Wound Vacuum-Assisted Closure Temporization after Tumor Resection of Soft Tissue Sarcomas – A Cost Analysis in a Propensity-Score Matched Population

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INTRODUCTION: Vacuum-assisted closure (VAC) temporization is a novel technique associated with high rates of local control used in locally aggressive soft tissue sarcomas such as myxofibrosarcoma. Despite its positive profile, VAC use remains limited due to the perceived higher costs of negative pressure wound therapy. However, no published cost studies exist for wound temporization and its alleged costs are largely extrapolated from standard wound management studies. Our study sought to **1**) compare the short-, medium-, and long-term costs of patients treated with wound VAC temporization vs. primary closure; and, **2**) compare complication rates between the 2 groups.

METHODS: A retrospective analysis of myxofibrosarcoma patients who underwent surgical resections at our institution from 2000 to 2020 was conducted. We included patients that underwent either primary tumor resection or tumor bed excision after surgery at an outside hospital. Data on treatment costs were obtained from our institutional electronic data warehouse using the date of admission as the starting point. Mean and median total cost from diagnosis to discharge, from surgery to discharge, at 90-days post-diagnosis, at 1-year post-diagnosis, and daily cost from surgery to discharge were assessed. Cost was compared between VAC temporized and single-stage (SS) excision/reconstruction patients. To control for treatment selection bias between groups and possible confounders, Propensity-Score Matching (PSM) was performed. Continuous variables were analyzed using Mann-Whitney U test (non-parametric) and categorical variables were compared using the Fisher's exact test. A p value ≤ 0.05 was considered statistically significant.

RESULTS: A total of 102 patients were included in our study. After PSM, 13 patients in the SS group and 13 in the VAC group were analyzed (Table 1). No differences in demographic and preoperative clinical variables were found between groups. Before PSM, mean total cost from date of diagnosis to discharge, from date of surgery to discharge, 90 days post-diagnosis, and 1-year post-diagnosis were higher for patients in the VAC group ($p<0.05$) (Table 2). While VAC temporized patients had a longer mean length of stay ($p<0.01$), cost per day from surgery to discharge were similar between groups ($p=0.11$). The median total cost for at all timepoints was higher in the VAC group ($p<0.01$). After PSM, no differences in mean and median total costs from diagnosis to discharge ($p=0.88$ and $p=0.88$), from surgery to discharge ($p=0.22$ and $p=0.19$), 90-days post-diagnosis ($p=0.61$ and $p=0.88$), and 1-year post-diagnosis ($p=0.74$ and $p=0.76$) between the VAC temporized and SS group were seen (Table 3). Although a trend toward lower median daily costs from surgery to discharge in the VAC group was found, this was not statistically significant ($p=0.22$). Likewise, no differences in rates of superficial SSI, deep SSI, thromboembolic events (DVT or PE), and unplanned flaps were seen between groups before and after PSM (Table 4). Although a higher rate of aseptic wound breakdown was found in the VAC group before PSM ($p=0.034$), this was no longer present in our propensity score matched cohort. Median length of stay was longer in the VAC group (10 days) than the single stage group (3 days) after PSM ($p=0.017$).

DISCUSSION AND CONCLUSION: In our study, use of vacuum-assisted closure temporization displayed comparable costs to primary closure without an increase in postoperative complications. Although a trend toward higher costs was seen in the VAC temporized group, likely due to the longer length of stay for these patients, costs tended to converge at the 90-day and 1-year timepoints. Therefore, VAC temporization represents a cost-effective treatment strategy for patients with locally invasive soft tissue sarcomas.

Table 1. Demographic, clinical and treatment characteristics of patients with myxofibrosarcoma before and after propensity score matching (PSM).

	Base cohort (n=102)			Propensity-score matched cohort (n=26)		
	Single stage (n=68)	VAC (n=34)	*p*	Single stage (n=13)	VAC (n=13)	*p*
	N (%) | median (IQR)			N (%) | median (IQR)		
Age at diagnosis [+]	69 (57–80)	72 (62–83)	0.19	69 (59–81)	71 (76–82)	0.59
Male sex	40 (59%)	20 (59%)	0.99	6 (46%)	6 (46%)	0.99
Race			0.53			0.22
White	48 (73%)	28 (85%)		9 (75%)	10 (77%)	
Black	2 (3%)	1 (3%)		2 (17%)	0 (0%)	
Asian	1 (2%)	0 (0%)		0 (0%)	0 (0%)	
Other	15 (23%)	4 (12%)		1 (8%)	3 (23%)	
Age-adjusted CCI [+]	6 (4–7)	6 (5–7)	0.49	6 (5–8)	6 (5–8)	0.99
"Oops" procedure	24 (35%)	14 (41%)	0.56	3 (23%)	3 (23%)	0.99
Stage (AJCC 8th Ed.)			0.78			0.14
I	4 (6%)	2 (6%)		0 (0%)	0 (0%)	
II	23 (34%)	15 (44%)		3 (23%)	6 (46%)	
III	38 (56%)	16 (47%)		7 (54%)	7 (54%)	
IV	3 (4%)	1 (3%)		3 (23%)	0 (0%)	
Grade			0.81			0.27
1	3 (4%)	2 (6%)		0 (0%)	0 (0%)	
2	29 (43%)	12 (36%)		6 (46%)	3 (25%)	
3	36 (53%)	19 (58%)		7 (54%)	9 (75%)	
Size (cm) [+]	5.25 (2.90–8.50)	4.90 (4.00–6.30)	0.92	6.00 (3.90–12.10)	5.50 (3.60–8.20)	0.57
Volume (cm^3) [+]	54.4 (10.0–222.7)	44.9 (13.6–99.0)	0.71	86.7 (19.3–389.2)	72.1 (16.5–210.1)	0.53
Subfascial tumor	37 (54%)	12 (35%)	0.068	6 (46%)	6 (46%)	0.99
Location			**0.035**			0.13
Upper extremity	9 (13%)	11 (32%)		3 (23%)	2 (15%)	
Lower extremity	46 (68%)	22 (65%)		7 (54%)	11 (85%)	
Trunk	11 (16%)	1 (3%)		3 (23%)	0 (0%)	
Head & Neck	2 (3%)	0 (0%)		0 (0%)	0 (0%)	
Sodium < 135 mEq/L	2 (6%)	0 (0%)	0.45	0 (0%)	0 (0%)	
Creatinine > 1.5 mg/dL	3 (8%)	1 (8%)	0.99	0 (0%)	1 (25%)	0.2
Albumin < 3.5 g/dL	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
Hemoglobin < 10 g/dL	3 (7%)	0 (0%)	0.3	2 (25%)	0 (0%)	0.19
Pre-operative RT	53 (78%)	32 (94%)	0.039	11 (85%)	12 (92%)	0.54

AJCC: American Joint Committee on Cancer, *CCI:* Charlson comorbidity index, *RT*: radiation therapy

Table 2. Cost analysis before propensity-score matching (PSM).

	Single stage (n=68)	VAC (n=34)	*p*
Mean Costs in CU (± SD)			
Total costs from diagnosis to discharge	506 ± 610	859 ± 594	**0.01**
Total costs from surgery to discharge	507 ± 623	886 ± 671	**0.01**
Total 90-day post-diagnosis costs	506 ± 616	842 ± 610	**0.048**
Total 1-year post-diagnosis costs	1.166 ± 1.089	1.742 ± 931	**0.01**
Length of stay (days)	4.1 ± 3.7	9.5 ± 7.4	**<0.01**
Daily cost from surgery to discharge	187 ± 248	112 ± 66	0.11
Median Costs in CU (IQR)			
Total costs from diagnosis to discharge	520 (203-1.037)	855 (411-1.372)	**<0.01**
Total costs from surgery to discharge	331 (159-534)	645 (357-1.258)	**<0.01**
Total 90-day post-diagnosis costs	362 (159-535)	762 (368-1.149)	**<0.01**
Total 1-year post-diagnosis costs	712 (196-1.473)	1.611 (1.252-2.314)	**<0.01**
Length of stay (days)	3 (1-4.8)	210 (75-285)	**<0.01**
Daily cost from surgery to discharge	130 (95-178)	102 (61-135)	**0.03**

CU: cost unit(s), *IQR:* interquartile range, *SD*: standard deviation, *VAC*: vacuum-assisted closure

Table 3. Cost analysis after propensity-score matching (PSM).

	Single stage (n=13)	VAC (n=13)	*p*
Mean Costs in CU (± SD)			
Total costs from diagnosis to discharge	918 ± 608	881 ± 517	0.88
Total costs from surgery to discharge	578 ± 434	807 ± 469	0.22
Total 90-day post-diagnosis costs	1.378 ± 1.017	1.203 ± 572	0.61
Total 1-year post-diagnosis costs	1.670 ± 1.082	1.544 ± 879	0.74
Length of stay (days)	4.8 ± 6.0	11.3 ± 9.1	**0.03**
Daily cost from surgery to discharge	168 ± 96	111 ± 86	0.15
Median Costs in CU (IQR)			
Total costs from diagnosis to discharge	973 (506-1.195)	850 (494-1.130)	0.88
Total costs from surgery to discharge	455 (266-776)	645 (446-1.102)	0.19
Total 90-day post-diagnosis costs	1.118 (834-1.626)	1.357 (921-1.638)	0.88
Total 1-year post-diagnosis costs	1.379 (1.036-2.205)	1.595 (1.036-1.796)	0.76
Length of stay (days)	3 (2-4.5)	10 (4-18.5)	0.07
Daily cost from surgery to discharge	134 (109-199)	98 (56-134)	0.07

CU: cost unit(s), *IQR:* interquartile range, *SD*: standard deviation, *VAC*: vacuum-assisted closure

Table 4. Post-operative outcomes of patients after VAC temporization or single-stage excision/reconstruction.

	Base cohort (n=102)			Propensity score matched cohort (n=26)		
	Single stage (n=68)	VAC (n=34)	*p*	Single stage (n=13)	VAC (n=13)	*p*
	N (%) | median (IQR)			N (%) | median (IQR)		
R0 margins	53 (78%)	31 (91%)	0.098	9 (69%)	10 (77%)	0.66
Number of tumor excisions (n) [+]	1 (1-2)	2 (1-2)	**<0.001**	1 (1-1)	2 (1-2)	**0.038**
Aseptic wound breakdown	7 (10%)	9 (26%)	**0.034**	2 (15%)	5 (38%)	0.18
Superficial SSI	5 (7%)	1 (3%)	0.37	2 (15%)	0 (0%)	0.14
Deep SSI (with OR management)	8 (12%)	4 (12%)	0.99	2 (15%)	0 (0%)	0.14
Unplanned flap	3 (4%)	2 (6%)	0.72	1 (8%)	1 (8%)	0.99
DVT / PE	2 (3%)	0 (0%)	0.31	1 (8%)	0 (0%)	0.31
Unplanned 90-day readmission	15 (22%)	10 (30%)	0.37	4 (31%)	3 (25%)	0.75
Length of stay (days) [+]	3 (1-5)	10 (3-14)	**<0.001**	3 (2-5)	10 (4-17)	**0.017**
Follow-up (years)	4.8 (2.2-7.8)	4.1 (2.7-5.8)	0.52	5.0 (1.9-6.3)	3.3 (2.6-3.7)	0.52
Disease-specific death	12 (18%)	3 (9%)	0.2	2 (15%)	0 (0%)	0.14

DVT: deep venous thrombosis, *PE:* pulmonary embolism, *SSI*: surgical site infection, *VAC:* vacuum-assisted closure