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Analgesic efficacy of Transverse Abdomen Plane Block in Kidney Transplantation

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ABSTRACT

Introduction: The transversus abdominis plane anesthetic block (TAP Block) technique was first introduced in 2001 by Rafi to promote anterolateral abdominal wall analgesia. This block involves the T7-L1, subcostal, ilioinguinal and iliohypogastric nerves. Kidney transplant recipients are candidates for this blocking method, since the surgical access to the kidney implant allows exposure of the nerve plexus, T7-L1, responsible for the parietal component of pain, allowing its blockade under direct vision. **Objectives:** To analyze the analgesic efficacy of TAP Block x local infiltration in kidney transplantation in three different moments: upon awakening after 6h and with 24h of rest and 24h of sitting down using the visual analogue pain scale for evaluation. **Methods:** Prospective, randomized, double-blind study with two groups, the control group: standard balanced general anesthesia and infusion of local anesthetic in the subcutaneous tissue; and the experimental: balanced general anesthesia and local anesthetic infusion (TAP Block) directly through the surgical access. These groups were evaluated postoperatively by a researcher who was unaware of the type of procedure the patient underwent. Candidates to participate in the study were patients from the General Transplant Unit, located at the Instituto de Medicina Integral Prof. Fernando Figueira (IMIP). **Results:** 45 patients were allocated in the study. After exclusions, 20 patients in the control group and 21 patients in the experimental group were analyzed. No clinical or demographic characteristics were statistically significant. In the control group, 72.6 % reported moderate/severe pain upon awakening, while moderate and severe pain was present in only 7.4 % of the experimental group, with $p<0.001$. In the 06h assessment, there was a significant difference in relation to moderate/severe pain scores between groups: 59.8 % in the control and 15 % for the experimental group, respectively, with $p < 0.007$. There was no statistical difference between the groups in the static and dynamic evaluation in the 24h period. **Conclusion:** Balanced general anesthesia associated with TAP Block proved to be effective in reducing moderate and severe pain scores in the initial moments: upon awakening, and after 6h, being, as expected, less effective in the 24-hour evaluation.

Descriptors: TAP block; Kidney transplant; Analgesia; Postoperative; Pain.

RESUMO

Introdução: A técnica para o bloqueio anestésico do plano transverso do abdome (TAP Block) foi introduzida pela primeira vez em 2001 por Rafi para promover a analgesia da parede abdominal anterolateral. Esse bloqueio envolve os nervos intercostais T7- L1, subcostal, ilioinguinal e ílio-hipogástrico. Receptores de transplante renal são candidatos para esse método de bloqueio, já que o acesso cirúrgico para o implante do rim permite a exposição do plexo nervoso, T7-L1, responsável pelo componente parietal da dor, permitindo o seu bloqueio sob visão direta. **Objetivos**: Analisar a eficácia analgésica do TAP Block x infiltração local no transplante renal em três momentos distintos: ao despertar após 6h e com 24h em repouso e 24h ao sentar-se utilizando para avaliação a escala visual analógica de dor. **Métodos:** Estudo prospectivo, randomizado, duplo cego com dois grupos, o grupo controle: anestesia geral balanceada padrão e infusão de anestésico local no tecido celular subcutâneo; e, o experimental: anestesia geral balanceada e infusão de anestésico local (TAP Block) diretamente através do acesso cirúrgico. Esses grupos foram avaliados no pós-operatório por um pesquisador que desconhecia qual tipo de procedimento o paciente foi submetido. Os candidatos a participar do estudo foram os

pacientes da Unidade Geral de Transplante, localizada no instituto de Medicina Integral Prof. Fernando Figueira (IMIP). **Resultados:** Foram alocados 45 pacientes no estudo. Após exclusões foram analisados 20 pacientes no grupo controle e 21 pacientes no grupo experimental. Nenhuma característica clínica ou demográfica teve significância estatística. No grupo controle 72,6 % referiram dor moderada/intensa ao despertar, enquanto dor moderada e intensa esteve presente em apenas 7,4 % do grupo experimental com p<0,001. Na avaliação de 06h houve diferença significativa em relação aos escores de dor moderada/intensa entre os grupos: sendo 59,8 % no controle e 15 % para o grupo experimental respectivamente com p < 0,007. Não houve diferença estatisticamente entre os grupos na avaliação estática e dinâmica no período de 24h. **Conclusão**: A anestesia geral balanceada associada ao TAP Block mostrou-se eficaz em reduzir os escores de dor moderada e intensa nos momentos iniciais: ao despertar, e com 6hs, sendo como esperado menos eficaz na avaliação com 24h.

Descritores: TAP Block; Transplante renal; Analgesia; Pós-operatório; Dor.

INTRODUCTION

The Transversus Abdominis Plane (TAP) Block was first introduced by Rafi in 2001[1] as a landmark-guided technique through the triangle of Petit to achieve a regional block. It involves blocking the T7-L1 intercostal nerves, subcostal nerve, ilioinguinal nerve, and iliohypogastric nerve, which provide sensory innervation to the anterior abdominal wall.[1-3] The TAP Block has demonstrated efficacy in providing postoperative analgesia by extending the time to administer the first dose of analgesic after awakening and by reducing total postoperative opioid consumption in various surgical procedures.[4-6] However, its inability to provide analgesia for visceral pain components raises questions about its effectiveness and analgesic utility in intraperitoneal surgeries. Renal transplantation involves an incision in the lower abdomen within the muscle group composed of the external oblique, internal oblique, and transversus abdominis muscles. These muscles are targeted by this type of regional analgesia, without invading or affecting the intraperitoneal cavity, eliminating the visceral pain component.[7,8]

Postoperative pain control typically involves the use of orally or intravenously administered analgesics, although their use is limited in renal transplantation. Non-steroidal anti-inflammatory drugs (NSAIDs) are avoided due to potential side effects, including prostaglandin synthesis inhibition, disturbances in water balance, bleeding risks, and platelet aggregation inhibition synergism associated with uremia.[9,10] While opioids are better tolerated, they carry a higher risk of undesirable side effects such as itching, nausea, vomiting, excessive sedation, apnea, and decreased gastrointestinal motility.[11] Therefore, TAP Block offers a secure analgesic approach for kidney transplant recipients, reducing medication consumption and enhancing postoperative recovery quality.[7]

The ultrasound-guided TAP Block technique is commonly used as an adjunct therapy for postoperative analgesia in abdominal surgeries such as gynecological procedures, laparoscopic cholecystectomy, and liver transplantation.[12-14] However, in the case of kidney transplantation, the block can be performed after the surgical access through an incision in the external oblique, internal oblique, and transversus abdominis muscles. This approach enables intraoperative visualization of the T7-L1, subcostal, ilioinguinal, and iliohypogastric nerves present in the anterolateral abdominal wall, making the TAP block practical and eliminating the need for ultrasound guidance. Nevertheless, its effectiveness needs evaluation.[15,16] A search on PubMed using keywords "TAP Block, renal transplant, analgesic efficacy" yielded results of TAP Block use in other types of surgeries and surgical approaches, demonstrating proven efficacy in reducing analgesic use, particularly in the early postoperative hours, always under ultrasound guidance. However, no results were identified specifically for renal transplantation.[7]

The primary objective of this study was to analyze the reduction in pain scores at three time points: upon awakening, at 6 hours, and at 24 hours (static), as well as at 24 hours (dynamic). A secondary objective was to quantify opioid usage and assess the side effects associated with its administration.

METHODOLOGY

Study Design

The study was conducted at the Transplant Unit of the Professor Fernando Figueira Institute of Integral Medicine (IMIP) from March to October 2021. It adhered to the principles of the Declaration of Helsinki and the new Resolution 466/2012 of the National Health Council. Data collection commenced after approval from the IMIP Scientific Research Ethics Committee (2014/16 Protocol No. 187) and obtaining informed consent from all patients through a signed Informed Consent Form (ICF). Inclusion criteria for the study were adult patients aged 18 to 85 years with end-stage renal disease, enrolled for kidney transplantation by the National Transplant Center. Exclusion criteria encompassed an inability to comprehend basic explanations about the study, relevant drug

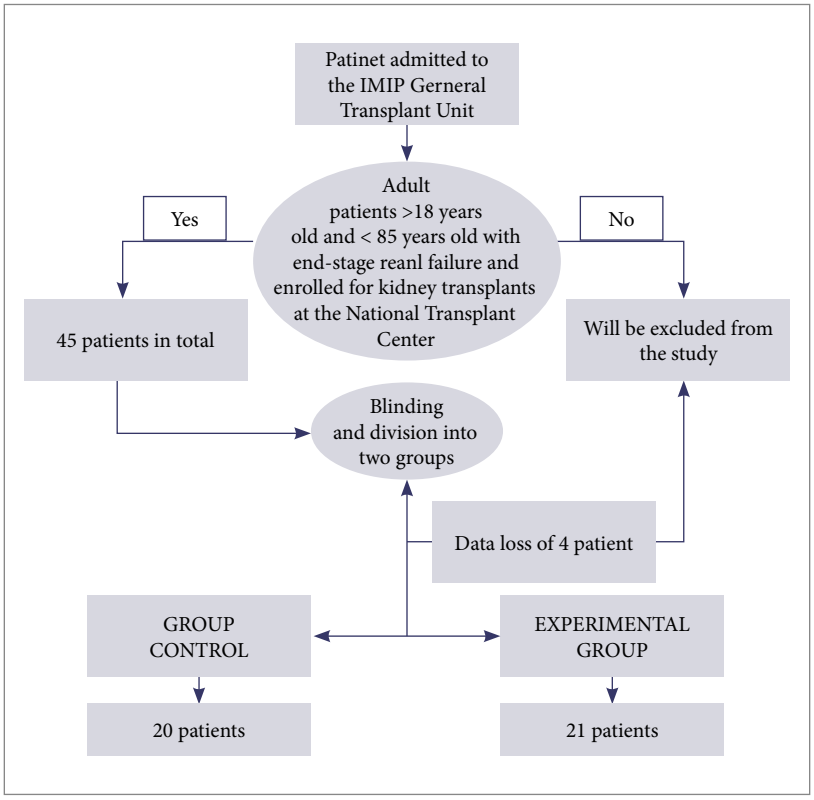
allergies, alcohol or substance abuse, daily opioid consumption, injection site infection, unblinding failure, and anatomical deformities that would hinder the procedure.

All patients participating in the study were monitored using pulse oximetry, electrocardiography, non-invasive blood pressure measurement, capnography/gas analysis, temperature measurement, and urine output assessment. Initially, a peripheral vein was punctured using an 18G or 16G catheter. Following anesthesia induction, a central venous access was established in the internal jugular vein under ultrasound guidance.

Anesthesia induction was achieved intravenously using midazolam 2.0 mg, ketamine 0.2 mg/kg, followed by continuous infusion of remifentanil at a dose of 0.3 mcg/kg/min for 3 minutes. Propofol was also administered at a dose of 1.0 to 2.0 mg/kg (until loss of eyelash reflex), and either atracurium 0.5 mg/kg or succinylcholine 1.0 to 1.5 mg/kg (for patients with fasting < 8 hours) were used for muscle relaxation. Anesthesia maintenance involved a mixture of O_2, air, and sevoflurane (aiming for an expiratory fraction between 1.0 and 2.0 %), along with remifentanil doses ranging from 0.1 to 0.5 mcg/kg/min. Patients were ventilated using Volume Control mode with a tidal volume of 6-8 ml/kg of predicted body weight, PEEP titrated at 5-10 cmH_2O, plateau pressure $\leq$ 30 cmH_2O, and drive pressure < 15 cmH_2O on a GE Carestation 650 anesthesia station.

After anesthesia induction, immunosuppression was initiated with 500 mg of methylprednisolone plus immunoglobulin (75 mg/6h) through central venous access. Intraoperative analgesia included 100 mg of tramadol administered 30 minutes before completion of the surgery, along with 2.0 g of dipyrone. If patients experienced pain upon awakening, morphine was administered at 50 mcg/kg, which could be increased to 100 mcg/kg until effective pain control was achieved. Prophylaxis for nausea and vomiting consisted of 4.0 mg of dexamethasone at induction and 4.0 mg of ondansetron 30 minutes before the surgery's completion.

The study employed a prospective, randomized, double-blind design involving 45 patients divided into two groups (control and experimental). Four patients were excluded due to data loss, leaving 20 patients in the control group and 21 in the experimental group, as depicted in Fig. 1. After anesthesia induction, all patients received a total of 30 ml of solution. The control group received 15 ml of 0.5 % ropivacaine solution in the subcutaneous tissue, adjacent to the entire surgical incision, and 15 ml of 0.9 % saline solution between the fascia of the transversus abdominis muscle and the internal oblique muscle (TAP), anatomically below the surgical incision. The experimental group received 15 ml of 0.9 % saline solution in the subcutaneous tissue along the surgical incision and 15 ml of 0.5 % ropivacaine solution between the fascia of the TAP. Thus, all patients in the study received local anesthesia, either in the subcutaneous tissue (control group) or in the TAP (experimental group).



Source: Elaborated by the authors

Figure 1. Research design flowchart.

For patient randomization, cards were prepared, each of which was placed in sealed black envelopes. Prior to commencing the surgical procedure, the instrument nurse from the team selected one of the pre-shuffled envelopes and thereby assigned the patient to a group by draw.

To maintain blinding, the surgical instrument nurse was the only team member with knowledge of the infusion sequence, with the first syringe always infiltrating the muscle and the second into the subcutaneous tissue.

In the Intensive Care Unit and on the ward, the postoperative analgesic regimen for cases of moderate or severe pain (NRS > 3) was established as follows: intravenous tramadol 100 mg or morphine 50 mcg/kg for rescue, as assessed by the attending physician.

Data Collection

Data were collected using a standardized form by trained researchers who were unaware of which group the patients belonged to. The criteria for data collection included not participating in the surgical team and not having access to the operating room until after the procedure was completed, thereby enhancing the reliability of the double-blind study.

The pain component was assessed using the Visual Analog Scale (VAS) at 3 distinct time points. In Moment 1, the level of static (resting) pain was assessed after awakening, still in the operating room. In Moment 2, the level of static pain was also assessed 6 hours after the surgical procedure's completion in the ICU or ward. In Moment 3, static and dynamic pain were assessed 24 hours after the surgical procedure's completion in the ICU or ward. For static assessment, the VAS scale was used with the patient lying at rest. For dynamic assessment, the patient was asked to sit up in bed and report their pain level.

Pain was considered mild if VAS ≤ 3, moderate if ≥ 4 and ≤ 7, and severe if ≥ 8. Analgesic consumption was measured by reviewing medical records, considering the total dose of tramadol or morphine over the first 24 hours postoperatively.

Data Processing and Analysis:

The collected data were entered into an Excel spreadsheet, then validated. An independent statistician was consulted for analysis. Absolute and relative frequency tables were created for categorical variables, and associations between these variables and the type of analgesia were assessed using the Pearson chi-square test or Fisher's exact test.

Comparisons of the percentages of moderate or severe pain between the two types of analgesia and across the four postoperative time assessments were performed by fitting a repeated binary outcome logistic regression model using the Generalized Estimating Equations (GEE) method, with robust variance (*).

RESULTS

The study sample consisted of 41 patients, with 21 in the Experimental group (TAP Block) and 20 patients in the Control group. The majority of study patients were female, accounting for 27 (65 %) of them, while 14 were male (35 %). The age range varied from 20 to 67 years, with a mean of 42.7 years. The mean BMI was 24.1 kg/cm²; 3 patients had low weight (BMI $\leq$ 18.5 kg/cm²), and 4 patients had Grade I or II obesity. Nausea was present in 10 (24.3 %) patients, and 8 (19.5 %) patients experienced vomiting. Only 5 (12.1 %) patients reported pruritus, and no patients exhibited clinically noticeable allergic reactions.

The majority of patients (90.2 %) underwent renal transplantation for the first time, while 4 patients underwent a second transplant. The vast majority (90.2 %) of the transplants were performed in the right iliac fossa.

In the first 24 hours, tramadol was administered to 19 (46.3 %) patients, with a higher prevalence in the control group, 11 (57.9 %) vs. 7 (36.8 %). Morphine usage was higher in the experimental group, 7 (36.8 %) vs. 6 (31.6 %). Demographic data and clinical characteristics did not reveal statistical significance as described in Table 1.

Table 1. Evaluation of the association between type of analgesia and clinical and demographic characteristics.

Clinical and demographic characteristics	Type of analgesia		p*
	Control	TAP Block	
	N (%)	N (%)	
Use of tramadol in the first 24h post-op			0,194*
Yes	11 (57,9)	7 (36,8)	
No	8 (42,1)	12 (63,2)	
Use of morphine in the first 24h post-op			0,732*
Yes	6 (31,6)	7 (36,8)	
No	13 (68,4)	12 (63,2)	
Systemic Arterial Hypertension			> 0,99**
Yes	4 (21,1)	4 (22,2)	
No	15 (78,9)	14 (77,8)	
Nausea			0,062*
Yes	8 (42,1)	2 (11,1)	
No	11 (57,9)	16 (88,9)	

Continue...

Tabela 1. Continuation.

Clinical and demographic characteristics	Type of analgesia		p*
	Control	TAP Block	
	N (%)	N (%)	
Vomit			0,232*
Yes	6 (31,6)	2 (11,1)	
No	13 (68,4)	16 (88,9)	
Pruritus			> 0,99*
Yes	3 (15,8)	2 (11,1)	
No	16 (84,2)	16 (88,9)	
BMI (kg/m2)			0,488*
Normal/Overweight (<30)	13 (100,0)	14 (87,5)	
Obesity (>=30)	0 (0,0)	2 (12,5)	
Sex			0,827**
Masculine	7 (35,0)	7 (31,8)	
Female	13 (65,0)	15 (68,2)	
No. of kidney transplants performed			> 0,99*
First KT performed	10 (83,3)	15 (88,2)	
Second TX performed	2 (16,7)	2 (11,8)	
Incision side			0,295*
Right	11 (78,6)	17 (94,4)	
Left	3 (21,4)	1 (5,6)	

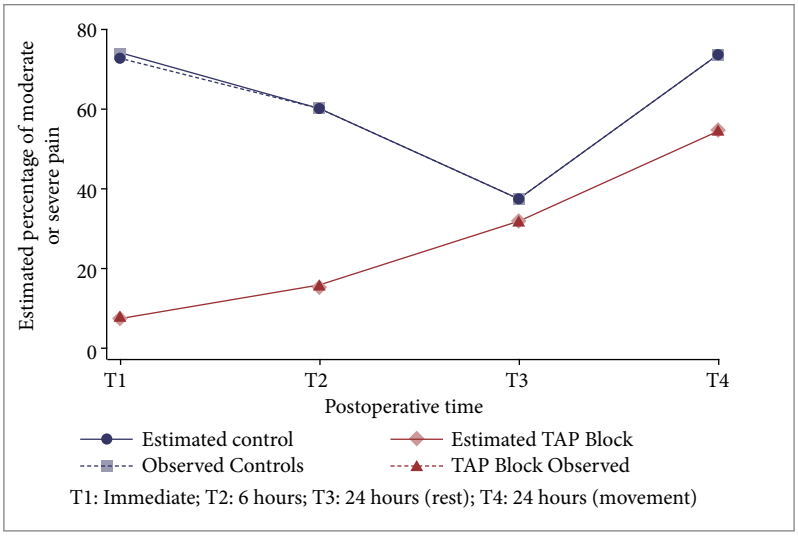
* Fisher's exact test; ** Pearson's chi-square test. Source: Elaborated by the authors

Table 2. Comparison of estimated percentages of moderate or severe pain between the two types of analgesia, according to postoperative time.

Time post-op	Comparison between types of analgesia	p*
	Control vs TAP Block (TAP Block – Control)	
Immediate	-65,6,0% (CI95%: -92,8 a -38,5%)	< 0,001
06 hours	-44,6% (CI95%: -76,8 a -12,4%)	0,007
24 hours (resting)	-5,0% (CI95%: -34,5 a -24,5%)	0,739
24 hours (dynamic)	-19,1% (CI95%: -48,2 a -9,9%)	0,197

*Wald test. Source: Elaborated by the authors

The assessment of moderate/severe pain demonstrated superior analgesic efficacy with TAP Block at two time points: upon awakening with $p < 0.001$, and at 6 hours with $p < 0.007$. No differences were found in the control of moderate/severe pain between the two groups in either static or dynamic assessments within 24 hours postoperatively (Table 2 and Fig. 2).



Source: Elaborated by the authors

Figure 2. Variation of percentages of moderate or severe pain according to operative time.

DISCUSSION

Postoperative pain control following general anesthesia can be achieved through a combination of non-steroidal anti-inflammatory drugs (NSAIDs), simple analgesics such as dipyrone/paracetamol, with or without opioids. However, significant complications such as nausea, vomiting, itching, and respiratory depression can occur after opioid use.[11] In patients undergoing renal transplantation, the use of NSAIDs should be avoided or contraindicated due to their inhibition of cyclooxygenase (COX) enzymes, which can lead to fluid retention, systemic hypertension, electrolyte imbalances, platelet aggregation inhibition, and reversible reduction in glomerular filtration rate (GFR).[9,17] In the General Transplant Unit of the present study, dipyrone and paracetamol are not used as analgesics due to their impact on fever dynamics.

The use of intrathecal or epidural morphine is still considered superior to other methods for postoperative pain control, though TAP block can be a valid option, especially when neuroaxial approaches are contraindicated.[18] In this context, the use of locoregional blocks offers better pain control while reducing opioid usage and associated side effects.[19]

Regarding pain control, our data showed a significant reduction in moderate/severe pain among patients undergoing TAP Block compared to the control group, particularly in the immediate postoperative period (awakening) and at six hours, which was not observed in the 24-hour assessment. These findings are similar to those in a comparison between TAP Block and local anesthesia by Milone[20], who compared TAP Block combined with local anesthesia to local anesthesia alone for inguinal herniorrhaphy surgery, and to the work of Mohammadi,[21] which compared TAP Block to 0.9% saline solution. Both studies found lower pain scores upon awakening and during the first 6 hours.

Although there is prevalent literature correlating reduced morphine use in patients undergoing TAP Block when compared to placebo16, our study did not show this association. This result could be attributed to the fact that all patients in our study received 15 ml of 0.5% ropivacaine (in TAP Block in the experimental group and in subcutaneous tissue in the control group), unlike other studies that compared anesthetic block with placebo.[21] Other data in the literature, such as that by Araújo,[22] which compared postoperative pain in patients undergoing laparoscopic nephrectomy with ultrasound-guided TAP Block vs. trocar site infiltration, did not find statistically significant differences in morphine consumption reduction between the groups, aligning with our findings. In this study, locoregional blockade at the time of incision was chosen, as visualization of the external oblique, internal oblique, and transversus abdominis muscles was possible under direct vision.

In the 24-hour assessment, no differences in pain control were found, and most patients experienced moderate/severe pain, especially in the dynamic assessment (73.7 % in the control group vs. 54.5 % in the TAP Block group). In this context, three considerations can be made regarding these findings. The use of 0.5 % ropivacaine for both fascial block and local infiltration has a duration of effect of 6-10 hours, which could explain similar pain findings in the 24-hour postoperative assessment. It was also observed that some patients, even when experiencing moderate/severe pain, did not request rescue analgesic doses, whether in the ICU or ward environment. This low administration of analgesics could have impacted better pain control.

Pain is a universal issue that spans many diseases. Recent studies report pain prevalence rates during interviews ranging from 43 % to 84 %, with intense pain reaching values of 42 % within 24 hours.[23,24] Early recognition and treatment of pain in hospitalized patients are considered relevant points in hospital health care and constitute an important quality indicator of care.[25] The results can raise awareness of this issue and guide institutions and multidisciplinary teams to adopt new strategies to reduce the incidence of pain. Our findings emphasize the need for greater attention to the pain component, as well as greater administration of analgesic agents to inpatients for better pain control.

Study limitations include a small number of patients due to the study's interruption caused by significant preliminary assessment differences and being restricted to a single center.

CONCLUSION

The clinical characteristics of renal transplant patients make analgesic therapy challenging due to restrictions on the use of non-steroidal anti-inflammatory drugs. In this context, TAP Block proved effective in reducing moderate/severe pain in patients undergoing renal transplantation upon awakening and during the first 6 hours of the postoperative period. It significantly contributes to postoperative analgesia and demonstrates its efficacy as a method for the early postoperative hours.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHORS' CONTRIBUTIONS

Substantial scientific and intellectual contributions to the study: Leão ALS, Leão CS, Silva MCM, Moraes ACMU**; Conception and design:** Leão CS, Leão ALS**; Analysis and interpretation of data:** Leão ALS, Leão CS, Silva MCM, Moraes ACMU**; Article writing:** Leão ALS, Leão CS, Silva MCM, Moraes ACMU**; Critical revision:** Leão ALS, Leão CS, Silva MCM, Moraes ACMU**; Final approval:** Leão CS.

AVAILABILITY OF DATA AND MATERIAL

All data generated or analyzed during this study are included in this article.

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Not applicable.

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