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SURGICAL TIME, BLEEDING, AND LENGTH OF STAY IN GMFCS V NEUROMUSCULAR SCOLIOSIS PATIENTS

TEMPO CIRÚRGICO, SANGRAMENTO E TEMPO DE INTERNAÇÃO HOSPITALAR NA ESCOLIOSE NEUROMUSCULAR GMFCS V

TIEMPO QUIRÚRGICO, SANGRADO Y DURACIÓN DE LA ESTANCIA HOSPITALARIA EN LA ESCOLIOSIS NEUROMUSCULAR GMFCS V

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ABSTRACT

Neuromuscular scoliosis usually involves patients in poor health conditions. In this context, minimizing intraoperative bleeding and length of hospital stay is essential while maintaining good clinical and radiological outcomes for the patient. Objective: The study aims to assess how variables such as age, weight, blood loss, and especially total surgical time influence the duration of hospital stay and identify a possible correlation between osteotomies and estimated blood loss. Method: This is a retrospective observational study where data was collected between January 2021 and December 2022. The inclusion criteria consisted of patients diagnosed with cerebral palsy GMFCS V suffering from neuromuscular scoliosis undergoing spine surgery for scoliosis correction, without age restrictions. Correlation analysis and linear regression were performed using the variables of interest, and $p < .05$ was accepted as a statistically significant difference. Results: A total of 26 patients were included, 14 males and 12 females. The median age was 13 years, and the median length of stay was 8 days. There was a significant, moderate, positive correlation between total surgical time and length of stay amongst class V surgically treated patients, $r(24) = .39$, $p = .043$. Conclusions: Prolonging the surgical procedure correlates with an extended hospital length of stay amongst surgically treated neuromuscular scoliosis GMFCS V patients with a pelvic obliquity of less than 20 degrees. ***Level of Evidence IV; Case-Control Study***.

Keywords: Scoliosis; Neuromuscular Diseases; bleeding; Osteotomy.

RESUMO

A escoliose neuromuscular geralmente afeta pacientes com saúde debilitada. Nesse contexto, é essencial minimizar o sangramento intraoperatório e o tempo de internação hospitalar, mantendo bons resultados clínicos e radiológicos para o paciente. Objetivos: Este estudo tem como objetivo analisar de que forma variáveis como idade, peso, perda de sangue e, principalmente, tempo total de cirurgia afetam o tempo de internação hospitalar e identificar a possível relação entre osteotomias e perda de sangue estimada. Métodos: Este é um estudo observacional retrospectivo em que os dados foram coletados entre janeiro de 2021 e dezembro de 2022. Os critérios de inclusão consistiram em pacientes diagnosticados com paralisia cerebral no nível V do GMFCS que tinham escoliose neuromuscular e foram submetidos a cirurgia da coluna vertebral para corrigir a escoliose, sem restrições de idade. A análise de correlação e regressão linear foi realizada usando as variáveis de interesse, e um valor de $p < 0,05$ foi aceito como uma diferença estatisticamente significativa. Resultados: Foram incluídos 26 pacientes, 14 do sexo masculino e 12 do sexo feminino. A idade média foi de 13 anos e o tempo médio de internação hospitalar foi de 8 dias. Foi observada uma correlação significativa, moderada e positiva entre o tempo operatório total e o tempo de internação em pacientes da classe V tratados cirurgicamente, $r(24) = 0,39$, $p = 0,043$. Conclusões: O tempo prolongado do procedimento cirúrgico está correlacionado com o aumento do tempo de internação hospitalar entre os pacientes com escoliose neuromuscular classificados como GMFCS V e com obliquidade pélvica inferior a 20 graus. ***Nível de Evidência IV; Estudo Caso-Controle.***

Descritores: *Escoliose; Doenças Neuromusculares; Sangramento; Osteotomia.*

RESUMEN

La escoliosis neuromuscular generalmente afecta a pacientes en condiciones de salud precarias. En este contexto, es esencial minimizar el sangrado intraoperatorio y la duración de la estancia hospitalaria, al tiempo que se mantienen buenos resultados clínicos y radiológicos para el paciente. Objetivos: Este estudio tiene como objetivo analizar de qué manera variables como edad, peso, pérdida de sangre y, especialmente, el tiempo total de cirugía afectan la duración de la estancia hospitalaria, además de identificar la posible relación entre osteotomías y la pérdida de sangre estimada. Métodos: Este es un estudio observacional retrospectivo en el que se recopilaron datos entre enero de 2021 y diciembre de 2022. Los criterios de inclusión consistieron en pacientes diagnosticados con parálisis cerebral en el nivel

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V de la GMFCS que padecían escoliosis neuromuscular y se sometieron a cirugía de columna para corregir la escoliosis, sin restricciones de edad. Se realizó un análisis de correlación y regresión lineal utilizando las variables de interés, y se aceptó un valor de p < 0,05 como una diferencia estadísticamente significativa. Resultados: Se incluyeron un total de 26 pacientes, 14 hombres y 12 mujeres. La edad mediana fue de 13 años y la duración mediana de la estancia hospitalaria fue de 8 días. Se observó una correlación significativa, moderada y positiva entre el tiempo quirúrgico total y la duración de la estancia en pacientes tratados quirúrgicamente de la clase V, r(24)= .39, p = .043. Conclusiones: La prolongación del tiempo de procedimiento quirúrgico está correlacionada con un aumento en la duración de la estancia hospitalaria entre los pacientes con escoliosis neuromuscular clasificados como GMFCS V y con oblicuidad pélvica de menos de 20 grados. ***Nivel de Evidencia IV; Estudio de Caso-Control.***

Descriptores: *Escoliosis; Enfermedades Neuromusculares; Sangrado; Osteotomía.*

INTRODUCTION

Scoliosis consists of an abnormal spine bending, mainly in the coronal plane of at least 10º, but also includes rotational and sagittal deformity, affecting about 3% of the population.[1-3] Neuromuscular scoliosis develops in childhood or early adolescence.[4-6] It may be due to different causes, and the most common ones are cerebral palsy, Friedrich's ataxia, Charcot-Marie-Tooth disease, syringomyelia, spinal cord injury, spinal muscular atrophy, and Duchenne muscular dystrophy.[5-7]

The treatment is carried out with clinical and serial radiographic monitoring. In general, surgical treatment is recommended when the Cobb angle reaches values of 50 to 60 degrees or pelvic obliquity exceeds 15 degrees; however, this decision should be individualized.[5,6] The goal of surgical treatment is to prevent the progression of the disease, maintain good pulmonary function, and appropriate postural tone, and prevent the development of pressure ulcers.[5-8] Intraoperatively, the extreme use of osteotomies and correction maneuvers does not necessarily lead to a better outcome[9-10] and may add severe morbidity,[11] including blood loss and an increased need for blood transfusion.[12]

A successful surgical outcome is related to meticulous care, especially in the intraoperative and postoperative stages.[9] In this study, we aim to comprehensively evaluate a subgroup of patients with cerebral palsy Gross Motor Function Classification System (GMFCS) V who underwent surgical correction of scoliosis. The correlation between osteotomies and blood loss will be assessed, and the associations of age, weight, blood loss, and total surgical time will be assessed with the duration of hospital stay.

METHODS

This is a retrospective observational study where data was collected between January 2021 and December 2022. The inclusion criteria consisted of patients diagnosed with cerebral palsy GMFCS V suffering from neuromuscular scoliosis undergoing spine surgery for scoliosis correction, without age restrictions. Patients with neuromuscular scoliosis due to other causes than cerebral palsy, incomplete medical records, or incomplete images were excluded. This study was approved by the institutional review board (CAAE 69927523.0.0000.0085 / number 6.145.239), and informed consent was waived.

The following measurements were used for standardization: age measured in years, gender (male or female), etiology of the underlying pathology involving the patient's spine, length of stay measured in days, scoliosis cobb angle measurements in degrees, osteotomy (yes or no), total blood loss in milliliters, total surgical time, and levels of instrumentation.

Measurements were obtained independently by two examiners with similar levels of experience. The examiners were trained to perform the measurements before the study, and five cases were selected for training purposes only. These cases were not included in the final sample. All examiners had the same training for all measurement evaluations, and the acceptable threshold variation was 2-3 degrees for angular measurements or 2-3mm for linear measurements.

De-identified data was stored in an Excel spreadsheet (Microsoft Corporation, Redmon, Wash.) After data clean-up and quality evaluation, it was imported into RStudio (RStudio, PBC, Boston, MA) for statistical analysis. Continuous data were described by the median and its minimum (min) and maximum (max) values. The absolute frequency (N) and respective categorical proportion (%) described the categorical data.

For statistical analysis, the data was normalized by applying the min-max function. This technique scales the values of a feature to range between 0 and 1. This is accomplished by subtracting the feature's minimum value from each value and dividing it by its range. Subsequently, correlation analysis and linear regression were performed using the variables of interest. A stratified analysis using any significant values will be performed if necessary. A type I error of up to 5% was accepted as a statistically significant difference.

RESULTS

A total of 26 patients were included in the study after applying the inclusion and exclusion criteria, including 14 males and 12 females. The median age was 13 years, and the median length of stay was 8 days (Table 1). The most common instrumentation level was T3-Iliac and posterior column osteotomies were performed in 92.30% of the cases. (Table 2)

The results did not demonstrate a correlation between osteotomy and total blood loss among GMFCS V surgically treated patients, $r(24) = .19$, $p > .05$.

Similarly, a correlation between age {$r(24) = -.06$, $p > .05$}, weight {$r(24) = -.15$, $p > .05$}, total blood loss {$r(24) = .03$, $p > .05$} with length of stay amongst class V surgically treated patients, respectively, was not found.

Finally, there was a significant, weak, positive correlation between total surgical time and length of stay amongst class V surgically treated patients, $r(24) = .39$, $p = .043$. Simple linear regression was used to test if total surgical time significantly predicted length of stay. The overall regression was statistically significant (Multiple R squared = .16, $F(1,24) = 4.56$, $p = .043$). A stratification analysis was also performed using the median value of pelvic obliquity as a cut-off point. For patients with a pelvic obliquity less than 20 degrees, there was a significant, moderate, positive correlation between total surgical time and length of stay amongst class V surgically treated patients, $r(9) = .62$, $p = .041$. We did not find a significant correlation for patients with a pelvic obliquity greater or equal to 20 degrees ($r(13) = .47$, $p = .072$).

Table 1. Demographic characteristics.

Gender - n, (%)	
Male	14, (53.85)
Female	12, (46.15)
Age - median years, (min-max)	13, (9-21)
Weight - median kilograms, (min-max)	30, (19-57)
Height - median meters, (min-max)	1.29, (1.01-1.60)
Total Surgical Time - median minutes, (mix-max)	290, (180-480)
Total Blood Loss - median milliliters, (min-max)	500, (300-1200)
Length of Stay - median days, (min-max)	8, (5-44)

Table 2. Cobb measurements, osteotomy, and levels of instrumentation.

Proximal Thoracic Cobb Angle - median °, (min-max)	
Preoperative	82.10, (74.2-90)
Postoperative	42.25, (39.8-44.7)
Thoracic Cobb Angle - median °, (min-max)	
Preoperative	90, (41-100)
Postoperative	21.20, (13-67)
Thoracolumbar-Lumbar Cobb Angle - median °, (min-max)	
Preoperative	72.50, (45-120)
Postoperative	29.70, (10-101.40)
Pelvic Obliquity - median °, (min-max)	
Preoperative	20, (0-45)
Postoperative	7.05, (2-22)
Posterior Column Osteotomy – N, (%)	
Yes	24, (92.30)
Facetectomy	13, (54.20)
+ Ponte	11, (45.80)
No	2, (7.70)
Levels of Instrumentation - N, (%)	
T2-Iliac	3, (11.50)
T3-Iliac	21, (80.80)
T4-Iliac	1, (3.85)
T3-S1	1, (3.85)

DISCUSSION

It is known that the surgical procedure causes significant volumetric loss, especially during curve correction.[13] Additionally, performing osteotomies at multiple levels is a significant risk factor for blood loss exceeding 30% of blood volume, along with a preoperative Cobb angle exceeding 50 degrees.[14]

When it comes to osteotomies, it is an important resource in curve manipulation. However, the literature tends to describe an increase in bleeding and surgical time, transfusion rates, and complication volume, as well as a lesser impact on scoliosis correction than kyphosis.[13,15-18] In this study, despite the contrary trend described above, we found no valid relationship between osteotomies and associated bleeding. This may be because almost all evaluated patients underwent osteotomies (92.3%), making the presence of an appropriate control group unfeasible.

Contrary to some previous data,[19] we did not find that age influences the average bleeding of surgeries. This relationship may be contested when considering that bleeding was estimated in absolute volume and not proportionally matched to body mass in this research.

No significant relationship was found between age, weight, bleeding, and hospital stay. This may be partly due to the relative homogeneity of the group, as in the cerebral palsy GMFCS V group, we observed a tendency towards low weight, limiting the comparative effect. There is some previous evidence that low weight is associated with massive blood loss,[20] while overweight patients do not have an increased risk compared to inappropriate weight conditions.[21]

Overall, considering what is documented in other studies, increased hospital stay is associated with the presence of comorbidities that weaken the patient, the number of fused levels, more severe curves, bleeding, and intraoperative complications.[22-26] The lack of correlation in this study may be due to the epidemiological profile of the evaluated patients, with the majority having a more severe clinical condition and severe curves, tending towards homogeneity.

The data presented statistical support for the following paired elements: surgical time and hospital stay. Roughly speaking, the longer the surgical time, the longer the hospital stay. Despite an ostensibly obvious relationship, the explanation lies in the fact that the surgical prolongation is due to the aforementioned factors that determine a longer hospital stay.[22-26] In other words, surgery takes longer in cases of more severe curves, excessive intraoperative bleeding, a greater number of fused levels, and clinical fragility of the patient. Additionally, these same factors are associated with a higher risk of postoperative infections,[27,28] which, when early, invariably lead to an increased hospitalization period for appropriate treatment.

Pelvic fixation is another risk factor for postoperative complications, such as infection.[28] The reasons for this may include more extensive dissection with the creation of extra dead space, a greater incision that extends closer to the rectum, and extra blood loss. These factors also contribute to a greater surgical time.[29]

There is still a significant lack of data regarding neuromuscular scoliosis compared to idiopathic scoliosis, and many of the references we rely on are based on idiopathic cases. Prospective studies related to the topic with more patients are needed. As important criticisms, we also highlight the research methodology, which consists of a retrospective analysis of cases, technically inferior to prospective cohort and interventional studies. Another criticism lies in the number of cases evaluated, which, considered small, makes it difficult to obtain statistical significance.

CONCLUSIONS

Prolonging the surgical procedure correlates with an extended hospital length of stay amongst surgically treated neuromuscular scoliosis GMFCS V patients with a pelvic obliquity of less than 20 degrees.

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