Technical and Cosmetic Differences Between the Types of Minimally Invasive Surgical Incisions Performed in Lumbar Spine Arthrodesis Surgery: a thermographic and public satisfaction analysis

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ABSTRACT

Introduction: Lumbar spinal arthrodesis surgery is an alternative for the treatment of low back pain and can be performed in a minimally invasive manner using two techniques: a median lumbar skin incision or two paramedian lumbar skin incisions. Objective: To conduct an analysis of the differences between median and paramedian cutaneous surgical incisions in vertebral arthrodesis, in terms of benefits and risks, aesthetic outcomes of the scar, postoperative quality and public satisfaction. Methodology: This is a quantitative-qualitative study, with a direct approach, in which 2 patients were selected, one undergoing a median skin incision and the other a paramedian skin incision, both in the posterior lumbar spine. Both were compared using thermography in the pre- and immediate post-operative period and 24h to 48h post-operatively. A public opinion survey was also carried out with 505 people using an electronic form, evaluating the importance of aesthetics in a surgical procedure. Results: The median skin incision seems to provide a better clinical-surgical outcome and suggests the reestablishment of perfusion in the immediate postoperative healing, more efficiently, based on the thermographic study. Public opinion research reveals the aesthetic preference for the median skin incision regardless of income, gender or cost. Conclusion: The study analysis suggests greater benefits from using the median skin incision in minimally invasive spine arthrodesis surgery. Even so, this study has as a restriction the small number of patients undergoing surgical analysis, so further studies are necessary.

Keywords: Vertebral Arthrodesis; Thermography; Incision; Aesthetics

RESUMO

Introdução: A cirurgia de artrodese de coluna lombar configura uma alternativa para o tratamento de dores lombares e pode ser realizada de forma minimamente invasiva por meio de duas técnicas: uma incisão cutânea lombar mediana ou duas incisões cutâneas lombares paramedianas. Objetivo: Realizar uma análise das diferenças entre as incisões cirúrgicas cutâneas mediana e paramediana, na artrodese vertebral, no que tange aos benefícios e riscos, aos desfechos estéticos da cicatriz, à qualidade do pós-operatório e à satisfação pública. Metodologia: Trata-se de um estudo quanti-qualitativo, de abordagem direta em que foram selecionados 2 pacientes, sendo um...
INTRODUCTION

Neurosurgery represents an area of Medicine marked for highly complex, high-risk procedures with direct implications on the individual’s quality of life. Therefore, a good doctor-patient relationship is crucial, in which the individual is also the protagonist in his/her treatment. Consequently, aligning the patient’s feelings, ideas, implications on functionality and expectations in relation to their health context is essential for the illness experience to have greater quality. In this sense, for many patients, aesthetics is also a factor that influences health, which makes the assessment of satisfaction with the surgical results and aesthetic outcome as a point of great importance.

In the context of lumbar spinal arthrodesis surgery is necessary to emphasize that this procedure represents an alternative for treating low back pain, a condition that affects approximately 80% to 90% of the Western population. An invasive approach is responsible for generating, in most cases, patient dissatisfaction, as it is a more aggressive procedure that can cause haemorrhages, muscle injuries and attractive aesthetic results. A minimally invasive approach, in turn, becomes the preferred option with lower risk of damage to soft tissues, reduced postoperative pain and, in the long term, better aesthetic results.

From this, it is possible to compare the incisions made in the minimally invasive procedure to determine, within the best approach, which is the best incision. Two main techniques were used: one single cutaneous incision in the posterior midline or two parallel cutaneous incisions in the posterolateral line, both in the lumbar spine. Comparing the two different approaches, in the literature, it is considered that the median incision generally provides a better aesthetic result and reduces the potential for complications.

The objective of the study is to perform an analysis of the differences between the cosmetic advances of each incision, the related benefits and risks, the quality of the postoperative period in each technique through thermographic analysis and the absolute and relative results of the opinion survey conducted for the study. This analysis aims to provide advancement for the patient, as well as promoting greater safety and support for the neurosurgeon regarding the technique of choice.

METHODOLOGY

This is a quantitative-qualitative study with a direct approach that aims to understand and describe, mainly, the cosmetic differences between the types of minimally invasive surgical incisions performed in lumbar vertebral arthrodesis from a thermographic analysis and public satisfaction.

Initially, two patients were selected who signed the consentment to the realization and publicize the results and images of the present study, being a case of median cutaneous incision and another case of paramedian cutaneous incision, both in the lumbar spine. The procedures took place at the Orizonti Oncomed Institute for Health and Longevity in the city of Belo Horizonte, where it was submitted to incision cutânea mediana e o outro à incisão cutânea paramediana, ambas em coluna lombar posterior. Foram comparados por meio de termografias no pré e no pós-operatório imediato e no pós-operatório de 24h a 48h. Foi realizada também uma pesquisa de opinião pública com 505 pessoas por meio de um formulário eletrônico, avaliando a importância da estética em um procedimento cirúrgico. Resultados: A incisão cutânea mediana parece configurar melhor desfecho clínico-cirúrgico e sugere o reestabelecimento da perfusão, na cicatrização do pós-operatório imediato, de forma mais eficiente, a partir do estudo termográfico. A pesquisa de opinião pública revela a preferência estética pela incisão cutânea mediana independentemente da renda, gênero ou custo. Conclusão: A análise do estudo sugere maiores benefícios da utilização da incisão cutânea mediana na cirurgia minimamente invasiva de arthrode de coluna. Ainda assim, esse estudo apresenta como restrição o número reduzido de pacientes submetidos à análise cirúrgica, então mais estudos são necessários.

Palavras-chave: Arthrode vertebral; Termografia; Incisão; Estética
possible to access professionals trained in performing vertebral arthrodesis surgeries with median and paramedian incisions.

For the thermographic analysis, we used the infrared thermal camera of the FLIR brand (Sweden), of the T420 model with 76,800 pixels. The spectral range was 7.5 to 13µm and the Algalnp semiconductor laser diode was 1mW/635nm. Before camera utilization, during the surgical procedure, a skin application of alcohol 74.7° GL was conducted, and dried after 10 seconds. The images were recorded after another 10 seconds and ensuring that the surgical environments had a temperature between 67.1-71.6°F, with humidity ranging between 50-55 g/m³ (Figure 1). Both procedures had similar surgical time, with about 2.5 hours.

A public satisfaction survey was conducted with 505 people through an electronic form with multiple-choice questions that evaluated the user’s preference for median and paramedian cutaneous incisions. The option of horizontal incision was also offered in order not to direct the responses. As inclusion criteria, it was necessary to add the items gender, age, ethnicity, family income and housing status. In this part of the study there were no exclusion criteria for submitting responses to the form, given that this is a survey of public interest and not only of patients in immediate need of vertebral arthrodesis surgery.

From this, the following variables were measured and evaluated: the aesthetic outcomes involved in each incision, the benefits and risks related to them, the quality of the postoperative period in each technique through thermographic analysis and the absolute and relative results of the opinion survey. In addition, this study was submitted to the research ethics committee of the Orizonti Oncomed Institute of Health and Longevity in the city of Belo Horizonte, where the research was conducted.

RESULTS

Case 1 - Median cutaneous incision

Female patient, 64 years old, searched for care of the neurosurgery team complaining of disabling lumbar and lower limb pain. It started with low back pain and later evolved with pain radiating to the right lower limb about a year ago and with progressive worsening that extends to the date of consultation. Several attempts at conservative treatment have been made without success. As comorbidities, the patient reported that she has rheumatoid arthritis, Pulmonary Fibrosis, hypothyroidism, depression, Type 2 Diabetes Mellitus (DM) and obstructive sleep apnoea (NYHA 2). Radiography and magnetic resonance imaging revealed isthmic spondylolisthesis with bilateral foraminal stenosis.

After positive criteria for surgical indication, L5-S1 vertebral arthrodesis was performed with a median cutaneous incision and Transforaminal Lumbar Fusion with an intersomatic device through the left access via Wiltse approach (MIS-TLIF). In addition, autologous left iliac crest graft with spinal aspirate was used.

The median cutaneous incision is a technique configured by a posterior lumbar median longitudinal cutaneous incision followed by two longitudinal paramedian incisions in muscular aponeurosis. The procedure is characterized by being less damaging to tissues and more comfortable in the postoperative period of patients by providing less bleeding and better aesthetic outcome. There are some advantages related to this technique such as the need for little traction during the procedure, generating less muscle ischemia; the maintenance of integrity of the supraspinous and interspinous ligaments, with less postoperative pain and low
incidence of infection; and the best aesthetic outcome of the scar when compared to other approaches. There are also some disadvantages such as the need for experience and familiarity with the surgical technique on the part of the surgeon, reduced visibility and the possibility of subcutaneous detachment\(^5\(^,\(^6\)\).

**Case 2 - Paramedian cutaneous incision**

Female patient, 73 years old, searched for care of the neurosurgery team complaining of low back pain, despite having undergone conservative treatment with 90 sessions of physiotherapy and acupuncture, chiropractic, ozone therapy and pilates sessions. On the date of the consultations, she presented with difficulties in walking, and limping. As comorbidities, the patient reported that she had systemic Arterial Hypertension (NYHA 1). On physical examination she was oriented in time and space and euphasic. Radiography and magnetic resonance imaging revealed Grade I L4-L5 degenerative spondylolisthesis with disc protrusion leading to canal stenosis in the segment.

With positive criteria for surgical indication, vertebral arthrodesis of L4-L5 with paramedian cutaneous incision and Transforaminal Lumbar Fusion with left access intersomatic device via Wiltse approach (MIS-TLIF) was performed. In addition, autologous left iliac crest graft with spinal aspirate was used.

The paramedian incision is a technique that is configured by two longitudinal cutaneous incisions located 30mm from the lumbar posterior spinous processes. The procedure allows direct access to bone structures and, for this reason, manages to respect the limits of cutaneous vascularization and avoid detachment of subcutaneous tissue\(^5\(^,\(^6\)\).

There are some advantages related to this approach, such as the reduced size of the paramedian incisions and direct access to the muscular planes and transverse processes of the vertebrae, without requiring great retraction pressure. In addition, there are also some disadvantages such as the greater potential for complications arising from two incisions and the worse aesthetic outcomes\(^5\(^,\(^6\)\).

**Thermographic Analysis**

Body temperature, regulated by the hypothalamus and physiologically oriented by the circadian cycle, is influenced by several factors, including basal metabolism, muscle contraction and food intake\(^7\). In addition, other variables can influence thermoregulation, such as age, gender, the patient’s health condition, room temperature and humidity\(^8\(^-\(^10\)\). In this context, the use of thermography for investigations and for the study of variations in body surface temperature is of great relevance, since it reveals important aspects about the patient\(^7\).

The thermographic image is produced from the capture of electromagnetic radiation and the conversion of this radiation into electrical signals, later displayed on a scale of colors visible through a graphic record of the temperature of the body area\(^11\). This record detects variations in skin temperature caused by changes in blood flow, consequently an area with greater flow is visualized in redder tones in the thermal image, while areas of lower temperature, that is, less vascularized, are identified in blueish tones\(^12\(^,\(^13\)\).

Based on this, thermal imaging mapping allows the location of superficial vessels and perforating arteries before the surgical incision. This tool, if correctly used, allows the surgeon to avoid any serious vascular damage to the patient, in addition to reducing the operation time and minimizing complications\(^14\). In order for the thermography to be recorded correctly, the area of interest must be cooled during the preoperative period and, after this process, the first area of highest temperature in the image is the one related to the site of a perforating artery. Besides preoperative functionality, thermography can also be used in the postoperative period, since it acts as an auxiliary tool for the evaluation of circulation at the site of injury and, consequently, for the evaluation of surgical wound healing\(^15\(^,\(^16\)\).

The thermographic record of Patient 1 (Case 1), in which the median cutaneous incision was performed, was made at the following times: immediate preoperative (Figure 2), immediate postoperative (Figure 3) and postoperative in 24h (Figure 4). In the case of Patient 2 (Case 2), in which the paramedian cutaneous incision was performed, thermographic recordings were performed at the following times: immediate preoperative (Figure 5), immediate postoperative (Figure 6) and postoperative in 48h (Figure 7).

Based on the assumption that thermoregulation can be influenced by several factors, both patients are female, close in age (64 and 73 years) and underwent vertebral arthrodesis under similar conditions of temperature, humidity and surgical time. In this sense, the thermographic analysis can be directed to the conditions of the surgical technique of choice and the healing conditions obtained from the images.
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Figure 2. Thermography of the surgical site in the posterior lumbar spine in the immediate preoperative period of Patient 1. Temperature at the indicated center of approximately 32.4°C = 90.32°F.

Figure 3. Thermography of the surgical site in the posterior lumbar spine in the immediate postoperative period of Patient 1. Temperature at the indicated center of approximately 31.6°C = 88.88°F.

Figure 4. Thermography of the surgical site in the posterior lumbar spine in the 24-hour postoperative period of Patient 1. Temperature at the indicated center of approximately 34.5°C = 94.1°F.

Figure 5. Thermography of the surgical site in the posterior lumbar spine in the immediate preoperative period of Patient 2. Temperature at the indicated center of approximately 30.4°C = 86.72°F.

Figure 6. Thermography of the surgical site in the posterior lumbar spine in the immediate postoperative period of Patient 2. Temperature at the indicated center of approximately 28.5°C = 83.3°F.

Figure 7. Thermography of the surgical site in the posterior lumbar spine in the 48-hour postoperative period of Patient 2. Temperature at the indicated center of approximately 34.5°C = 94.1°F.
Comparing the surgical techniques of the cutaneous incisions, it can be emphasized that, in the case of the median incision, Patient 1 was subjected to a single trauma, configured by a single cutaneous incision. In the case of paramedian incisions, patient 2 underwent multiple trauma, configured by two cutaneous traumas.

Comparing the healing conditions between the two patients studied, it should be considered that healing is related to several factors such as surgical technique, extent of the lesion, age and systemic diseases such as Diabetes Mellitus (DM) and hypothyroidism. Patient 1 had Type 2 DM and hypothyroidism, factors that may be predictors of less efficient healing, while Patient 2 does not have pre-existing conditions that may influence the healing process.

In the surgical incision to which Patient 1 was submitted, there is a reduction in the temperature of the immediate preoperative period (90.32°F) in relation to the immediate postoperative period (88.88°F) of approximately 3.44°F. Then, there is an increase in the temperature in the postoperative period with 24 hours (94.1°F) of approximately 37.22°F in the surgical incision to which Patient 2 was submitted, there is a reduction in the temperature of the immediate preoperative period (86.72°F) in relation to the immediate postoperative period (88.88°F) of approximately 33.44°F in immediate operative period (83.3°F) of approximately 35.42°F. Then, there is a significant increase in temperature in the postoperative period after 48 hours (94.1°F) of approximately 42.8°F. The main factor for the registered cooling of the immediate preoperative period in relation to the immediate postoperative period is the use of the local anaesthetic ropivacaine with vasoconstrictor, used in both cases.

Comparing the two cases, it was expected that the reduction in incision temperature, reflecting the reduction in local cutaneous perfusion, in Patient 1 would be lower due to the less extensive nature of the lesion in relation to the double incision in Patient 2. It was also expected that the healing of Patient 1, due to her comorbidities, would be less efficient. This is demonstrated, in part, by the postoperative thermographs of 24 to 48 hours that showed an increase in temperature at the surgical site of the two patients, although Patient 1 had a less expressive elevation. Another possible explanation for the postoperative thermographic record of 24 to 48 hours, between the two patients, presenting a difference of 3.1°C could be the fact that there is a difference of 24 hours between the records. This could mean the existence of better reestablishment of perfusion in the healing process of the Patient 2.

It is necessary to emphasize that this study presents as a restriction the reduced number of patients submitted to the analysis. This factor may limit the reproducibility of conclusions about postoperative surgical and aesthetic outcomes. For future investigations, increasing the number of cases analyzed may have more data to prove the benefit or not of one of the techniques over the other.

**Aesthetics and patient satisfaction**

Aesthetics is an important factor for improving self-esteem, while it can affect psychological health and social living. From this, with the need to undergo elective surgery, the aesthetics of a surgical procedure using minimally invasive techniques has become an important factor for most patients today.

Therefore, an open survey was conducted to the population through an electronic form via Google Forms™ platform that obtained 505 responses, of which 295 (58.41%) people were female and 210 (41.58%) male. When comparing gender with the type of incision chosen by each one (Figure 8), it was concluded that both men and women have a predilection for a median line incision, with 262 (51.88%) female responses and 183 (36.23%) for males.

Another question to be considered is the relationship between age and type of incision divided between females (Figure 9) and males (Figure 10). It was again attested that, in all age groups of both sexes, the median incision obtained better aesthetic acceptance.

Comparing the income of users in minimum wages with the preferred type of incision (Figure 11), it was noted that, regardless of income, in all stratifications the predilection for the midline incision of the lumbar spine stood out, even representing a surgical technique of higher value.

When asked about the importance of the cost of the procedure in relation to the aesthetic result of the scar, 367 (72.67%) people answered that the aesthetic result is more important than the cost of the chosen surgical procedure and 138 (27.32%) people believe that the cost of the procedure is more important than the aesthetic result (Figure 12). In addition, when comparing the cost with individual income and with the preferred type of incision (Figure 13), it was proven that regardless of income, except for people with no income, the aesthetic result of the scar is more important than the cost of the procedure, and the median incision is also the preferred choice for most.
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Figure 8. Choice of surgical incision preferably according to gender.

Figure 9. Choice of surgical incision preferably according to female gender by age.

Figure 10. Choice of surgical incision preferably according to male gender by age.
Figure 11. Choice of surgical incision preferably according to income in minimum wages.

Figure 12. Comparison of importance between financial cost and aesthetic result of the procedure.

Figure 13. Comparison between the financial cost, the income of users in minimum wages and the preferred type of incision.
CONCLUSION

This study suggests that there are greater benefits in the use of the median cutaneous incision in minimally invasive lumbar spine arthrodesis surgery compared to the use of the paramedian cutaneous incision. These benefits are related to the lower risks involved in the execution of the surgical technique, the better cicatricial conditions of the lesion and the expressive popular preference for the cosmetic outcome of the surgical scar. According to the survey conducted with 505 people, it is proven that regardless of race, sex, social status, and cost, the cosmetic result is the most relevant factor. However, the study presents a restriction regarding the number of patients studied and analyzed through the thermographic record of surgical incisions. Further studies are needed to obtain an evident technical conclusion regarding the cicatricial process involving the patient and the neurosurgical procedure performed.

REFERENCES


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