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Reconstructive

Immediate Plastic Surgery Intervention after Soft Tissue Sarcoma Resection: Examining Wound Healing, Readmission, and Reoperation

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Background: Many orthopedic and surgical oncologists use a multidisciplinary approach to soft tissue sarcoma (STS) resection. This study assesses the role of immediate plastic surgeon involvement during index soft tissue sarcoma resection.
Methods: Adult patients who underwent index STS resection between 2005 and 2018 were queried from an institutional database. Main outcomes analyzed were 90-day same-site reoperation, any-cause readmission, and wound healing complications. Univariate and multivariate logistic regression were used to identify risk factors. Additional evaluation was then performed for the following two cohorts: patients with and without plastic surgeon involvement.
Results: In total, 228 cases were analyzed. Multivariate regression demonstrated the following predictors for 90-day wound-healing complications: plastic surgery intervention [OR = 0.321 (0.141–0.728), $P = 0.007$], operative time [OR = 1.003 (1.000–1.006), $P = 0.039$], and hospital length of stay [OR = 1.195 (1.004–1.367), $P = 0.010$]. For 90-day readmission, operative time [OR = 1.004 (1.001–1.007), $P = 0.023$] and tumor stage [OR = 1.966 (1.140–3.389), $P = 0.015$] emerged as multivariate predictors. Patients whose resection included a plastic surgeon experienced similar primary outcomes despite these patients having expectedly longer operative times (220 ± 182 versus 108 ± 67 minutes, $P < 0.001$) and hospital length of stay (3.99 ± 3.69 versus 1.36 ± 1.97 days, $P < 0.001$).
Conclusions: Plastic surgeon involvement emerged as a significant protector against 90-day wound healing complications. Cases that included plastic surgeons achieved similar complication rates in all categories relative to cases without plastic surgery intervention, despite greater operative time, hospital length of stay, and medical complications.
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INTRODUCTION

Soft tissue sarcomas (STS), a central focus of orthopedic oncologists, are a rare and diverse group of malignant tumors believed to be of mesenchymal origin. According to the World Health Organization Classification of Tumors,[1] there are over 100 different histologic subtypes of STS, with liposarcoma, leiomyosarcoma, and undifferentiated pleomorphic sarcoma constituting the most prevalent subtypes, respectively.[2] Despite the vast heterogeneity of STS, the collective group makes up less than 1% of annual cancer diagnoses in the United States, with an estimated 13,460 new cases of soft tissue cancer diagnosed in 2021.[3,4]

Tumor stage, size, and depth are the main characteristics that define a patient's prognosis.[5–9] For STS patients who undergo surgical intervention, wide surgical resection with negative margins as part of limb salvage surgery

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is the current preferred treatment for patients and surgeons.[10–12] However, although refined adjuvant radiotherapy techniques and improved local disease control with limb salvage have reduced the morbidity of previous limb amputation,[13] such operations are associated with a high incidence of wound complications resulting from extensive exposures, preoperative radiation, and large soft tissue defects.[12] The most common wound complications of STS resection include dehiscence, infection, and hematoma formation, which are linked to higher rates of hospital readmission, reoperation, and limb amputation.[14–21]

Given the nature of the procedure and risk of such complications, many orthopedic and surgical oncologists have opted for a collaborative, multidisciplinary approach to STS index resection cases that includes the early intervention of plastic surgeons in planning and performing early soft tissue reconstruction.[22–24] Although plastic surgeons and orthopedic or surgical oncologists have historically worked independently to address demanding skeletal and soft tissue reconstruction cases, a new partnership between plastic surgeons and orthopedics dubbed "orthoplastic surgery" or "orthoplasty" has emerged. The goals and benefits of early plastic surgeon involvement include preserving patient function, limiting limb amputation, meeting the increased need of flap reconstruction, and optimizing closure and postoperative healing outcomes.[25–30]

The purpose of this study is to build upon research examining collaboration between plastic surgeons and orthopedic or surgical oncologists by investigating and comparing complication rates of the following two cohorts: (1) patients who underwent index STS resection with immediate plastic surgeon intervention and (2) patients who underwent STS resection without a plastic reconstructive surgeon attending the case. The authors hypothesize minimal variation in primary outcomes of short-term any-cause readmission, same-site reoperation, and wound healing complications despite expectedly longer and potentially more complicated surgeries for patients whose cases involve plastic surgeon intervention. Our comparison of these two cohorts was performed alongside an analysis of risk factors for postresection complications. Complication rate findings for our cohorts and overall patient population are discussed in the context of prior research examining plastic surgeon involvement in STS resection and reconstruction.

Takeaways

Question: Does immediate plastic surgeon intervention improve outcomes for patients undergoing soft tissue sarcoma resection?

Findings: This retrospective cohort study found that plastic surgeon involvement is a significant multivariate protector against 90-day wound healing complications. Cases with plastic surgeon involvement had similar complication rates despite greater operative time, hospital length of stay, and postoperative medical complications.

Meaning: Our study showed that immediate plastic surgeon intervention after soft tissue sarcoma resection may be of particular benefit to patients undergoing complex tumor resection or patients at increased risk of postoperative medical complications.

METHODS

Overview

This was a retrospective, single-institution cohort study. The two cohorts examined were those that underwent oncologic soft tissue index resection with a plastic surgeon involved during the initial surgery, and those that underwent oncologic soft tissue index resection without a plastic surgeon involved during the initial surgery. The study was approved by our institutional review board prior to data collection and analysis. All data were obtained from a single institution's enterprise data warehouse, which exists to provide a comprehensive repository of clinical data to facilitate research and clinical quality efforts. Each demographic, procedural, and independent data point provided by the enterprise data warehouse was verified by manual chart review, performed by authors S.W. and J.D.

ICD and CPT Coding

Patients were selected based on Current Procedural Terminology (CPT) and International Classification of Diseases (ICD) codes. CPT codes are standardized medical codes maintained by the American Medical Association. Category 1 CPT codes, which were used for this study, correspond to a specific procedure or service provided by a physician. ICD codes are maintained by the World Health Organization and are used globally as a diagnostic tool for epidemiology and health management purposes. ICD codes are updated, with the most recent 10th version (ICD-10) supplanting the ninth version (ICD-9) in 2015. Given the timeline of the study, which extends prior to 2015, both ICD-9 and ICD-10 codes were used for query purposes. [**See table, Supplemental Digital Content 1,** which displays current procedural terminology (CPT) and international classification of diseases (ICD) codes. **http://links.lww.com/PRSGO/C550.**]

Search and Inclusion/Exclusion Criteria

Adult subjects with an STS diagnosis who underwent oncologic soft tissue index resection between January 1, 2005 and December 31, 2018 were queried from the institution's enterprise data warehouse using CPT codes. Cases were excluded if the patient was under 18 years old, underwent resection for head or neck malignancy or a previous resection at the same institution, underwent resection for a non-STS mass, or had a total surgical time of less than 20 minutes (n = 9 patients) given the unrealistic completion of the studied procedures in that time. An orthopedic oncology or surgical oncology surgeon must have served as the primary resection surgeon for all cases, regardless of plastic surgeon intervention. Nonplastics cases did not include plastic surgeons in any operative capacity (ie, neither immediate nor delayed or staged intervention). STS diagnoses were queried by ICD code, with the following soft tissue malignancies included: pleomorphic sarcoma, liposarcoma, leiomyosarcoma, myxofibrosarcoma, synovial sarcoma, spindle cell sarcoma, angiosarcoma, rhabdomyosarcoma, fibrosarcoma, Kaposi sarcoma, extraosseous Ewing sarcoma, malignant peripheral nerve sheath tumor, and dermatofibrosarcoma protuberans. In addition to relying on CPT and ICD codes, intraoperative reports, operative reports, postoperative notes, and postoperative pathology reports were queried and manually reviewed for every case to validate procedure, diagnosis, and various surgical variables, including tumor size and grade/stage, operative time, and plastics procedure type.

Postoperative Complication Variables

Primary postoperative complications assessed in this study included any-cause readmission, same-site reoperation, and wound healing complications, all at 90 days postoperation, resulting in a 14-year study period. Wound healing complications included dehiscence, infection, flap ischemia or nonviability, and hematoma or seroma formation requiring clinical monitoring. Secondary postoperative complications analyzed include pulmonary embolism, myocardial infarction, pneumonia, sepsis, deep vein thrombosis, arterial embolism thrombosis, urinary tract infection, stroke, acute kidney injury, and acute blood loss anemia.

Independent Variables

Several independent variables were included in this study to better evaluate the impact of plastic surgeon involvement in oncologic soft tissue index resection. These variables included involvement of a plastic surgeon during index resection, patient gender, age at surgery, total surgery time, tumor size, American Society of Anesthesiologists Physical Status Classification, pre- and postoperative radiation, hospital length of stay (LOS), BMI, smoking status, prior diabetes diagnosis, tumor grade, and tumor stage. All plastic surgeon involvement occurred during the postresection period (ie, wound closure and/or reconstruction). The American Society of Anesthesiologists Physical Status Classification system has been used for over 60 years to assess preanesthesia medical co-morbidities. The Fédération Nationale des Centres de Lutte Contre le Cancer (FNCLCC) system and American Joint Committee on Cancer TNM system were used for sarcoma grading and staging, respectively.

Statistical Analyses

Two methods of statistical analysis were used to evaluate the impact of plastic surgeon involvement and other potential risk factors of postoperative complications. First, univariate and forward binary stepwise multivariate logistic regression with chi-squared model fit analysis were used to assess the effects of the study's independent variables on the complications investigated in this study. Second, Pearson's chi-squared test and unpaired *t* test were used to compare incidence of primary and secondary complication rates between the two cohorts, for categorical and continuous variables, respectively. Microsoft Excel (2020 Microsoft Office; Redmond, Wash.) was used to sort all data as well as perform preliminary analysis, including counts, averages, standard deviations, and chi-squared tests. RStudio (RStudio, PBC; Boston, Mass.) was used to perform univariate and multivariate logistic regressions. The cutoff for statistical significance was defined as $P < 0.05$ for all analyses.

RESULTS

A total of 228 patients were included in the final analysis. Patient demographic, medical burden, and postoperative complication information for this overall patient group, as well as the two with/without plastic surgeon involvement cohorts, are detailed in Table 1. Of the 228 total cases included in the study, 103 resections included a plastic surgeon and 125 did not include a plastic surgeon. In total, 104 cases included an orthopedic oncologist as the primary surgeon, whereas 114 cases included a surgical oncologist as the primary surgeon, with consistent usage of margin negative radical resection for tumor removal. Patients whose index resections included plastic surgeons had significantly longer operative times (220 ± 182 min versus 108 ± 67 min; $P < 0.001$) and hospital LOS (3.99 ± 3.69 days versus 1.36 ± 1.97 days; $P < 0.001$). Patients whose resections did and did not include a plastic surgeon achieved statistically similar rates of all three primary outcomes analyzed: 90-day readmission, reoperation, and wound complication rates. Patients whose resections included a plastic surgeon had statistically higher rates of 90-day nonwound medical complications (24.27% versus 8.00%, $P < 0.001$), driven mainly by acute blood-loss anemia (21.36% versus 4.00%, $P < 0.001$).

Specific plastic surgery procedure type and volume are detailed in Figure 1, with specific subset analysis of primary outcomes by plastic surgery procedure type in Figure 2. Wound healing complication, readmission, and reoperation rates were highest among patients who underwent dermal substitute (42.86%, 100.00%, and 42.86% of cases, respectively) and free muscle flap placement (50.00%, 44.44%, and 22.22% of cases, respectively).

A univariate analysis of all independent variables, separated into patient demographic and surgical independent variables, was performed (Table 2). Operative time ($P = 0.001$), hospital LOS ($P = 0.003$), and tumor stage ($P = 0.003$) were found to be associated with 90-day readmission. Operative time ($P = 0.012$) and hospital LOS ($P = 0.005$) were found to be associated with 90-day reoperation. American Society of Anesthesiologists classification ($P = 0.041$), smoking history ($P = 0.043$), operative time ($P = 0.002$), and hospital LOS ($P < 0.001$) were found to be associated with 90-day wound complications.

A multivariate analysis was performed with all independent variables for each primary outcome (Table 3). Fit of all three multivariate models was verified with chi-squared goodness-of-fit tests (all $P < 0.01$). Plastic surgery intervention was identified as a protective predictor against 90-day wound healing complications [OR = 0.321 (0.141–0.728), $P = 0.007$]. Operative time [OR = 1.003 (1.000–1.006), $P = 0.039$] and hospital LOS [OR = 1.195

Table 1. Plastic Surgeon Involvement: Comparing Cohort Predictors and Outcomes

	All Patients (n = 228), Count (%) or Av ± SD	Plastic Surgery Involvement (n = 103), Count (%) or Av ± SD	No Plastic Surgery Involvement (n = 125), Count (%) or Av ± SD	*P* (± Plastics)
Independent variables				
Gender				
Men	121 (53.07%)	51 (49.51%)	70 (56.00%)	0.329
Women	107 (46.93%)	52 (50.49%)	55 (44.00%)	
Age at surgery (y)	56.62 ± 16.19	57.18 ± 17.12	56.15 ± 15.44	0.634
Tumor size (cm)	8.12 ± 6.22	7.81 ± 5.51	8.38 ± 6.76	0.492
Operation time (min)	158.39 ± 143.09	219.97 ± 181.82	107.64 ± 67.38	**<0.001**
ASA classification	2.38 ± 0.56	2.37 ± 0.60	2.38 ± 0.54	0.895
Hospital LOS (d)	2.55 ± 3.16	3.99 ± 3.69	1.36 ± 1.97	**<0.001**
BMI	29.87 ± 7.41	29.65 ± 7.55	30.05 ± 7.32	0.686
Smoking	88 (38.60%)	42 (40.78%)	46 (36.80%)	0.539
Diabetes	36 (15.79%)	12 (11.65%)	24 (19.20%)	0.120
Radiation	147 (64.47%)	68 (66.02%)	79 (63.20%)	0.658
Preoperative	83 (36.40%)	40 (38.83%)	43 (34.40%)	0.592
Postoperative	64 (28.07%)	28 (27.18%)	36 (28.80%)	
Tumor stage				
1	69 (30.26%)	26 (25.24%)	43 (34.40%)	0.446
2	53 (23.25%)	24 (23.30%)	29 (23.20%)	
3	95 (41.67%)	48 (46.60%)	47 (37.60%)	
4	11 (4.82%)	5 (4.85%)	6 (4.80%)	
Tumor grade				
1	69 (30.26%)	26 (25.24%)	43 (34.40%)	0.067
2	65 (28.51%)	26 (25.24%)	39 (31.20%)	
3	94 (41.23%)	51 (49.51%)	43 (34.40%)	
Primary complications				
90-day readmission	58 (25.44%)	28 (27.18%)	30 (24.00%)	0.583
90-day reoperation	28 (12.28%)	14 (13.59%)	14 (11.20%)	0.584
90-day wound healing complications	63 (27.63%)	27 (26.21%)	36 (28.80%)	0.664
Dehiscence	8 (3.51%)	4 (3.88%)	4 (3.20%)	0.780
Infection	21 (9.21%)	5 (4.85%)	16 (12.80%)	**0.039**
Flap/sub viability	13 (5.70%)	13 (12.62%)	0 (0.00%)	N/A
Hematoma/seroma	21 (9.21%)	5 (4.85%)	16 (12.80%)	**0.039**
Secondary medical complications				
Any nonwound medical complication	35 (15.35%)	25 (24.27%)	10 (8.00%)	**<0.001**
Pulmonary embolism	2 (0.88%)	1 (0.97%)	1 (0.80%)	0.890
Myocardial infarction	0 (0.00%)	0 (0.00%)	0 (0.00%)	N/A
Pneumonia	3 (1.32%)	1 (0.97%)	2 (1.60%)	0.678
Sepsis	2 (0.88%)	0 (0.00%)	2 (1.60%)	N/A
Deep vein thrombosis	4 (1.75%)	2 (1.94%)	2 (1.60%)	0.845
Arterial embolism	1 (0.44%)	1 (0.97%)	0 (0.00%)	N/A
Urinary tract infection	2 (0.88%)	1 (0.97%)	1 (0.80%)	0.890
Stroke	0 (0.00%)	0 (0.00%)	0 (0.00%)	N/A
Acute kidney injury	3 (1.32%)	2 (1.94%)	1 (0.80%)	0.451
Acute blood-loss anemia	27 (11.84%)	22 (21.36%)	5 (4.00%)	**<0.001**

Bolded values statistically significant, $P < 0.05$.

(1.044–1.367), $P = 0.010$] were found to be significant positive predictors of 90-day wound healing complications. Operative time [OR = 1.004 (1.001–1.007), $P = 0.023$] and tumor stage [OR = 1.966 (1.140–3.389), $P = 0.015$] were identified as significant positive predictors of 90-day readmission.

DISCUSSION

The major findings in our study included that immediate plastic surgeon intervention emerged as a significant multivariate protector against 90-day wound complications. Additionally, despite longer operative times, longer hospital LOS, and higher rates of medical complications in the cohort whose index resections included a plastic surgeon, there were no statistical differences between our two cohorts in any of the three primary outcomes: 90-day readmission, reoperation, and wound complication rates. The study findings suggest that the multidisciplinary treatment approach results in similar outcomes to the nonplastic surgery cohort despite the cohort with plastic surgery involvement encountering greater obstacles related to greater

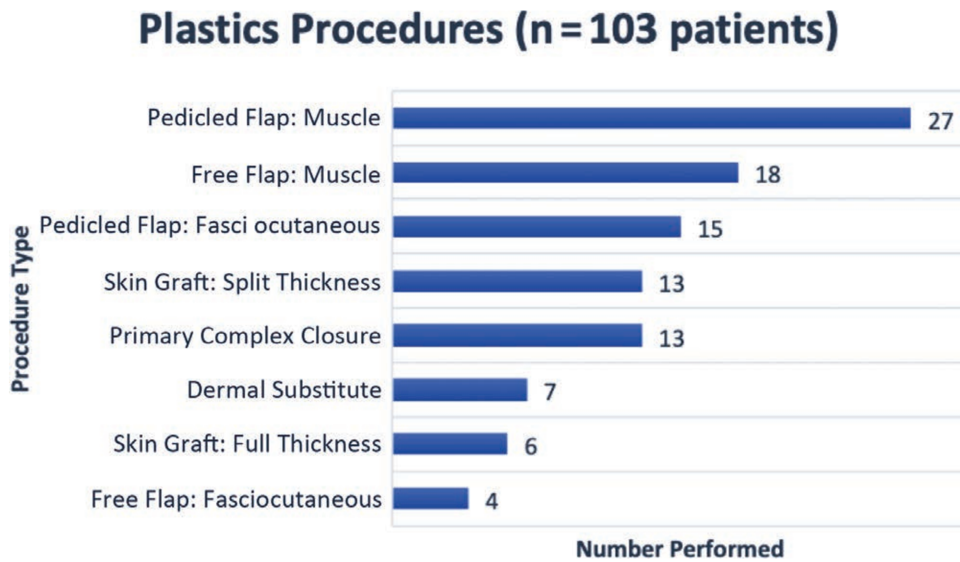

Fig. 1. Plastic surgery procedures: types and volume.

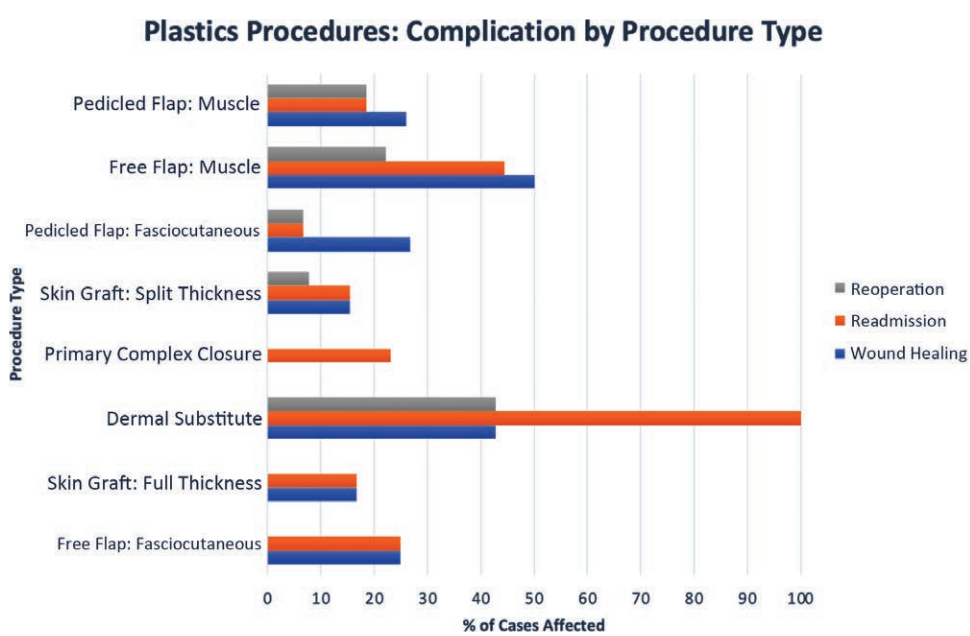

Fig. 2. Complications by plastic surgery procedure type.

medical and operative burden. More specifically, our cohorts displayed similar complication rates despite the higher incidence of acute blood-loss anemia, as well as longer operative times and hospital LOS experienced by patients in the plastic surgery cohort, which were both found to be independently predictive of postoperative complications in multivariate analysis.

Various studies have investigated incidence and risk factors for wound healing complications. Perrault et al found 43% of patients who underwent lower extremity STS resection experienced wound complications, with neoadjuvant radiation therapy, recurrent tumor presentation, and immediate reconstruction instead of primary closure constituting significant risk factors.[14] LeBrun et al found diabetes, Grade 2+ radiation dermatitis, and three-dimensional conformal radiation therapy—as opposed to intensity-modulated radiation therapy or proton radiation—were significant risk factors for wound complications and subsequent treatment, including reoperation, hospital readmission for nonoperative wound management, and prolonged deep wound packing.[17] Moore et al produced similar findings regarding diabetes and added that cigarette smoking, proximal lower extremity tumor location, BMI ≥30, the broader use of preoperative radiation therapy, and a large tumor diameter were associated with increased wound complication rates.[19]

Unlike some studies of STS resection readmission and reoperation risk factors,[17,19,31] BMI, smoking history, and

Table 2. Univariate Analysis of Risk Factors for Postoperative Complications

	90-Day	
Readmission	**Odds Ratio (95% CI)**	***P***
Patient predictors		
Gender	0.930 (0.512–1.689)	0.812
Age at surgery	0.987 (0.968–1.005)	0.149
ASA classification	1.280 (0.748–2.190)	0.367
BMI	1.016 (0.976–1.057)	0.442
Smoking history	1.062 (0.577–1.954)	0.848
Diabetes	0.539 (0.212–1.368)	0.193
Preoperative radiation	1.611 (0.877–2.957)	0.124
Postoperative radiation	0.861 (0.439–1.692)	0.665
Surgical predictors		
Tumor size	1.024 (0.978–1.072)	0.314
Operative time	**1.003 (1.001–1.005)**	**0.001**
Hospital LOS	**1.144 (1.046–1.251)**	**0.003**
Plastics involved	1.182 (0.651–2.149)	0.583
Tumor grade	1.337 (0.928–1.926)	0.119
Tumor stage	**1.690 (1.200–2.380)**	**0.003**
Reoperation	**90-Day**	
	Odds Ratio (95% CI)	***P***
Patient predictors		
Gender	0.529 (0.236–1.188)	0.123
Age at surgery	1.004 (0.979–1.029)	0.767
ASA classification	0.906 (0.450–1.826)	0.783
BMI	0.958 (0.902–1.018)	0.166
Smoking history	1.034 (0.460–2.324)	0.936
Diabetes	0.376 (0.085–1.658)	0.196
Preoperative radiation	1.150 (0.511–2.590)	0.735
Postoperative radiation	0.836 (0.337–2.075)	0.700
Surgical predictors		
Tumor size	1.005 (0.944–1.070)	0.888
Operative time	**1.003 (1.001–1.005)**	**0.012**
Hospital LOS	**1.165 (1.047–1.296)**	**0.005**
Plastics involved	1.247 (0.565–2.752)	0.584
Tumor grade	1.526 (0.923–2.525)	0.100
Tumor stage	1.408 (0.907–2.187)	0.127
Wound Healing Complication	**90-day**	
	Odds Ratio (95% CI)	***P***
Patient predictors		
Gender	0.882 (0.493–1.576)	0.671
Age at surgery	1.007 (0.990–1.026)	0.410
ASA classification	**1.754 (1.025–3.004)**	**0.041**
BMI	1.019 (0.981–1.059)	0.340
Smoking history	**1.836 (1.019–3.308)**	**0.043**
Diabetes	0.852 (0.376–1.929)	0.701
Preoperative radiation	1.106 (0.607–2.014)	0.743
Postoperative radiation	1.419 (0.757–2.660)	0.276
Surgical predictors		
Tumor size	1.026 (0.981–1.074)	0.256
Operative time	**1.003 (1.001–1.005)**	**0.002**
Hospital LOS	**1.184 (1.082–1.295)**	**<0.001**
Plastics involved	0.878 (0.489–1.577)	0.664
Tumor grade	1.174 (0.827–1.666)	0.369
Tumor stage	1.250 (0.911–1.714)	0.166

Bolded values statistically significant, $P < 0.05$.

Table 3. Multivariate Analysis of Risk Factors for Postoperative Complications

	Odds Ratio (95% CI)	*P*
90-day readmission		
Operative time	**1.004 (1.001–1.007)**	**0.023**
Tumor stage	**1.966 (1.140–3.389)**	**0.015**
90-day wound healing complication		
Plastics intervention	**0.321 (0.141–0.728)**	**0.007**
Operative time	**1.003 (1.000–1.006)**	**0.039**
Hospital length of stay	**1.195 (1.044–1.367)**	**0.010**

Bolded values statistically significant, $P < 0.05$.

diabetes were not found to be significant positive predictors of such complications in this study. Rather, our study found that longer operative time and hospital LOS, as well as tumor stage and plastic surgery intervention, were key predictors of readmission and wound healing complications. Our findings reflect a 2021 study by Hoftiezer and colleagues that identified longer operative times as independently associated with 30-day soft tissue complications after upper extremity sarcoma resection.[32] Dadras et al and Houdek et al reached similar conclusions in their analyses of extremity STS resection, finding that prolonged operative time was a positive predictor for 90-day wound-healing complications and delayed wound healing, respectively.[33,34]

Unlike other multivariate predictors in this study, plastic surgeon intervention was found to be protective against wound healing complications in multivariate analysis, but not in univariate analysis. The inclusion and examination of all independent variables in multivariate analysis is recommended due to potential issues of omitted variable bias, in which biased estimates of the effects of covariates are incorrectly calculated as a result of early exclusion of nonsignificant variables after univariate analysis.[35,36] As opposed to univariate analysis alone, multivariate models such as the one included in this study properly account for variable interaction,[35] a likely explanation for the phenomenon observed with our plastic surgery intervention predictor.

The theoretical benefits of plastic surgeon involvement in musculoskeletal tumor resections have been realized and described in many studies.[15,24,37,38] Multiple studies have established that immediate one-stage soft tissue reconstruction following resection is both technically feasible and not associated with increased risk of complications.[24,39] Marre et al found significantly lower complication rates in patients who underwent early reconstruction by a plastic surgeon after STS resection when compared with patients who waited more than 1 year for reconstruction.[15] Sanniec et al produced similar findings, and not only identified early plastic surgery involvement as beneficial to preoperative planning and reducing complication rates, but also as the most predictive factor of sarcoma resection complications—ahead of tumor size, radiation, and chemotherapy.[40] More recently, Dadras et al further highlighted the role that plastic surgery reconstruction plays in limb-conserving STS resection, especially with cases including neoadjuvant radiation therapy.[27]

The value of a multidisciplinary team in addressing the needs of STS patients is not only well-documented, but also extends beyond lower complication rates. A prospective study of over 10,000 STS patients performed by Blay et al found that in addition to lower reoperation rates, physician compliance to practice guidelines and patient relapse-free survival were both improved for patients in whom initial treatment was guided by a pretherapeutic multidisciplinary tumor board.[23] Our findings also agree with the notion that a multidisciplinary approach to STS resection cases benefits patient outcomes. Unlike Perrault et al,[14] we concluded that immediate reconstruction was not a significant risk factor for the development of wound complications, and was instead predictive of lower 90-day complication rates. Our findings aligned with prior studies that have found that immediate one-stage soft tissue reconstruction following resection is both technically feasible and not associated with increased risk of various postresection complications.[24,39] Although our study did not find significantly lower complication rates for patients whose resection cases involved a plastic surgeon, as has been found in some other studies,[15,40] our study did find statistically similar complication rates despite significantly greater operative time and hospital LOS characteristic of the plastic surgeon involvement cohort. These similar complication rates were impressive despite the selection bias that was difficult to quantify, wherein the cases in which the multidisciplinary approach was used were presumably more challenging and had higher risk or concern for wound healing complications. As such, our results corroborate the notion that plastic surgeon involvement may be of particular benefit to patients in whom considerable medical burden is noted or for whom complex resections and reconstructions are planned.

Limitations of this study include its retrospective and single-institution nature, as well as its comparison of unmatched cohorts to avoid limiting cohort sizes. There was likely selection bias in the decision to perform immediate reconstruction for cases with an increased risk of complications due to known factors such as large tumors adjacent to bone, exposed vessels, or nerves, or in particularly complex locations like the groin. These data were not readily available and were likely related to surgeon experience. Additionally, longer operative time and related surgical complications may either be influenced by the addition of a plastic surgery procedure to the STS resection or the increased complexity of the case. Although our institution is a regional center of oncology care and referrals and participates in the "Care Everywhere" EMR platform with several other major institutions nearby, patients may have received care related to this study's primary and secondary complications at other institutions without the researchers' knowledge. Another limitation includes potential differences in procedure and complication coding across time and between surgeons. Our team attempted to mitigate this potential variation with manual chart review, which involved reviewing postoperative hospitalization and clinic visit notes. A final limitation noted by the researchers was that the primary outcome follow-up interval of 90-days likely did not capture all clinically significant complications and hospital interactions. The authors chose the 90-day interval to best encompass the short-term incidence of postresection complications, and because this interval aligns most closely with prior risk factor studies. In addition to prospectively analyzing postresection complication risk factors and the impact of plastic surgeon involvement in STS resection cases, future studies should investigate the decision-making process behind applying collaborative surgery principles. More specifically, further insight is needed into when and how plastic surgeons and their colleagues should collaborate during STS resection and reconstruction cases. Finally, future studies should examine the influence of plastic surgery intervention on patients' long-term quality of life, including their functional and aesthetic outcomes.

CONCLUSIONS

The major finding in our study was that plastic surgeon involvement emerged as a multivariate protector against wound healing complications. Additionally, despite longer operative times, longer hospital LOS, and higher rates of medical complications in the cohort whose index resections included a plastic surgeon, there were no statistical differences between our two cohorts in any of the primary outcomes analyzed. Our findings corroborate the notion that plastic surgeon involvement may be of particular benefit to patients in whom considerable medical burden is noted or for whom complex resections and reconstructions are planned.

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DISCLOSURES

Dr. Ko has received consulting fees from Integra LifeSciences Corporation. All the other authors have no financial interest to declare in relation to the content of this article.

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