

# What Factors can Influence Massive Blood Loss in the Surgical Treatment of Neuromuscular Scoliosis?\*

## *Quais fatores podem influenciar perdas sanguíneas extensas no tratamento cirúrgico da escoliose neuromuscular?*

Marta Maio<sup>1</sup>  Alfredo Carvalho<sup>2</sup> André Pinho<sup>3</sup> Francisco Serdoura<sup>3</sup> Vitorino Veludo<sup>3</sup>

<sup>1</sup> Department of Orthopaedics and Traumatology, Centro Hospitalar de Trás os Montes e Alto Douro, Vila Real, Portugal

<sup>2</sup> Department of Orthopaedics and Traumatology, Centro Hospitalar Cova da Beira, Covilhã, Portugal

<sup>3</sup> Department of Orthopaedics and Traumatology, Centro Hospitalar São João, Porto, Portugal

Address for correspondence Marta Maio, MD, Department of Orthopaedics and Traumatology, Centro Hospitalar Trás os Montes e Alto Douro, Vila Real, Portugal (e-mail: martadml.maio@gmail.com).

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### Abstract

**Objective** The aim of the present study is to identify the incidence, predisposing factors and prognostic impact of blood loss in patients with neuromuscular scoliosis submitted to corrective surgery.

**Methods** Retrospective cohort study, including pediatric patients diagnosed with neuromuscular scoliosis undergoing instrumentation and posterior vertebral fusion in a university hospital. Patient characteristics were collected from the hospital information system.

**Results** A total of 39 patients were included in the study. The intraoperative blood losses were 962 ml, representing a loss of 35.63% of the blood volume. In 20 cases, there was a massive blood loss (> 30%) and only 7 patients did not need a transfusion. The group of patients with massive blood loss had a slightly higher age (13.75 versus 13.53 years old), a lower body mass index (BMI) percentile (25 versus 50), and for each decrease of 0.38 in the BMI, intraoperative blood losses increased 1% ( $p < 0.05$ ). The value of preoperative albumin had influence on the percentage of blood loss, and for each decrease of 0.4 of albumin, blood loss increased 1% ( $p < 0.05$ ).

**Conclusions** The factors that most contributed to the differences in blood loss were age, BMI, and preoperative albumin value. There was no significant association between Cobb angle, number of fusion levels and duration of surgery. We can conclude that these patients would benefit from preoperative nutritional control.

### Keywords

- ▶ neuromuscular diseases
- ▶ scoliosis
- ▶ blood loss, surgical

### Resumo

**Objetivo** O objetivo do presente estudo é identificar a incidência, os fatores predisponentes e o impacto prognóstico da perda de sangue em pacientes com escoliose neuromuscular submetidos a cirurgia corretiva.

\* Study conducted at the Department of Orthopedics and Traumatology, Centro Hospitalar São João, Porto, Portugal.

**Palavras-chave**

- ▶ doenças neuromusculares
- ▶ escoliose
- ▶ perda sanguínea cirúrgica

**Métodos** Estudo de coorte retrospectiva, incluindo pacientes pediátricos com diagnóstico de escoliose neuromuscular submetidos a instrumentação e fusão vertebral posterior em um hospital universitário. As características dos pacientes foram coletadas no sistema de informações do hospital.

**Resultados** Um total de 39 pacientes foram incluídos no estudo. As perdas sanguíneas intraoperatórias foram de 962 mL, representando uma perda de 35,63% do volume sanguíneo; a perda de sangue foi extensa em 20 casos (> 30%) e apenas 7 pacientes não necessitaram de transfusão. O grupo de pacientes com perda maciça de sangue apresentou idade um pouco maior (13,75 versus 13,53 anos) e menor percentil do índice de massa corporal (IMC) (25 versus 50); para cada diminuição de 0,38 no IMC, as perdas sanguíneas intraoperatórias aumentaram 1% ( $p < 0,05$ ). A concentração pré-operatória de albumina influenciou o percentual de perda de sangue e, para cada diminuição de 0,4 de albumina, a perda de sangue aumentou 1% ( $p < 0,05$ ).

**Conclusões** Os fatores que mais contribuíram para as diferenças na perda sanguínea foram idade, IMC e concentração pré-operatória de albumina. Não houve associação significativa entre ângulo de Cobb, número de níveis de fusão e duração da cirurgia. Podemos concluir que esses pacientes se beneficiariam do controle nutricional pré-operatório.

**Introduction**

Posterior vertebral instrumentation and fusion is the standard surgical procedure for the definitive treatment of scoliosis.<sup>1</sup> Despite recent advances in surgical and anesthetic techniques, this continues to be a major surgery associated with large blood loss, and need for allogenic blood transfusion.<sup>1-6</sup> This issue is of concern to surgeons and anesthesiologists because of the risks, costs and blood availability.<sup>2,4,6</sup>

Studies have shown that patients with neuromuscular scoliosis have a greater predisposition to large blood loss and, therefore, for need of transfusions.<sup>1-3,6</sup> As the prevalence of this pathology is low, there are still few studies on this subject.<sup>2</sup> However, the literature reports several reasons why blood loss is greater in neuromuscular patients, the most obvious being highest Cobb angles and a greater number of fused segments than in patients with idiopathic scoliosis.<sup>1,4,5</sup> Some studies also report that nutritional status in the perioperative period has been shown to be important in intra- and postoperative hematologic complications.<sup>2,5,7,8</sup> In addition, many of these patients take antiepileptic medication that may affect coagulation.<sup>2,5</sup> Some studies found that blood loss is also dependent on neuromuscular disorders; patients with cerebral palsy have more loss than those with spinal muscular atrophy, myelomeningocele, and Duchenne muscular dystrophy.<sup>9</sup>

It is therefore important to identify the factors that influence blood loss, to establish strategies to control them. The aim of the present study is to identify the incidence, predisposing factors and prognostic impact of blood loss in patients with neuromuscular scoliosis submitted to corrective surgery.

**Material and Methods**

A retrospective cohort study was conducted, including pediatric patients diagnosed with neuromuscular scoliosis under-

going instrumentation and posterior vertebral fusion between 2012 and 2016 in a university hospital. All of the surgeries were performed using only a posterior approach and pedicle screw fixation. Patients undergoing scoliosis revision surgeries were excluded.

Information on gender, age, height, weight, preoperative medical history and laboratory data, preoperative Cobb angle, postoperative Cobb angle, fused level, surgical procedures, duration of surgery, and estimated blood loss data was collected through consultation of the clinical process and visualization of complementary diagnostic tests. Total blood loss was calculated as the sum of intraoperative loss, included the blood in the suction container and on the soaked sponge. The definition of massive blood loss was total blood loss > 30% of the estimated blood volume, which was calculated as 70 mL/kg.<sup>4,5</sup>

SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) was used for description and statistical analysis of the data, with  $p < 0.05$  being considered statistically significant. Continuous data were reported as means with standard deviation. To compare means with a normal distribution between two groups, a *t* test was used and analysis of variance (ANOVA) for three groups or more. To analyze the correlation between two continuous data, the Pearson correlation was performed. Being a retrospective study, it was required an authorization from the ethics committee for the consultation and use of the data.

**Results**

The characteristics of the population are described in **Table 1**. A total of 39 patients were included in the study, 24 were females and 15 males, the mean age was  $13.56 \pm 3.58$  years old. The body mass index (BMI) was on average  $19.58 \pm 6.25$  kg/m<sup>2</sup>, and the most frequent percentile was < 5 (9 patients). Preoperative albumin was 24.9mg/dL, and total proteins 71.88mg/dL. The most common pathology was cerebral palsy (10) followed

**Table 1** Characteristics of population

Variable	Mean	Standard deviation
Age (years old)	13.56	3.58
Body mass index (kg/m <sup>2</sup> )	19.58	6.25
Preoperative Cobb angle (°)	67.60	17.77
Postoperative Cobb angle (°)	24.56	15.43
Correction percentage (%)	65.13	17.77
Fusion levels	13.36	2.580
Surgery duration (hours)	3.26	0.69
Hemoglobin preoperative (g/dL)	13.61	1.08
Albumine preoperative (mg/dL)	24.90	5.83
Proteins preoperative (mg/dL)	71.88	9.49
Drainage intraoperative (mL)	962.37	461.08
Percentage of blood loss (%)	35.63	17.49

by myelomeningocele (4). In 9 of the patients, cardiac pathology was present, 12 patients had pulmonary pathology and 16 had epilepsy. Only 16 were able to walk, and pelvic obliquity was present in 17. Five patients had percutaneous endoscopic gastrostomy (PEG) for feeding.<sup>10</sup>

The preoperative Cobb angle of the sample was  $67.60^\circ \pm 17.77^\circ$  and a final value of  $24.56^\circ \pm 15.43^\circ$ , and the correction percentage was 65%. A mean of 13 levels were instrumented; in 14 cases, pelvic instrumentation was performed, and the average duration of the surgery was 3 hours and 15 minutes. Intraoperative blood losses were 962 mL, which represented a loss of 35.63% of the blood volume, which implies that in 20 cases there was a massive loss of blood (> 30%), and only 7 patients did not need a transfusion. On average, each patient received 1.7 transfusions.

The group of patients with massive blood loss (> 30%) had a slightly higher age (13.75 versus 13.53 years old) ( $p < 0.05$ ), a lower BMI percentile (25 versus 50), with  $p < 0.05$ , and greater number of transfusions (2.0 versus 1.2) ( $p < 0.05$ ). For each decrease of 0.38 in the BMI, intraoperative blood losses increased 1% ( $p < 0.05$ ). This group received on average a greater number of blood transfusions (2.0 versus 1.2) ( $p < 0.05$ ). The value of preoperative albumin had an influence on the percentage of blood loss, and each decrease of 0.4 of albumin increased losses by 1% ( $p < 0.05$ ).

Although it was not a statistically significant result, the preoperative Cobb angle was higher in the group in which there was massive blood loss, and this group had a longer operative time.

## Discussion

Compared with patients with idiopathic scoliosis, patients with neuromuscular scoliosis are more prone to have greater blood loss during posterior spine surgery and transfusion requirement. If the risk factors of massive blood loss during this surgery could be identified and corrected preoperatively,

we could reduce the demand of allogeneic blood transfusion and its associated complications.<sup>1</sup>

According to our analyses, a risk factor was increased age. Patients with massive blood loss were older, which can be explained by the lower flexibility of the curve with increased age, and a more difficult reduction maneuver.<sup>2</sup>

Another factor was lower BMI percentile; the group of massive blood loss had a percentile of 25 and the other group 50, and the blood loss increased 1% for each decrease of 0.38 in the BMI. Patients with neuromuscular diseases have more risk of low weight; this can be due to their diseases and related treatments, and the blood loss amounts are magnified in effect in smaller patients, as in our sample, whose majority were of low weight.<sup>2-4,6,8</sup>

Children with lower BMI are also at risk of poor nutritional status, which can be marked by hypoalbuminemia. In the present study, the value of preoperative albumin had an influence on the percentage of blood loss; for each decrease of 0.4 of albumin, blood loss increased 1%. This can be explained by the strong relationship previously found between nutrition status and bone density and mineralization, which increase bleeding during surgical procedures.<sup>3,7,8</sup>

Although in the literature the preoperative Cobb angle, duration of surgery and number of fusion levels are considered prognostic factors for blood loss and transfusions, even though we found an association, it was not statistically significant, which can be related to the small sample size.<sup>4,9</sup>

Some authors suggest that consumption of coagulation factors during spinal surgery in association with dilution of these factors enhance blood loss. In addition, many neuromuscular patients have epilepsy and take medications, some of which can affect coagulation. In our study, we didn't find any association between blood loss and epilepsy.<sup>2,4,5</sup>

The use of antifibrinolytic medications, such as tranexamic acid, has been increasing in this type of surgery, with good results in the reduction of blood loss, but further studies are still needed.<sup>11</sup>

The present study has several limitations, such as the small sample size, the variability of the scoliosis etiology, the type of study, a retrospective study from a single hospital, and the quantification only of intraoperative blood loss.

## Conclusions

Blood loss in scoliosis surgery is a matter of concern and is the subject of several studies. However, the predictors of hemorrhage are difficult to identify and, above all, to control.

In the present study, the factors that most contributed to the differences in blood loss were age, BMI, and preoperative albumin value. There was no significant association between Cobb angle, number of fusion levels and duration of surgery. We can conclude that these patients would benefit from preoperative nutritional control.

### Conflict of Interests

The authors have no conflict of interests to declare.

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