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Outcome of Surgical Wound in Neuromuscular Scoliosis: Conventional Dressings vs. Negative Pressure Therapy

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ABSTRACT

Objective: To evaluate surgical wound complications by comparing conventional dressings and incisional negative pressure therapy (NPT) in spinal surgeries. Method: This was a longitudinal, observational, exploratory, and retrospective study with a quantitative approach, including 50 patients treated with conventional dressings and 50 with incisional NPT, conducted between 2017 and 2021. Data collection involved the analysis of 25 variables, with statistical tests conducted using an alpha level (p-value) of 0.05 and a 95% confidence interval (CI). Results: The overall complication rate was 37%, with a higher incidence of exudate and suture dehiscence. Patients treated with conventional dressings experienced more complications during hospitalization (88.24%) compared to those in the NPT group, who had a higher proportion of complications after discharge (50%) (p = 0.03). No statistically significant differences were found for the other variables. The conventional group also showed a higher frequency of infection one year postoperatively (14% vs. 12.24%). Conclusion: Patients with neuromuscular scoliosis have high rates of surgical wound complications. NPT was associated with a reduction in surgical wound infection and high-volume exudate compared to conventional dressings, although these differences were not statistically significant. Expanding the study sample is necessary to confirm the efficacy and potential superiority of incisional NPT.

DESCRIPTORS: Negative-pressure wound therapy. Enterostomal therapy. Surgical wound. Scoliosis. Surgical wound infection.

Desfecho de ferida operatória em escoliose neuromuscular: curativos convencionais versus terapia por pressão negativa

RESUMO

Objetivos Avaliar complicações de ferida operatória comparando coberturas convencionais e Terapia por Pressão Negativa (TPN) de manejo incisional, em cirurgias de coluna. Método: Estudo longitudinal, retrospectivo, exploratório, observacional, com abordagem quantitativa, composta por 50 pacientes de curativo convencional e 50 de TPN de manejo incisional, de 2017 a 2021. A coleta de dados analisou 25 variáveis, e testes estatísticos levaram em consideração um α bidirecional (p-valor) de 0,05 e um intervalo de confiança (IC) de 95%. Resultados: A taxa de complicação foi de 37%, com maior incidência de exsudato e deiscência de pontos. Pacientes com curativo convencional apresentaram mais complicações durante internação (88,24%) do que os pacientes com TPN após alta (50%) (p=0,03); demais variáveis não apresentaram diferença estatística. A amostra controle teve maior frequência de infecção em um ano após o procedimento cirúrgico (14% no convencional e 12,24% na

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TPN). Conclusão: Pacientes com escoliose neuromuscular possuem altas taxas de complicação de ferida operatória. A TPN apresentou uma redução de infecção de ferida operatória e de alto volume de exsudato em comparação com a amostra de curativo convencional, porém sem diferença estatística. É necessário ampliar o número de pacientes da pesquisa para comprovar a eficácia e a superioridade da TPN de manejo incisional.

DESCRITORES: Tratamento de ferimentos com pressão negativa. Estomaterapia. Ferida cirúrgica. Escoliose. Infecção de ferida cirúrgica.

Evolución de la herida quirúrgica en escoliosis neuromuscular: curaciones convencionales vs. terapia de presión negativa

RESUMEN

Objetivo: Evaluar las complicaciones de la herida operatoria comparando apósitos convencionales y terapia de presión negativa (TPN) para el manejo incisional en cirugías de columna. Método: Estudio longitudinal, observacional, exploratorio, retrospectivo y con enfoque cuantitativo, compuesto por 50 pacientes con apósitos convencionales y 50 con TPN para el manejo incisional, entre 2017 y 2021. La recolección de datos analizó 25 variables, y las pruebas estadísticas consideraron un α bidireccional (valor p) de 0,05 y un intervalo de confianza (IC) del 95%. Resultados: La tasa de complicaciones fue del 37%, con mayor incidencia de exudado y dehiscencia de sutura. Los pacientes con apósitos convencionales presentaron más complicaciones durante la hospitalización (88,24%) en comparación con los pacientes con TPN después del alta (50%) (p=0,03). No se observaron diferencias estadísticas para las otras variables. La muestra de control presentó una mayor frecuencia de infección un año después del procedimiento quirúrgico (14% en el grupo de apósitos convencionales y 12,24% en el grupo de TPN). Conclusión: Los pacientes con escoliosis neuromuscular presentan altas tasas de complicaciones de la herida operatoria. La TPN mostró una reducción en la infección de la herida quirúrgica y en el alto volumen de exudado en comparación con los apósitos convencionales, aunque sin diferencias estadísticamente significativas. Es necesario ampliar el número de pacientes en la investigación para confirmar la eficacia y superioridad de la TPN para el manejo incisional.

DESCRIPTORES: Terapia de presión negativa para heridas. Estomaterapia. Herida quirúrgica. Escoliosis. Infección de la herida quirúrgica.

INTRODUCTION

Scoliosis is a spinal deformity characterized by a twisting of the spinal elements around the vertical axis and is considered a multiplanar deformity[1]. When this condition does not have a specific known cause, it is defined as idiopathic, which accounts for more than 80% of scoliosis cases, according to the Scoliosis Research Society.

Although less common, there are rarer forms of scoliosis that tend to result in more severe spinal curvatures. These are associated with syndromic conditions, congenital malformations, and neuromuscular disorders[2]. The irregular curvature of the spine observed in neuromuscular scoliosis is linked to disorders of the brain, spinal cord, and muscular system[1], as seen in cerebral palsy (considered the most common etiology[2]), spinal muscular atrophy, muscular dystrophy, myelomeningocele, and spinal cord injuries, among others[1,2] In these conditions—often associated with pelvic obliquity[2]—nerves and muscles are unable to maintain proper alignment of the spine and trunk[1].

Muscle weakness, paralysis, poor motor control, and spasticity compromise spinal muscle strength, rendering the spine unable to maintain its symmetry. During periods of accelerated skeletal growth, these muscular imbalances become more pronounced, resulting in rapidly progressing spinal curves[1].

The management of neuromuscular scoliosis ideally begins with conservative treatment and may progress to surgical intervention. Surgical decisions take into account not only the progression of the Cobb angle but also respiratory function, curve flexibility and rigidity, and pelvic obliquity[1].

According to a prospective multicenter study conducted by the Harms Study Group in patients with neuromuscular scoliosis secondary to cerebral palsy, the main indications for spinal fusion surgery—according to caregivers and surgeons—were to improve sitting balance, prevent difficulties while sitting, avoid pulmonary compromise, and improve head control/positioning[3].

Although surgical procedures, when appropriately indicated, help improve sitting balance, reduce pain, and slow the progression of spinal curvature, corrective surgeries for neuromuscular scoliosis are associated with high complication rates[1].

A study conducted from 2012 to 2017 confirmed previous findings by showing that the most common surgical complications in pediatric patients with cerebral palsy undergoing spinal fusion surgery included wound-related complications. The 90-day readmission rate was 17.6%, with the most common causes being wound dehiscence, surgical site infection (SSI), and other infections[4].

Given this scenario, in which the literature confirms the complexity of this surgical procedure, as well as the risks of complications and high infection rates, in July 2018 the institution implemented a managed protocol for the treatment of neuromuscular scoliosis, as it performs approximately 40% of the national volume of neuromuscular scoliosis procedures.

Prior to 2018, all postoperative dressings were applied using semi-permeable coverings with non-adherent absorbent cotton gauze or with adhesive elastic bandages to support compression therapy, along with adhesive skin sutures. However, there was significant concern regarding contamination of the surgical wound with urine and feces, due to the neurological profile of the patients, the presence of infections, prolonged hospital stays, and readmissions.

Following the implementation of the protocol, the use of incisional Negative Pressure Wound Therapy (NPWT) was standardized. This therapy is applied directly to the surgical wound by the surgeon in the operating room and remains in place for five to seven days. After this period, the dressing is replaced with a semi-permeable covering and non-adherent absorbent cotton gauze.

According to recent evidence in the literature, several benefits are associated with the use of NPWT for incisional management in the treatment of complex acute and chronic wounds[5-8]. Incisional NPWT uses an open-cell reticulated foam technology that collapses toward its geometric center, reducing lateral tension, keeping the surgical wound edges approximated, and managing wound fluids at a negative pressure of 125 mmHg. It is believed to promote wound healing, tissue granulation, and angiogenesis[9], in addition to reducing the local inflammatory response.

A study conducted in a population of patients undergoing abdominal wall reconstruction and panniculectomy aimed to evaluate the impact of NPWT on surgical incisions compared to conventional dressings. The results showed a reduction in postoperative wound complication rates in patients treated with NPWT, attributed to decreased superficial wound breakdown and reduced need for additional surgical interventions[10].

Another prospective study conducted in 2021 aimed to evaluate the effect of incisional NPWT compared to conventional dressings in reducing SSI in patients undergoing spinal surgery. The study concluded that infection rates were significantly reduced with the use of NPWT compared to conventional dressings[11].

Although several recent studies have demonstrated the effectiveness of NPWT for incisional management, there is still a paucity of literature on the use of this therapy in patients undergoing surgery for neuromuscular scoliosis.

OBJECTIVES

To identify and compare the main surgical wound complications and the presence or absence of SSI in patients who underwent corrective surgery for neuromuscular scoliosis between 2017 and 2021, using either conventional dressings or incisional NPWT at an orthopedic hospital.

METHODS

This is a retrospective, longitudinal, exploratory, and observational study with a quantitative approach. The study was conducted at an orthopedic hospital located in São Paulo, recognized as a Center of Excellence in Scoliosis, which has implemented a managed protocol for the treatment of patients with neuromuscular scoliosis—a major surgical procedure typically performed in complex cases due to associated neurological impairments.

The institutional census sample consisted of 100 patients who underwent corrective surgery for neuromuscular scoliosis at the institution between 2017 and 2021—a period encompassing the development of the managed protocol. The sample included 50 patients treated prior to the implementation of incisional NPWT, from 2017 to July 2018 (conventional dressing group), and 50 patients treated after the protocol implementation, from August 2018 to 2021 (NPWT group).

Regarding the selection criteria, the sample included patients with spinal deformities of neuromuscular origin who underwent primary spinal arthrodesis between 2017 and 2021; were admitted to the institution through the Unified Health System (SUS in Portuguese), private insurance, or out-of-pocket payment; had documentation of surgical incision progression in the electronic medical record; and had follow-up in the outpatient clinic or medical center within up to 90 days for wound complications and up to one year for wound infections after surgery[12]. As for the exclusion criteria, patients without complete data on the postoperative wound progression in the electronic medical record through the post-discharge period were excluded from the sample.

Data collection was conducted using the institutional data management systems Qlik Sense and Channel, which store information from managed protocols. A report was generated listing all neuromuscular scoliosis surgeries performed between 2017 and 2021. Subsequently, the researchers screened the data to exclude patients who did not meet the selection criteria. The relevant information was then retrieved from the Tasy electronic medical record system by reviewing notes and clinical documentation regarding surgical wound progression.

The sample was limited to 50 patients treated with conventional dressings and 50 treated with NPWT, due to the retrospective nature of the study, which required complete surgical wound records in the electronic medical record. This requirement limited the study sample, as incomplete records were excluded from the analysis. Of the 80 patients initially selected for analysis in the conventional dressing group (2017–2018), 30 were excluded, resulting in the inclusion of 50 patients who met the predefined inclusion and exclusion criteria. In the group treated with incisional NPWT, 23 patients were excluded, and 50 were included.

The information collected from the medical records was entered into a Microsoft Excel spreadsheet, where 25 variables were analyzed (Table 1). The most relevant variables for the study were those related to the types of surgical wound complications, the type of dressing used, the timing and duration of complications, and the presence of wound infection within one year.

After completing the medical record review, the data were anonymized and submitted for statistical analysis.

All statistical tests used a two-tailed alpha level (p-value) of 0.05 and a 95% confidence interval (CI). Analyses were conducted using the R[1] statistical software or IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA). Qualitative variables were described using frequencies and confidence intervals, while quantitative variables were described using measures of central tendency (mean and median) and measures of dispersion (standard deviation, interquartile range, minimum, and maximum). Associations between qualitative variables were tested using the chi-square test, with Yates correction applied when the expected frequency in any category was less than five.

The association between quantitative and qualitative variables was assessed using the Wilcoxon test. The sensitivity of the chi-square test for the primary outcome (presence of complications by dressing type) was calculated using the G*Power software[13].

The project was approved by the Health Research Ethics Committee of the Association for Assistance to Disabled Children (São Paulo), under opinion no. 6.236.881 and CAAE no. 69794623.0.0000.0085.

Table 1. Descriptive statistics of the variables used in the study. São Paulo (SP), Brazil, 2023.

Variable name	Categories	Type
ID		
Payer source	1 'Private Insurance' 2 'Public Health System (SUS)' 3 'Out-of-pocket'	Qualitative - Nominal
Sex	1 'Male' 2 'Female'	Qualitative - Nominal
Age	In years	Quantitative - Discrete
Diagnosis	1. Cerebral Palsy 2. Myelomeningocele 3. Syndromes 4. Other diagnoses	Qualitative - Nominal
Surgery date	Date dd/mm/yyyy	
Surgical time	In minutes	Quantitative - Discrete
Dressing type	1 'Conventional' 2 'Incisional NPWT'	Qualitative - Nominal
Wound complications	0 'No' 1 'Yes'	Qualitative - Nominal
Timing of complication	1 'During hospitalization' 2 'Post-discharge'	Qualitative - Nominal
Complication period	1 'Up to 30 days' 2 '30 to 90 days'	Qualitative - Nominal
Ischemia	0 'No' 1 'Yes'	Qualitative - Nominal
Dehiscence	0 'No' 1 'Yes'	Qualitative - Nominal
Hypergranulation	0 'No' 1 'Yes'	Qualitative - Nominal
Hyperemia	0 'No' 1 'Yes'	Qualitative - Nominal
Bulging	0 'No' 1 'Yes'	Qualitative - Nominal
Necrosis	0 'No' 1 'Yes'	Qualitative - Nominal
Slough	0 'No' 1 'Yes'	Qualitative - Nominal
Exudate	1 'Dry or low' 2 'Moderate or high'	Qualitative - Nominal
Imaging exam	0 'No' 1 'Yes'	Qualitative - Nominal
Infection within 1 year	0 'No' 1 'Yes'	Qualitative - Nominal
Readmission	0 'No' 1 'Yes'	Qualitative - Nominal
Surgical reintervention	0 'No' 1 'Yes'	Qualitative - Nominal
Wound care follow-up	0 'No' 1 'Yes'	Qualitative - Nominal
Plastic surgery follow-up	0 'No' 1 'Yes'	Qualitative - Nominal
Hyperbaric chamber	0 'No' 1 'Yes'	Qualitative - Nominal
Complete medical records	0 'No' 1 'Yes'	Qualitative - Nominal

RESULTS

The study included 100 patients, with 50 in the conventional dressing group and 50 in the incisional NPWT group. Most patients in the study were covered by private insurance (72%). The sample was evenly distributed by sex, with 48% male and 52% female patients. The majority had cerebral palsy as the associated condition (64%), followed by myelomeningocele (11%).

The mean age of patients was 14 years, ranging from 7 to 26 years. The average duration of surgical procedures was 288 minutes (5 hours), ranging from 165 to 550 minutes (approximately 2.7 to 9 hours).

Surgical wound complications were observed in 37% of cases, with most occurring during hospitalization (67%) and within 15 days postoperatively (74%).

Among the variables assessed, no patients developed hypergranulation, and most did not exhibit ischemia, hyperemia, bulging, necrosis, or slough.

Overall, considering both the conventional dressing and NPWT groups, the majority of patients did not develop an infection within one year following the surgical procedure (86.9%). Additionally, 87% of patients did not require readmission, and 92% of the sample showed no evidence of fluid collections on imaging (Table 2).

Exudate was the most frequent complication in both groups (30% in the conventional group and 32% in the NPWT group). Although the NPWT group had a numerically higher rate of exudate, only 6% (n=3) of patients in this group presented with a high volume of exudate, compared to 14% (n=7) in the conventional dressing group. The second most common complication was suture dehiscence (20% in the conventional group and 28% in the NPWT group).

The distribution of complication types was similar between the conventional and NPWT groups (Table 3).

Complications were more frequent in the NPWT group (40%) compared to the conventional dressing group (34%), although no statistically significant difference in complication frequency was found between the two dressing types.

Patients in the conventional dressing group had a higher frequency of infection within one year after surgery (14%) compared to those in the NPWT group (12.24%). However, more patients in the NPWT group required readmission (18%, n=9) (Table 4).

Patients who developed complications had a longer average surgical time (303 minutes, or 5 hours) compared to those without complications (279 minutes, or 4.6 hours).

When comparing surgery duration between patients with and without complications across the two dressing groups, those in the NPWT group with complications had a higher mean surgical time (323 minutes, or 5.4 hours).

The majority of complications occurred during hospitalization (70.27%), with a smaller proportion occurring after discharge (29.73%).

There was a statistically significant difference (p=0.03) in the location of complication occurrence between the conventional and NPWT groups (Table 5), with conventional dressing patients experiencing a higher frequency of complications during hospitalization (88.24%) compared to 50% in the NPWT group, whose complications occurred after discharge.

When considering only complications occurring in the hospital setting, there was a reduction in the rate of dehiscence in the NPWT group (45.45%, n=5) compared to the conventional dressing group (53.55%, n=8). No patients in the NPWT group presented with surgical wound necrosis, in contrast to the conventional dressing group (13.33%, n=2).

Most complications occurred within the first 15 days after the surgical procedure (76%, n=28). No complications were identified beyond 90 days.

Although patients with cerebral palsy comprised the majority compared to those with other associated conditions, the distribution of complications and infections was similar across the different disease groups.

When comparing patient sex with the presence of complications, a significant association was observed between sex and the occurrence of suture dehiscence (p=0.036), with males showing a higher prevalence of dehiscence (67%) compared to females.

Overall, the statistical analysis concluded that the sample size was too small to detect significant effect sizes and lacked the statistical power to confidently state that the dressing types are equivalent.

Table 2. Descriptive statistics of patient complication characteristics, with the number of patients per category (N) and the percentage with a 95% confidence interval. São Paulo (SP), Brazil, 2023.

Variable/Categories	N	% (95% CI)
Presence of complications?		
No	63	63 (53.28–71.98)
Yes	37	37 (28.02–46.72)
Did the complication occur during hospitalization or post-discharge within 6 months after surgery?		
Hospitalization	26	66.67 (51.1–79.86)
Post-discharge	13	33.33 (20.14–48.9)
Time to complication onset (days)		
15	29	74.36 (59.27–85.99)
30	6	15.38 (6.69–28.99)
60	3	7.69 (2.21–19.13)
90	1	2.56 (0.28–11.36)
Time to complication (grouped) (days)		
Up to 30	35	89.74 (77.43–96.44)
Between 30 and 90	4	10.26 (3.56–22.57)
Presence of ischemia?		
No	96	96 (90.77–98.64)
Yes	4	4 (1.36–9.23)
Presence of dehiscence?		
No	76	76 (66.97–83.55)
Yes	24	24 (16.45–33.03)
Presence of hypergranulation?		
No	100	100 (100–100)
Yes	0	0 (0–0)
Presence of hyperemia?		
No	93	93.94 (87.94–97.43)
Yes	6	6.06 (2.57–12.06)
Presence of bulging?		
No	97	97 (92.21–99.15)
Yes	3	3 (0.85–7.79)
Presence of necrosis?		
No	97	97 (92.21–99.15)
Yes	3	3 (0.85–7.79)
Presence of slough?		
No	85	85 (77.05–90.96)
Yes	15	15 (9.04–22.95)
Amount of exudate?		
Dry	69	69 (59.49–77.43)
Low	10	10 (5.26–17.01)
Moderate	11	11 (5.99–18.23)
High	10	10 (5.26–17.01)
Exudate amount (grouped)		
Dry or low	79	79 (70.26–86.09)
Moderate or high	21	21 (13.91–29.74)
Imaging exam showing fluid collection?		
No	92	94.85 (89.07–98.01)
Yes	5	5.15 (1.99–10.93)
Infection within 1 year post-surgery?		
No	86	86.87 (79.19–92.43)
Yes	13	13.13 (7.57–20.81)
Readmission due to surgical wound complication or infection within 1 year?		
No	87	87 (79.38–92.51)
Yes	13	13 (7.49–20.62)

Tabela 3. Descriptive statistics of complication characteristics by dressing type, with the number of patients per category (N), percentage with 95% confidence interval (CI), and chi-square test of association. São Paulo (SP), Brazil, 2023.

	Dressing type				p-value
	Conventional		Incisional NPWT		
	n	% (IC95%)	n	% (IC95%)	
Presence of ischemia?					
No	48	96 (87.78–99.16)	48	96 (87.78–99.16)	0.980
Yes	2	4 (0.84–12.22)	2	4 (0.84–12.22)	
Presence of dehiscence?					
No	40	80 (67.42–89.23)	36	72 (58.58–82.96)	0.349
Yes	10	20 (10.77–32.58)	14	28 (17.04–41.42)	
Presence of hyperemia?					
No	46	93.88 (84.55–98.25)	47	94 (84.85–98.28)	0.980
Yes	3	6.12 (1.75–15.45)	3	6 (1.72–15.15)	
Presence of bulging?					
No	49	98 (91.03–99.78)	48	96 (87.78–99.16)	0.558
Yes	1	2 (0.22–8.97)	2	4 (0.84–12.22)	
Presence of necrosis?					
No	48	96 (87.78–99.16)	49	98 (91.03–99.78)	0.558
Yes	2	4 (0.84–12.22)	1	2 (0.22–8.97)	
Presence of slough?					
No	45	90 (79.46–96.08)	40	80 (67.42–89.23)	0.161
Yes	5	10 (3.92–20.54)	10	20 (10.77–32.58)	
Amount of exudate?					
Dry	35	70 (56.45–81.31)	34	68 (54.34–79.64)	0.347
Low	3	6 (1.72–15.15)	7	14 (6.49–25.53)	
Moderate	5	10 (3.92–20.54)	6	12 (5.17–23.07)	
High	7	14 (6.49–25.53)	3	6 (1.72–15.15)	
Exudate amount (grouped)					
Dry or low	38	76 (62.93–86.16)	41	82 (69.72–90.7)	0.461
Moderate or high	12	24 (13.84–37.07)	9	18 (9.3–30.28)	
Imaging with collection?					
No	45	95.74 (87.04–99.11)	47	94 (84.85–98.28)	0.698
Yes	2	4.26 (0.89–12.96)	3	6 (1.72–15.15)	

Table 4. Descriptive statistics of infection occurrence by dressing type, with the number of patients per category (N), percentage with 95% confidence interval (CI), and chi-square (χ^2) test of association. São Paulo (SP), Brazil, 2023.

	Dressing Type				p-value
	Conventional		Incisional NPWT		
	n	% (95% IC)	n	% (95% IC)	
Infection within 1 year post-surgery?					
No	43	86 (74.47–93.51)	43	87.76 (76.49–94.72)	0.796
Yes	7	14 (6.49–25.53)	6	12.24 (5.28–23.51)	
Readmission due to surgical wound complication or infection within 1 year post-surgery?					
No	46	92 (82.09–97.24)	41	82 (69.72–90.7)	0.234
Yes	4	8 (2.76–17.91)	9	18 (9.3–30.28)	

NPWT: Negative Pressure Wound Therapy.

Table 5. Descriptive statistics of the timing of complication occurrence by dressing type, with the number of patients per category (N), percentage with 95% confidence interval, and chi-square (χ^2) test of association. São Paulo (SP), Brazil, 2023.

	Dressing Type				p-value
	Conventional		Incisional NPWT		
	n	% (95% CI)	n	% (95% CI)	
Complication during hospitalization or post-discharge within 6 months?					
Hospitalization	15	88.24 (67.32–97.47)	11	50 (30.2–69.8)	0.030
Post-discharge	2	11.76 (2.53–32.68)	11	50 (30.2–69.8)	
Time to complication (days)					
15	15	88.24 (67.32–97.47)	14	63.64 (42.87–81.07)	0.248
30	2	11.76 (2.53–32.68)	4	18.18 (6.47–37.64)	
60	0	0 (0–0)	3	13.64 (4–32.09)	
90	0	0 (0–0)	1	4.55 (0.49–19.34)	

NPWT: Negative Pressure Wound Therapy.

The control group (conventional dressing) achieved an 86% success rate. Assuming the experimental group (incisional NPWT) achieved a 14% higher success rate (i.e., 100% success), the minimum sample size required to adequately detect this difference would be between 110 and 120 patients (with 80% power). To detect a 5% improvement attributable to the treatment (incisional NPWT) with adequate power, a sample size of 1,330 participants would be necessary. It is important to note that the difference observed in this study—although not statistically significant—was below 2%.

DISCUSSION

Corrective scoliosis surgeries are associated with high rates of postoperative complications, including SSI[14,15]. Among the different types of scoliosis, neuromuscular scoliosis presents the highest complication rates due to patients' associated comorbidities, comparatively poorer nutritional status, reduced mobility, compromised bone integrity, age at surgery, magnitude of the primary curve, and history of prolonged hospitalizations[12,16-18].

Our study identified cerebral palsy as the most prevalent diagnosis associated with neuromuscular scoliosis, with a mean patient age of 14 years—demographic characteristics that align with findings reported in other studies[15]. Considering the pediatric population as the primary target group for neuromuscular scoliosis correction surgeries at the institution, it is worth noting that there is literature supporting the efficacy and safety of incisional NPWT in this population. A retrospective study conducted between 2016 and 2018 aimed to evaluate the effectiveness of incisional NPWT in a sample of pediatric and neonatal patients. Negative pressure of 125 mmHg was applied in children aged 9 years and older, while 50 mmHg was used for children under 8 years of age, infants, and neonates. The study concluded that incisional NPWT in children and neonates is a safe and effective practice for reducing incisional infection rates[13].

A retrospective chart review conducted between 2008 and 2016 at Shriners Hospitals for Children in Philadelphia examined perioperative complications and risk factors in patients undergoing surgical correction of neuromuscular scoliosis. It identified prolonged operative time as one of the predictors of complications in these patients[14]. Although not statistically significant, our study also observed a correlation between longer mean operative times (303 minutes, or 5 hours) and the incidence of surgical wound complications.

According to the International Best Practice Recommendations for the Early Identification and Prevention of Surgical Wound Complications, a surgical wound complication is defined as an interruption in the normal healing of the incisional wound after surgery, associated with the presence of hyperemia, edema, excessive exudate, wound dehiscence, fluid collection, among other signs. Complications are most commonly reported between postoperative days 7 and 9 but may occur

up to 90 days following surgeries involving implants[12]. These data are consistent with our findings, as most surgical wound complications occurred within the first 15 days after the procedure (76%).

A relevant point, considering the findings of our study, is that although the experimental group (n=22) experienced more surgical wound complications than the control group (n=17), patients treated with conventional dressings had a higher frequency of complications during hospitalization (88.24%, n=15), whereas those in the incisional NPWT group had a higher percentage of complications occurring after discharge (50%, n=11) compared to the conventional group. This result was statistically significant in our study (p=0.03), and the difference observed between the groups may be associated with the continuity of surgical wound care in the outpatient setting, provided by patients and their families.

A cross-sectional quantitative study was conducted in two metropolitan tertiary hospitals in Queensland, Australia, to identify patients experiences and preferences regarding the care they received for surgical wounds post-discharge. A questionnaire was developed in which patients were asked about the health education they received at the time of discharge for managing wounds at home. Only 65.4% were able to identify signs of SSI, 56.7% knew how to properly clean the wound, and 47.8% reported knowing which dressing to use at home[13]. The findings from this study highlight the need for healthcare teams to reinforce discharge instructions to ensure proper management of surgical wounds in the home setting, aiming to minimize postoperative complications and the development of SSIs, which may be preventable with improved discharge education.

Surgical wound dehiscence, the second most frequent complication in our study, is defined as the rupture of opposing or sutured margins of a surgical incision. It can be classified as: grade 1, involving only the epidermis; grade 2, involving the subcutaneous layer; grade 3, involving the fascia; and grade 4, when viscera, implants, or bone are exposed, with or without signs and symptoms suggestive of infection in each category[16]. A 2020 retrospective cohort study concluded that when incisional NPWT is used preferentially in patients at high risk for postoperative wound complications, it helps prevent increased rates of dehiscence and SSIs[9].

A randomized clinical trial published in 2024, conducted at a hospital in Spain, concluded that incisional NPWT in non-idiopathic scoliosis surgeries is less likely to result in surgical wound complications—particularly dehiscence—contributing to significantly faster healing and offering excellent cost-effectiveness[14]. Our study did not find evidence to support a reduction in the rate of surgical wound dehiscence with incisional NPWT. However, when considering only complications occurring within the hospital setting, we observed a reduction in the rate of dehiscence (n=5) compared to the conventional group (n=8), although this difference was not statistically significant.

According to updated recommendations and practices from the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Association for Professionals in Infection Control and Epidemiology (APIC) for the prevention of SSI, there is moderate-certainty evidence indicating that NPWT on closed incisions is effective in reducing fluid accumulation in the surgical wound[18]. This evidence is consistent with the results observed in our study. Although 16 patients in the incisional NPWT group presented with exudate (32%) compared to 15 patients in the conventional dressing group (30%), we observed that in the experimental group, 7 had a small amount of exudate (14%), 6 had a moderate amount (12%), and only 3 had a high volume (6%). In comparison, among the conventional dressing group, only 3 had a small volume (6%), 5 had a moderate amount (10%), and 7 had a high volume (14%).

Thus, although more patients treated with incisional NPWT presented with exudate, we observed a significant reduction in exudate volume, particularly in cases of high-volume exudate (6% for NPWT vs. 14% for conventional dressings)—which is the most concerning manifestation of this complication. This finding is relevant and aligns with evidence from other studies demonstrating the benefit of incisional NPWT in reducing wound exudate volume.

SSI considered one of the primary types of surgical wound complications, may manifest up to one year postoperatively if an implantable device is placed, and it remains the leading cause of hospital readmission[12]. These infections can significantly increase postoperative length of stay and readmission rates, and patients may require surgical reintervention,

additional treatments, consultations with specialists, or prolonged antibiotic use—as observed in the groups analyzed in our study. It is estimated that healthcare costs for patients who develop an SSI are 1.4 to 3 times higher than for those who do not, creating a substantial financial burden on healthcare systems[15].

Our study concluded that the majority of patients did not develop an infection within one year after surgery (86.9%) and did not require readmission (87%). Fifteen patients required surgical reintervention (conventional dressing = 6; incisional NPWT = 9); 14 required follow-up with a wound care specialist (conventional = 7; NPWT = 7); 3 required follow-up with plastic surgery (conventional = 1; NPWT = 2); and 5 underwent hyperbaric oxygen therapy sessions (conventional = 4; NPWT = 1).

The indications for using incisional NPWT are broad and include prophylaxis against SSI. Experimental evidence suggests that NPWT promotes wound healing by increasing local blood flow and granulation tissue formation while reducing wound contamination, edema, and exudate[19].

There is moderate-certainty evidence that individuals with primarily closed surgical wounds who are prophylactically treated with NPWT experience fewer SSIs than those treated with conventional dressings[19]. Although the sample size in our study was small (n=100) to detect statistically significant differences between the groups, we observed that the group treated with incisional NPWT had fewer infections within one year compared to patients treated with conventional dressings.

This finding is consistent with results from a 2023 retrospective review that evaluated the prophylactic use of incisional NPWT following neuromuscular scoliosis surgery in reducing SSI rates. That study assessed 71 children—30 received conventional dressings and 41 received NPWT. Although a lower infection rate was observed in the NPWT group, no statistically significant difference was found between the groups[20], reinforcing the need for larger sample sizes to detect meaningful effect sizes.

Study Limitations

The limitations of this study include the sample size (N = 100), the absence of complete data regarding the progression of surgical wounds through the post-discharge period in the electronic medical records, and the reported challenges in managing NPWT technology, particularly related to device alarms and alerts, as documented by healthcare professionals. These limitations and reported difficulties, as recorded in the patient charts, may have contributed to the very similar results observed between the conventional dressing and incisional NPWT groups.

Recommendations

Looking ahead, it is necessary to increase the number of patients in future studies to achieve sufficient statistical power to confirm the efficacy and superiority of incisional NPWT over conventional dressings in reducing surgical wound complications and infections.

CONCLUSION

Patients with neuromuscular scoliosis exhibit high rates of surgical wound complications, with a 37% incidence observed in this study. Patients treated with conventional dressings had a higher frequency of wound complications during hospitalization (88.24%), whereas those treated with incisional NPWT experienced a greater proportion of complications after discharge (50%) ($p = 0.03$). No statistically significant differences were found for the other variables analyzed. Although not statistically significant, the benefits associated with incisional NPWT included a reduction in high-volume exudate, lower rates of suture dehiscence in the inpatient setting, absence of wound necrosis, and a decreased incidence of SSI within one year after surgery, compared to conventional dressings.

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Author Contributions:

PSL: project administration, formal analysis, conceptualization, data curation, writing – original draft, writing – review and editing, investigation, methodology, funding acquisition, resources, supervision, validation, visualization.

ICOY: formal analysis, conceptualization, data curation, writing – original draft, writing – review and editing, investigation, methodology, resources, validation, visualization.

RSS: conceptualization, data curation, writing – original draft, investigation, methodology, validation, visualization.

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