite some minor difficulties. This study also showed good reproducibility of the proposed measures, suggesting that the technique in the lateral and prone positions is capable of generating quality images.

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

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