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The Function of Plastic Reconstructive Surgery in Soft Tissue Sarcoma Surgical Therapy

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Abstract

Ablative surgery with complete tumour resection continues to be the primary approach for the management of soft tissue sarcoma. Within this particular context, the practise of reconstructive plastic surgery has emerged as a significant component of a multidisciplinary approach to sarcoma therapy. The primary objective of this therapeutic approach is to preserve the affected limb as a viable alternative to amputation. In this scholarly investigation, a comprehensive examination was conducted over a span of two years at a solitary medical facility. The analysis involved 290 patients diagnosed with soft tissue sarcoma (SST). The findings of this study demonstrated a correlation between surgical procedures resulting in clear margins (R0 resections) and the presence of higher-grade sarcoma in patients who underwent free flap reconstructive surgeries. Notably, the study did not identify any statistically significant variances in complication rates when comparing different methods of reconstruction. The risk of local recurrence was found to be more than two-fold higher in cases where primary wound closure was performed compared to cases where flaps were utilised. Defect reconstructions in soft tissue sarcomas (STS) have been demonstrated to exhibit a high degree of reliability and safety. Consequently, it is imperative to recognise the indispensable role of plastic and reconstructive surgeons within the realm of interdisciplinary surgical STS treatment.

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Introduction

Surgical resection serves as the primary therapeutic modality and fundamental pillar for managing extremity soft tissue sarcomas [1]. While radiation therapy and/or chemotherapy frequently contribute to the multimodal management of these malignancies, they are typically employed in conjunction with surgical excision of the neoplasm. Soft tissue sarcomas (STSs) are a type of neoplasm that exhibits low incidence rates, primarily manifesting in the extremities [2, 3]. The most commonly observed subtypes of soft tissue sarcomas (STS) encompass liposarcomas (LPSs), leiomyosarcomas (LMSs), and sarcoma not otherwise specified (NOS). The lower extremity, specifically the thigh, is the predominant anatomical region of initiation, with the upper extremity and trunk following suit [4]. In the annals of medical history, amputation has long been considered the preferred surgical intervention for addressing conditions affecting the extremities [5, 6]. However, a plethora of clinical studies have presented ample evidence indicating that limb-sparing resections with wide surgical margins, in conjunction with perioperative irradiation in cases of more aggressive tumours, result in comparable survival rates [7].

Given the infrequency of these malignant neoplasms, there exists limited knowledge regarding the implications of reconstructive surgical interventions within the context of the multidisciplinary management of soft tissue sarcomas (STS). The majority of research endeavours have been directed towards investigating neoadjuvant and adjuvant radio(chemo)therapy as well as chemotherapy in the context of soft tissue sarcomas (STS). However, there has been a growing interest in the field of reconstructive surgery for STS, as evidenced by the increasing attention it has received [8].

Reconstructive surgery may potentially facilitate the administration of higher radiation dosages in cases of recurrent tumours, provided that nonirradiated tissue is transplanted.

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Additionally, transplantation procedures have the potential to mitigate common radiation-related complications, such as fibrosis and radiation ulcers [9]. However, the rates of complications associated with reconstructive surgery in soft tissue sarcoma (STS) have not been studied to date, in comparison to surgical treatment of STS without the use of reconstructive surgery [10]. Moreover, there is a lack of clarity regarding the potential correlation between the utilisation of flaps, specifically microvascular free flaps, by reconstructive surgeons and the likelihood of achieving favourable outcomes in soft tissue sarcoma (STS) resection, specifically in terms of increased numbers of free resection margins. In this research endeavour, a comprehensive retrospective analysis was conducted on the medical records of 290 patients. The primary focus of this analysis was to evaluate the demographic and tumour characteristics of these patients, as well as their survival rates. Additionally, the study aimed to investigate the influence of various reconstruction methods on patient outcomes, including the occurrence of complications and rates of recurrence.

Materials and Methods

A retrospective analysis was conducted on all individuals who underwent surgical intervention for soft tissue sarcoma (STS) within the time frame of September 2020 to August 2022. This study was carried out at the Department of Plastic Surgery, Patna Medical College Hospital, located in Patna, India.

Inclusion criteria: The study included individuals who had received a histologically confirmed diagnosis of soft tissue sarcoma (STS) and had undergone treatment at the Department of Plastic Surgery, Patna Medical College Hospital, Patna. The individuals who provided their informed consent for participation in the research study were subsequently included in the sample.

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Exclusion criteria: Patients with gastrointestinal stromal tumors (GISTs), without a diagnosis of STS per the final tumor pathology report and who did not give consent for the study were excluded.

Data Collection: Demographic data, such as age and sex, along with information on sarcoma diagnosis, including the date of first diagnosis, tumour classification using the TNM system, tumour grade, and recurrence status, were collected. The location of the tumour was categorised as upper extremity, lower extremity, trunk, or head/neck. The patient's treatment history, including any previous interventions at other medical institutions, as well as any complications experienced postoperatively, were documented. The use of neoadjuvant or adjuvant therapy, as well as the specific details of the surgical reconstruction, were recorded. The resection margins were classified according to the residual tumour classification system, with R0 indicating complete resection, R1 indicating microscopic residual tumour, and R2 indicating macroscopic residual tumour. Follow-up and any postoperative complications were also documented.

Statistical Analysis

The statistical analyses were conducted utilising the Statistical Package for the Social Sciences (version 19.0, SPSS Inc., Chicago, IL, USA). The evaluation of survival was conducted by employing the Kaplan-Meier method along with log-rank tests (Mantel-Cox) to examine potential factors that may have an impact. The assessment of survival was conducted using Cox regression, which is a statistical method for analysing multiple variables simultaneously. Patient characteristics between the groups were analysed using cross-tabulation and the chi-square test for categorical variables, the Mann–Whitney U test and Fisher’s exact test for ordinal variables, and Student’s t-test for continuous variables.

Results

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A comprehensive cohort of 290 individuals undergoing medical intervention was identified during the period spanning from 2020 to 2022. A total of 280 patients underwent sarcoma resection procedures at either the Department of Plastic and Hand Surgery or the Department of Surgery. A total of eighty-one patients underwent primary sarcoma resection at various hospitals lacking specialised oncologist expertise in the field of soft tissue sarcomas (STS). Only seven patients had a R0 status and had undergone reconstructive surgical intervention solely at our academic medical centre.

The demographic and tumour characteristics of the patients are presented in Table 1. The predominant anatomical distribution of the soft tissue sarcoma (STS) in our study population was observed in the lower extremity (46.6%), followed by the trunk (19%). Additionally, the STS was found to be localised within the abdomen or thorax in 18.6% of cases, with four of these cases demonstrating involvement of the thoracic/abdominal wall. The upper extremity accounted for 12.1% of cases, while the head/neck region accounted for 3.8% of cases. Among the various tumour entities, liposarcoma was found to be the most prevalent, followed by fibroblastic/myofibroblastic sarcoma. The distribution and localization of sarcomas treated at our institution are depicted in Table 1, highlighting the various subtypes.

Table 1. Baseline characteristics

Characteristics		Frequency	Percentage
Sex	Male	167	57.6%
	Female	123	42.4%
Adjuvant CT	Yes	44	15.2%
	No	243	83.8%
	Adjuvant, before reconstruction	3	1%
Neoadjuvant CT	Yes	141	48.6%

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	No	149	53.1%
Adjuvant RT	Yes	31	10.7%
	No	259	89.3%
Neoadjuvant RT	Yes	136	46.9%
	No	154	53.1%

A cohort of 168 individuals underwent primary wound closure, whereas a smaller subset of 22 patients received treatment through the application of split skin grafts. Local/regional flaps were employed in a cohort of 54 individuals, while free flaps were administered to a group of 40 patients. A total of six patients were excluded from the reconstruction analysis due to premature discontinuation of operative treatment while hospitalised, owing to the presence of advanced tumour disease. A total of 81 patients, accounting for 28% of the study population, underwent initial soft tissue sarcoma (STS) resection at an external institution. Among these patients, 58% underwent R1 resection at various hospitals that lacked the presence of an oncologist specialised in STS. Moreover, a total of 20% of the subjects exhibited a macroscopic residual tumour (R2), while 13% presented with indeterminate resection margins. In instances where positive (R1 and R2) or indeterminate (RX) margins or limited free margins were observed (total n = 71), a subsequent surgical procedure was conducted at our medical facility.

Discussion

Surgical intervention assumes a pivotal role in the therapeutic management of patients diagnosed with soft tissue sarcomas (STS). Radiotherapy and chemotherapy are commonly utilised as (neo)adjuvant therapeutic modalities and have demonstrated efficacy in the management of soft tissue sarcomas (STS) and hard tissue sarcomas [11, 12]. Numerous

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studies documented in the medical literature have identified positive margins as the primary prognostic factor for local recurrence [13]. In instances involving substantial, profound, and high-grade sarcomas with invasive proliferation into vital anatomical components, such as prominent nerves, vessels, and osseous structures, a greater incidence of metastasis is commonly observed [14].

In our study population, a notable increase in the incidence of cases exhibiting unencumbered margins was observed within the cohort undergoing free-flap reconstructions. Furthermore, the statistical analysis revealed a significant increase of local control by more than two-fold in the cohort receiving local/regional flaps or free flaps compared to the cohort undergoing primary wound closure. Nevertheless, within our cohort, there was a notable prevalence of local recurrence in cases involving split skin grafts, despite the fact that the R0 rate surpassed that of primary closure. The incidence of local recurrence in cases where primary closure and split skin grafts were employed did not exhibit a statistically significant disparity.

The results of our multivariate analysis indicate that none of the following factors: grading, amputation, resection margins, or size of excision, were found to be independent risk factors for recurrence in our cohort. Remarkably, a heightened incidence of local recurrence was observed within the split skin graft cohort, which appears incongruous with the assertion that positive margins serve as the primary prognostic indicator for local recurrence. However, extensive studies in the medical literature examining the prognostic importance of surgical margins in soft tissue sarcomas (STS) have also yielded inconclusive findings [15-20]. The aetiology underlying the elevated rate of recurrence in instances involving split-thickness skin grafts remains elusive and requires further investigation. Nevertheless, a plausible explanation could be attributed to the dimensions of the margins, particularly in terms of depth. It is possible that the margins were adequately wide to facilitate the creation of a split skin graft, thereby ensuring a wound that is suitable for healing without compromising any

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vital anatomical structures. However, it has been observed in the existing medical literature that both narrow and wide negative margins do not appear to have a significant impact on local recurrence rates [21]. Therefore, it is possible that the retrospective design of our study may have introduced a bias, which could explain our findings.

In this research investigation, the assessment of outcomes revealed a statistically significant elevation in grading within the cohort of patients who underwent free flap procedures as opposed to those who underwent primary wound closure. In a study conducted by Dadras et al., similar findings regarding the correlation between grading and primary wound closure were observed when comparing a cohort undergoing flap transplantation [5]. Nevertheless, despite the presence of a greater number of high-grade sarcomas within our cohort, we observed a statistically significant increase in the incidence of cases with uninvolved surgical margins among the group of patients who underwent free flap procedures. This observation suggests that the surgical removal of sarcoma may achieve a higher success rate in achieving clear margins, meaning a sufficiently thorough removal, when the option for reconstruction is made available through the involvement of a separate team, specifically plastic surgeons. This approach allows the oncological surgeon to focus solely on the tumour removal without being hindered by the complications associated with the resulting defect and the subsequent need for reconstruction.

In our research, individuals who underwent split skin grafts exhibited a statistically significant association with advanced age (median age being higher), which may potentially influence the process of wound healing. Moreover, the incidences of split-thickness skin grafts exhibited variations based on the anatomical site. The potential correlation between the specific anatomical site and the susceptibility to cutaneous breakdown is worth considering as a potential risk factor. In contrast, within our cohort, only eleven cases of soft tissue sarcomas (STS) located at the head and neck region were included, rendering statistical analysis of this

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specific subgroup unfeasible. Autologous split-thickness skin grafts were exclusively conducted on anatomical regions with abundant vascularity by proficient surgeons affiliated with the Department of Surgery and the Department of Plastic and Hand Surgery, adhering to established medical protocols. Based on our collective expertise, it is imperative to thoroughly evaluate the utilisation of split skin grafts as a viable option for sarcoma reconstruction, as opposed to local/regional or free flaps. Split-thickness skin grafts are often considered as the primary therapeutic approach for superficial skin defects. Nevertheless, the treatment of sarcoma typically encompasses neoadjuvant or adjuvant radiotherapy or chemotherapy. In addition to other potential aetiologies elucidated earlier, the utilisation of split skin grafts for reconstruction purposes can give rise to an unstable cicatrix, while the adjunctive application of radiotherapy may induce subsequent dehiscence within the grafted cutaneous region. It would have been intriguing to assess the utilisation of split skin grafts exclusively in cases devoid of premeditated radiotherapy. However, the feasibility of conducting such an evaluation was hindered by the lack of consistent data pertaining to this inquiry across the majority of medical records. Moreover, in the event of a localised recurrence, there was a notable increase in wound complications compared to the initial resection.

Conclusion

The current state of interdisciplinary surgical soft tissue sarcoma (STS) treatment poses a complex challenge. Surgical resection frequently leads to the formation of defects that necessitate reconstruction. Consequently, successful STS reconstruction demands the expertise of a reconstructive plastic surgeon who possesses comprehensive knowledge and proficiency in various reconstructive techniques. Utilising STS (Soft Tissue Sarcoma) reconstruction techniques, which are established in the medical field for their reliability and safety, the implementation of microvascular free flaps has shown potential in enhancing

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recurrence-free survival rates following extensive sarcoma resections. This positive outcome can be attributed to the higher incidence of achieving negative resection margins, a crucial factor in preventing the recurrence of sarcomas. Therefore, it is imperative that reconstructive surgery, encompassing a comprehensive range of reconstruction techniques, be firmly integrated into the interdisciplinary surgical approach to soft tissue sarcoma (STS). This is due to the indispensable role of anatomical and functional reconstruction in the treatment of STS.

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