

## ORIGINAL ARTICLE

# Factors affecting postmusculoskeletal tumour surgery wound problem treatment with negative pressure wound therapy

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## Abstract

The aim of the study is to investigate the risk factors identified in literature that have been associated with prolonged Negative Pressure Wound Therapy (NPWT). Our study included patients who developed local wound problems after bone or soft tissue sarcoma surgery with negative margin at our clinic between 2012 and 2018 and treated with NPWT. All patients were followed up of at least 6 months. Sex, albumin level, skin infiltration, type of wound problem, postoperative intensive care unit (ICU) requirement, and intraoperative blood loss were found to be influential factors on NPWT > 10 sessions. We conclude that treatment may be prolonged and the necessary precautions need to be taken in patients with an impaired preoperative nutritional condition, with intraoperative high amount of blood loss, and with long postoperative stays in the ICU as well as if the underlying cause for wound problem is an infection.

## KEYWORDS

musculoskeletal tumour surgery, negative pressure wound therapy, wound complication

## 1 | INTRODUCTION

Limb salvage surgery for treatment of sarcomas of the extremities, the most significant problem is covering the reconstruction site with healthy tissue,<sup>1</sup> while the second largest obstacle is performing reconstruction in the same session as the resection.<sup>2-5</sup> In patients with malignant bone or soft tissue tumours, postoperative wound site problems have been reported to occur at rates of 16% to 56%.<sup>6,7</sup> Previous studies have reported on the risk factors associated with wound site problems,<sup>1-10</sup> which can be classified under three groups, based on the patient, the disease and the treatment received. Patient-based risk factors include smoking status and alcohol use, diabetes, nutritional status (albumin levels) and comorbidities; disease-related risk factors include high grade, large in size, localised in proximal lower extremity, infiltrated to the skin, being recurrent and

identified to have metastasized at diagnosis; and the received treatment-based risk factors include neoadjuvant and adjuvant chemotherapy (CT), radiotherapy (RT) administered to the patient, implants or megaprosthesis, longer operation duration, intraoperative blood loss and high amounts of transfusion.

Bone or soft tissue sarcoma surgery challenges both the surgeon and the patient in different ways, the first of which is the mass not being resected with negative margins, leading to recurrence; the second is the high prevalence of risk factors that can lead to wound problems at the surgical site; and the third is the treatment of wounds when postoperative wound problems occur.

The optimum approach to the prevention of wound problems is the careful preoperative planning of soft tissue reconstruction, and their performance in the same session as the resection.<sup>2,3,11</sup> One of the most commonly

used methods to be applied when wound problems occur is Negative Pressure Wound Therapy (NPWT),<sup>12-15</sup> which creates a pressure gradient between the wound and the suction through a direct effect. Furthermore, its indirect effect reduces bacterial colonisation and wound site edema, and increases local blood flow, epithelisation, and granulation.<sup>12-16</sup>

Conventional dressing is cheap, easy to use, and accessible in most clinics easily; however, it should be changed when it becomes saturated with exudate because of loss of its effectiveness. Conventional dressings often have to be changed in postoperative chronic wound problems. Otherwise the wound can be easily become infected and it will be difficult to overcome the infection.<sup>17</sup>

In the current study, the patients with the majority of risk factors recovered after one session of NPWT, while others necessitated  $\geq 100$  sessions of NPWT. The aim of the present study is to investigate the risk factors identified in literature that have been associated with prolonged NPWT.

## 2 | MATERIALS AND METHODS

This retrospective study was conducted upon the approval of our institution's ethics committee (09.2019.585). The study included patients who were operated on because of bone or soft tissue sarcoma with negative margin at our clinic between 2012 and 2018, developed postoperative local wound problems, received NPWT and were followed up for at least 6 months. All information related to the patients, i.e. demographics (gender, age, body mass index), comorbidities (smoking, alcohol use, diabetes, asthma, heart failure, etc.), status of distant organ metastasis at diagnosis, nutritional status (albumin levels), tumour localization, primary or recurrence nature of mass, pathological diagnosis, pathological tumour volume (volume approximated by multiplying the length, width and depth of each gross pathologic description), tumour grade, status of skin infiltration, operation type, operation duration, status of implant or megaprosthesis placement, skin closure method (primary, skin graft, rotational flap, free flap), duration of operation, amount of bleeding, amount of transfusion, type of wound problem (infection, wound dehiscence, skin necrosis), culture positivity-negativity, receipt of adjuvant therapy (chemotherapy, radiotherapy), number of NPWT administrations, postoperative intensive care unit (ICU) requirement, the length of ICU stay, duration of follow-up and status of post-NPWT recurrence, was retrieved from the patients' archive files and the hospital computer records. Patients who received NPWT but who died before completing the wound problem treatment,

### Key Messages

- wound problems are frequently encountered after tumour surgery.
- negative Pressure Wound Therapy (NPWT) is a reliable and effective method in the treatment of wound problems.
- NPWT may be prolonged and the necessary precautions need to be taken in patients with an impaired preoperative nutritional condition, with intraoperative blood loss at high amounts, and with long postoperative stays in the intensive care unit as well as if the factor causing wound site problem is an infection

those who underwent postoperative incision vacuum treatment and those who underwent NPWT for wound problems unrelated to tumour surgery were excluded from the study.

All NPWT units used in this study were designed and manufactured by Kinetic Concepts, Incorporated (KCI<sup>®</sup> Inc, San Antonio, Texas). NPWT was applied at 125 mmHg at continuous mode without instillation. NPWT was changed at bedside every 3 to 4 days.

### 2.1 | Statistical analysis

The statistical analysis was performed using the NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah) software. The study data were evaluated using descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, and maximum). A Kolmogorov-Smirnov test, a Shapiro-Wilk test, and graphical assessments were used to test for the normality of distribution of the quantitative data. A Mann-Whitney *U* test was used to compare the data that were abnormally distributed between two groups; three or more groups that with an abnormal distribution were compared using a Kruskal Wallis test; and a paired comparison was made using a Bonferroni-Dunn test. A Spearman's Correlation Analysis was used to evaluate the relationship between variables that were abnormally distributed. After obtaining the total score of possible risk factors, diagnostic and screening tests (sensitivity, specificity, positive predictive value, and negative predictive value), and receiver operating characteristic (ROC) analysis were used to determine the predictive value of NPWT number. The level of significance was considered to be  $P < .05$ .

### 3 | RESULTS

Of the 436 patients operated because of bone or soft tissue sarcoma at our institution between 2012 and 2018, 46 developed postoperative local wound problems, received NPWT and were followed up for at least 6 months. The study was conducted with 42 cases, 52.4% ( $n = 22$ ) of which were female and 47.6% ( $n = 20$ ) were male. Patient age varied between 8 and 79 years, with a mean of  $39.38 \pm 21.72$  years. Regarding the Body Mass Index (BMI) of the cases, 2.4% ( $n = 1$ ) were underweight, 54.7% ( $n = 23$ ) were of normal weight, 11.9% ( $n = 5$ ) were overweight, and 31.0% ( $n = 13$ ) were obese. Furthermore, 23.8% ( $n = 10$ ) had diabetes, 33.3% ( $n = 14$ ) had comorbidities, 19.0% ( $n = 8$ ) were smokers, 54.8% ( $n = 23$ ) had low albumin, and 38.1% ( $n = 16$ ) had metastasis at diagnosis.

Assessment of disease characteristics (tumour localization, tumour volume, laterality, operation type, operation duration, blood transfusion, intraoperative blood loss, skin infiltration, lesion presentation, tumour grade, use of chemotherapy, use of radiotherapy, the methods of wound closure, wound complication, wound culture, postoperative ICU requirement, the length of ICU stay and follow up, and the number of NPWT sessions) are shown in Table 1.

The pathological tumour diagnoses and tumour localization distribution of the patients are presented in Table 2.

The number of NPWT sessions was found to be higher in females than males ( $P = .008$ ). A statistically significant difference was noted between postoperative ICU need and number of NPWT sessions ( $P = .003$ ;  $P < .01$ ); cases requiring postoperative ICU had a higher number of NPWT sessions than those without a postoperative ICU requirement. A statistically significant difference was noted in the number of NPWT sessions required by cases with skin-infiltrated tumours ( $P = .003$ ;  $P < .01$ ). The number of NPWT sessions was lower in cases with skin infiltration than in those without skin infiltration. The number of NPWT sessions required in cases with postresection infection was higher than those with dehiscence. No statistically significant difference was identified between the number of NPWT sessions required and the culture results ( $P = .072$ ;  $P > .05$ ), although it is remarkable that the number of NPWT sessions required was higher in cases with a positive culture than it was in cases with a negative culture (Table 3).

When skin infiltrating tumours were compared with noninfiltrating tumours, the operation duration of the skin infiltrating tumours were short ( $P = .022$ ), the amount of intraoperative blood loss was low ( $P = .017$ ), and split thickness skin graft, rotational flap, and free flap were

mainly required for wound closure ( $P = .009$ ) so there were less requirement for NPWT in this cohort of patients.

No statistically significant difference was established between the NPWT numbers of the cases and albumin levels ( $P = .053$ ;  $P > .05$ ), although it is remarkable that the NPWT number was higher in cases with low levels of albumin comparing to cases with normal albumin levels (Table 4).

No statistically significant association could be identified between the number of NPWT sessions required and BMI, presence of diabetes, smoking, presence of comorbidities, presence of metastasis at diagnosis, tumour size, tumour grade, tumour localization, operation type, duration of operation, amount of blood transfusion, status of postoperative wound closure, status of preoperative/postoperative CT, and preoperative RT administration ( $P > .05$ ) (Tables 3 and 4).

A statistically and significantly positive (increasing NPWT session numbers with increasing blood loss) but relatively weak association was found between intraoperative blood loss and NPWT session numbers ( $r:0.376$ ;  $P = .014$ ;  $P < .05$ ). The number of NPWT sessions required was not found to be associated with tumour size ( $P = .140$ ) or the operation duration ( $P = .123$ ).

Sex, albumin level, skin infiltration, type of wound problem, postoperative ICU requirement, and intraoperative blood loss were found to be influential factors on NPWT > 10 sessions. It was observed that the prediction value of intraoperative blood loss 1200 cc and above posed a risk for NPWT > 10. The presence of skin infiltration poses a higher risk than other variables. The score for this variable is 3 points if the risk situation occurs.

When logistic regression analysis was performed and total score was taken as independent variable, the model was found to be statistically significant ( $\chi^2 = 17.943$ ;  $P < .001$ ). Odds Ratio level of 1 unit increase in total score was found to be 2.233. [OR (%95 GA): 2.233 (1.357;3.673),  $P = .002$ ] (Table 5). The total score is divided into four groups as  $\leq 2$ , 3-4, 5-7, and 8, the results are as shown in Table 5. Accordingly, if the total score was 8, NPWT > 10 was observed in all cases. If the total score is 2 or less, NPWT > 10 is not observed at all.

When the ROC curve analysis was performed, the area under the curve was found to be 0.841. [AuROC (% 95 GA): 0.841 (0.695; 0.935);  $P < .001$ ].

### 4 | DISCUSSION

Wound problems are common after bone or soft tissue tumour resections, and their treatment is difficult and

**TABLE 1** Characteristic of disease and patients

		<i>n</i> (%)
Tumour site	PLE	18 (42.9)
	DLE	7 (16.7)
	UE	5 (11.9)
	PELVIS	12 (28.6)
Tumour volume (cm <sup>3</sup> )	Min-max (median)	14.88-6600 (376.12)
	Mean $\pm$ SD	1068.71 $\pm$ 1481.50
Laterality	Right	26 (61.9)
	Left	14 (33.3)
	Midline	2 (4.8)
Treatment method	WR	23 (54.7)
	WR + EPR	13 (31.0)
	WR + PF	6 (14.3)
Operation time (h)	Min-max (median)	0.75-12 (6.3)
	Mean $\pm$ SD	6.59 $\pm$ 3.16
Blood transfusion	Yes	28 (66.7)
	No	14 (33.3)
Intraoperative blood loss (ml)	Min-max (median)	70-7000 (1200)
	Mean $\pm$ SD	1621.91 $\pm$ 1526.18
Skin infiltration	Yes	9 (21.4)
	No	33 (78.6)
Lesion presentation	Primary	26 (61.9)
	Recurrent	16 (38.1)
Tumour grade	No	1 (2.4)
	Low	6 (14.3)
	Intermediate	2 (4.8)
	High	33 (78.5)
Use of chemotherapy	Yes	31 (73.8)
	No	11 (26.2)
Use of radiotherapy	Yes	23 (54.8)
	No	19 (45.2)
Wound closure	Primary	22 (52.4)
	Rotational flap	7 (16.6)
	Free flap	2 (4.8)
	STSG	11 (26.2)
Wound complication	Dehiscence	16 (38.1)
	Infection	26 (61.9)
Wound culture	Negative	13 (31.0)
	Positive	29 (69.0)
Postoperative ICU requirement	Yes	18 (42.9)
	No	24 (57.1)
Length of Stay in ICU (d)	Min-Max (median)	1-28 (2)
	Mean $\pm$ SD	3.28 $\pm$ 6.26

(Continues)

**TABLE 1** (Continued)

		<b>n (%)</b>
The number of NPWT session	Min-max (median)	1-128 (12)
	Mean $\pm$ SD	26.02 $\pm$ 29.43
Follow up (mo)	Min-max (median)	6-100 (20)
	Mean $\pm$ SD	30.43 $\pm$ 25.59

Abbreviations: DLE, distal lower extremity; EPR, endoprosthetic reconstruction; ICU, intensive care unit; NPWT, negative pressure wound therapy; PF, plate fixation; PLE, proximal lower extremity; STSG, split thickness skin graft; UE, upper extremity; WR, wide resection.

**TABLE 2** Pathological diagnosis and the distribution of tumour sites

		<b>n</b>	<b>%</b>
Histology	Malignant mesenchymal tumour	21	50.0
	Osteosarcoma	8	19
	Ewing sarcoma	7	16.7
	Other	5	14.3
Tumour site	Thigh	8	19
	Pelvis	5	11.9
	Distal femur	4	9.5
	Femur	3	7
	Gluteal	3	7
	Sacrum	2	4.8
	Proximal femur	2	4.8
	Ankle	2	4.8
	Shoulder	2	4.8
	Abdominopelvic	1	2.4
	Gluteal + thigh	1	2.4
	Inguinal	1	2.4
	Knee	1	2.4
	Tibia	1	2.4
	Distal tibia	1	2.4
	Calcaneus	1	2.4
	Leg	1	2.4
	Proximal humerus	1	2.4
	Arm	1	2.4
	Elbow	1	2.4

troublesome. Unless treated, surgical site infections may lead to periprosthetic infections and even extremity loss.<sup>16,18</sup> In addition to such conventional methods as wound debridement, irrigation, and delayed wound closure treatment for the treatment of non-healing wounds, closed-system wound-care application systems, which have gained popularity over the last 15 years, may be

considered.<sup>19</sup> NPWT, is reported to be safer and more effective, and has been associated with lower complication rates, shorter treatment durations, and reduced costs, decreases bacterial contamination by keeping the wound site closed, as an alternative to conventional dressing treatment.<sup>19</sup> A previous study reported that NPWT should not be used at the site of the wound problem in the tumour-resected area,<sup>20</sup> while several studies argue that it can be used safely.<sup>12,21</sup> In the current study, no recurrence resulting from NPWT treatment for wound problems following tumour resection with negative margin was identified. The application of NPWT to the site of a tumour that cannot be resected with negative margins creates a possibility of recurrence, as NPWT increases local blood flow, fibroblast growth factor (FGF), and vascular endothelial growth factor (VEGF). We believe, however, that NPWT is a safe approach at sites resected with negative margins, in line with literature. Malignant tumour resections with positive surgical margins will ultimately rear with or without NPWT usage.

Generally, there is a need for postoperative follow-up in the ICU for patients with impaired hemodynamics, who may have low immunity and impaired nutritional status because of CT, as the duration of their operation is longer and the amount of intraoperative bleeding is higher.<sup>22</sup> Wound treatment takes longer in patients who require intensive care than those who do not, which suggests a colonisation of intensive care-acquired agents and nosocomial infections in patients with impaired immunity and nutritional status.<sup>23,24</sup> In the current study, the number of NPWT sessions were significantly higher in patients in need of postoperative ICU. We speculate that this risk factor can be minimised by considering all kinds of gain and loss relations about assessing the need of the patients for postoperative intensive care during the treatment process.

In our study, NPWT requirements were higher in patients with a higher amount of intraoperative blood loss among those experiencing postoperative wound site problems. It was detected that the prediction value of intraoperative blood loss 1200 cc and above posed a

**TABLE 3** Assessments of disease characteristics

		NPWT session			P
		n	Min-max (median)	Mean ± SD	
Tumour site <sup>a</sup>	PLE	18	1-128 (12)	23.72 ± 31.54	.885
	DLE	7	5-91 (31)	30.29 ± 30.31	
	UE	5	7-40 (20)	22.20 ± 14.92	
	PELVIS	12	3-109 (10)	28.58 ± 32.76	
Treatment method <sup>a</sup>	WR	23	1-91 (12)	20.17 ± 19.60	.487
	WR + EPR	13	3-109 (10)	25.31 ± 29.58	
	WR + PF	6	5-128 (41)	50.00 ± 49.62	
Blood transfusion <sup>b</sup>	Yes	28	3-128 (20)	28.96 ± 30.03	.209
	No	14	1-109 (10)	20.14 ± 28.32	
Skin infiltration <sup>b</sup>	Yes	9	3-29 (6)	8.56 ± 7.95	.003**
	No	33	1-128 (20)	30.79 ± 31.38	
Lesion presentation <sup>b</sup>	Primary	26	1-128 (12)	27.85 ± 32.78	.669
	Recurrent	16	3-91 (15)	23.06 ± 23.69	
Grade <sup>a</sup>	No	1	1	1.00	.994
	Low	6	5-39 (16)	19.50 ± 14.63	
	Intermediate	2	8-35 (21.5)	21.50 ± 19.09	
	High	33	3-128 (12)	28.24 ± 32.11	
Use of chemotherapy <sup>b</sup>	Yes	31	1-128 (14)	27.81 ± 30.90	.492
	No	11	3-91 (10)	21.00 ± 25.47	
Use of radiotherapy <sup>b</sup>	Yes	23	1-128 (20)	28.87 ± 29.89	.260
	No	19	3-109 (10)	22.58 ± 29.28	
Wound closure <sup>a</sup>	Primary	22	1-128 (12)	28.91 ± 34.37	.807
	Rotational flap	7	5-91 (35)	31.86 ± 29.99	
	Free flap	2	3-5 (4)	4.00 ± 1.41	
	STSG	11	4-70 (14)	20.55 ± 18.92	
Wound complication <sup>b</sup>	Dehiscence	16	4-39 (9)	12.88 ± 10.29	.027*
	Infection	26	1-128 (24.5)	34.12 ± 34.32	
Wound culture <sup>b</sup>	Negative	13	4-40 (9)	13.69 ± 11.53	.072
	Positive	29	1-128 (20)	31.55 ± 33.30	
Postoperative ICU requirement <sup>b</sup>	Yes	18	3-128 (30.5)	38.94 ± 33.16	.003**
	No	24	1-109 (9)	16.33 ± 22.41	

Note: It was not taken into statistical evaluation because of the small number of people.

Abbreviations: DLE, distal lower extremity; EPR, endoprosthesis reconstruction; ICU, intensive care unit; NPWT, negative pressure wound therapy; PF, plate fixation; PLE, proximal lower extremity; STSG, split thickness skin graft; UE, upper extremity; WR, wide resection.

<sup>a</sup>Kruskal Wallis Test.

<sup>b</sup>Mann Whitney U Test.

\* $P < .05$ ; \*\* $P < .01$ .

statistically significant risk for NPWT >10. For patients with intraoperative blood loss, several fluids, blood products are transfused in order to maintain hemodynamic stability.<sup>25</sup> Allogenic blood transfusions are known to increase the risk of infection in blood transfusion patients.<sup>25</sup> Intraoperative blood loss is an operation-

induced condition, and this risk factor is likely to be minimised if precautions are taken and careful haemostasis is applied.

Another risk factor for patients suffering from surgical wound problems is impaired nutritional status. In addition to the impaired immunity of oncology patients,

**TABLE 4** Evaluation of NPWT sessions according to descriptive properties

		NPWT sessions			
		<i>n</i>	Min-max (median)	Mean ± SD	<i>P</i>
Sex <sup>a</sup>	Female	22	4-128 (29.5)	36.09 ± 34.49	.008 <sup>a</sup>
	Male	20	1-76 (9.5)	14.95 ± 17.54	
BMI (kg/m <sup>2</sup> ) <sup>b</sup>	Underweight	1	128	128.00	.992
	Normal	23	3-109 (10)	24.87 ± 27.78	
	Overweight	5	1-40 (20)	20.00 ± 15.35	
	Obesity	13	3-91 (14)	22.54 ± 23.83	
Diabetes <sup>a</sup>	Yes	10	3-109 (24.5)	30.40 ± 30.87	.359
	No	32	1-128 (11)	24.66 ± 29.33	
Smoking <sup>a</sup>	Yes	8	4-76 (10)	20.75 ± 24.59	.542
	No	34	1-128 (13)	27.26 ± 30.65	
Comorbidity <sup>a</sup>	Yes	14	3-91 (21.5)	25.64 ± 23.34	.530
	No	28	1-128 (11)	26.21 ± 32.44	
Preoperative albumin > 3.5 g/dl <sup>a</sup>	Yes	19	4-39 (10)	14.37 ± 11.21	.053
	No	23	1-128 (25)	35.65 ± 36.01	
Metastasis at diagnosis <sup>a</sup>	Yes	16	3-128 (27.5)	39.06 ± 40.21	.186
	No	26	1-76 (11)	18.00 ± 16.57	

Note: It was not taken into statistical evaluation because of the small number of people.

<sup>a</sup>Mann Whitney *U* test.

<sup>b</sup>Kruskal Wallis test.

**TABLE 5** Factors affecting NPWT > 10 and related scoring

Factors	Status	Point			
Albumin	Normal	0			
	Low	1			
Sex	Male	0			
	Female	1			
Skin infiltration	Yes	0			
	No	3			
Wound complication	Dehiscence	0			
	Infection	1			
Postoperative ICU requirement	No	0			
	Yes	1			
Intraoperative Blood Loss	<1200 ml	0			
	≥1200 ml	1			
			NPWT ≤ 10 <i>n</i> (%)	NPWT > 10 <i>n</i> (%)	<i>P</i>
Total score	≤2	7 (100)	0 (0)	<.001**	
	3-4	6 (66.7)	3 (33.3)		
	5-7	7 (35)	13 (65)		
	8	0 (0)	6 (100)		

Note: Pearson chi-square test.

\*\**P* < .01.

especially after neoadjuvant CT, nutritional status is also impaired because of the side effects of CT.<sup>26</sup> This manifests in wound site healing problems and susceptibility to infections. In the current study albumin level was low in 54.5% of patients. Albumin, which is an important parameter, was often overlooked because of concentration on oncological surgery. Before an operation, the nutritional status of the patient should be examined meticulously, albumin replacement should be administered if necessary, and nutritional status should be monitored closely during treatment.

Tumours infiltrating the skin or being close to the skin surface have been reported as another risk factor for wound site development.<sup>3,7</sup> In the current study, a longer course of NPWT was required in patients with no skin-infiltrated tumours than in those with tumours that had infiltrated the skin. Because a wide resection is required in tumours infiltrating to skin, free flaps or rotational flaps are needed for wound site closure in such patient groups. Although there have been studies<sup>27</sup> arguing that a greater mass size increases the risk of wound site development complications, others claim that such complications can be minimised if the reconstruction of the resection site is performed properly.<sup>5,28</sup> In our study shorter operation duration and less intraoperative blood loss of skin infiltrating tumours can be explained by reducing wound morbidity.

Patients with a primary wound site closure after a bone or soft tissue mass resection may develop dehiscence, skin necrosis, seroma or infection.<sup>2,21,27</sup> In the current study the number of NPWT sessions required in cases with postresection infection was higher than those with dehiscence. In order to alleviate the wound site problem, the factors causing the infection should be carefully investigated. The treatment of infection-induced wound problems varies based on the source of infection, virulence and antibiotic resistance, although this can be challenging, and further NPWT may be needed.

The current study is limited by its single-centre, retrospective design, the lack of a control group and the limited number of patients. On the other hand, all operations and follow up by a single surgeon are positive aspects of the study. With prospective randomised and controlled studies involving a larger and more homogeneous group of patients with soft tissue or bone sarcoma, treatment algorithms that provide more details of the risks of wound problems in patients during treatment and the durations of treatment may be developed in the preoperative period.

## 5 | CONCLUSIONS

In conclusion, the target is to improve patient survival by achieving a functionally and aesthetically good body region that is tumour-free through resections of bone or soft tissue tumours. When encountering postoperative wound problems in patients with bone or soft tissue tumours, NPWT is one of the most reliable methods for the treatment of wound site problems. We conclude that treatment may be prolonged and the necessary precautions need to be taken in patients with an impaired preoperative nutritional condition, with intraoperative blood loss at high amounts, and with long postoperative stays in the intensive care unit ICU as well as if the factor causing wound site problem is an infection. On the other hands, it is not possible to take precautions if the tumour infiltrates the skin or not.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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**How to cite this article:** Baysal Ö, Sağlam F, Akgülle AH, et al. Factors affecting postmusculoskeletal tumour surgery wound problem treatment with negative pressure wound therapy. *Int Wound J.* 2020;17:692–700. <https://doi.org/10.1111/iwj.13326>