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Research Article

Functional Outcome of Upper Limb Reconstruction After Resection of Soft Tissue Sarcoma

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Abstract

Background: About 20% all soft tissue sarcoma involve the upper limb. Extensive surgical resections often require reconstruction. The aim of reconstruction is an aesthetic and functional upper limb.

Objective: To determine the functional outcome of upper limb reconstruction after resection of soft tissue sarcoma. This is a retrospective Cohort Study was done at Plastic and Reconstructive Surgery Shifa International Hospital Islamabad Pakistan, from January 2013 to December 2022.

Methodology: Patient of either gender, between the age of 18 to 70 years, requiring upper limb reconstruction after resection of soft tissue sarcoma were included in this study. The WHO Sample Size calculator calculated the sample size 50%. Patients were clinically evaluated up to a six-month follow-up period using the Musculoskeletal Tumor Society (MSTS) Score to evaluate functional outcomes. Functional outcomes were labelled as excellent (>25 score), Good (20-25 Score), Satisfactory (10-19 Score) and Poor (< 10 score).

Results: The Mean Baseline MSTS Score was 7.78 ± 2.105 while the six-month Mean follow-up MSTS Score was 23.53 ± 3.829. There was a statistically significant difference between the MSTS Scores pre and post-operatively with a p-value < 0.001. Free flaps had 51.4% of Excellent functional outcomes while the Pedicled flaps had 30.0% of Excellent functional outcomes. Fifty-one (92.7%) patients had no complications while only 01 (1.8%) patient had partial flap loss and 03 (5.5%) patients had complications of wound infection and delayed wound healing.

Conclusion: Excellent functional outcome was achieved in the appropriate immediate reconstruction of the soft tissue defect following sarcoma resection in the upper limb.

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Introduction

Primary Soft Tissue Sarcomas (STS) are uncommon and make up only 1% of all adult malignancies however they are highly varied tumors that can originate almost anywhere in the body, affect people of all ages and share a mesenchymal origin.[1] About 20 % of all STS are found in the upper extremities and diagnosed at a median age of 38 years.[2] Higher incidence of Malignant Fibrous Histiocytoma/Undifferentiated Pleomorphic Sarcoma (UPS), Synovial Sarcoma (SS), Epithelioid Sarcoma (ES) and Clear Cell Sarcoma (CCS) are reported on the upper extremities, out of 50 different histological and molecular subtypes.[3]

Over the past few decades, the 5-year survival rate of STS patients has improved to 80% with the recent treatment guidelines.[4] Gold standard treatment for STS patients is limb preservation surgery and only a small proportion of about 5% will require amputation. A multidisciplinary team approach is always needed, choosing surgery with a combination of neoadjuvant or adjuvant chemotherapy and/or radiotherapy, which probably minimizes local spread in more than 90% of cases and has an excellent effect on disease-free survival.[5] In the past, patients with larger or higher-grade tumors often had amputation as a treatment option.[6] Due to the advent of adjuvant therapy and sophisticated reconstructive techniques, the survival rate has improved and a fall in recurrence rate has also been noticed.[7] Studies have reported almost 90% of excellent functional outcomes in patients who underwent upper limb reconstruction after resection of STS.[8-10]

For patients with STS of the extremities, a resection strategy comprises free-margin excision, reconstructive surgery that is both aesthetically and functionally acceptable, and application of supportive therapy protocols.[11] At the expense of disease-free margins large soft tissue defects are formed with the involvement of tendons, vessels, and nerves. That will require reconstruction of the involved structures with pedicled or free tissue transplantation to achieve a functional limb.

Large complex soft tissue defects are formed after STS resection in the upper extremities. Pedicled or free flap reconstruction is often required for coverage of defect. Additional procedures such as nerve & tendon reconstruction are also required to restore the functionality of the involved limb.

The research aims to find out the functional outcome of upper limb reconstruction after resection of STS and offer significant perspectives into the effectiveness of treatment, quality of life of the patient, and informed clinical decision-making. The findings from this study will benefit both healthcare providers and patients, ultimately leading to better outcomes for patients with STS requiring upper limb reconstruction in our local population.

Methodology

This retrospective study was conducted at Plastic and Reconstructive Surgery Shifa International Hospital Islamabad Pakistan, from January 2013 to December 2022. Ethical approval Ref No: (IRB # 0325-23) was obtained from the Ethical Committee and Institutional Review Board. The WHO Sample Size calculator calculated the sample size with 90% proportion of excellent functional outcome of upper limb reconstruction surgery for extremity sarcoma and 5% significance level. Data were collected using a nonprobability consecutive sampling approach.

Patients of either gender between the ages 18 to 19 years with upper limb Soft Tissue Sarcoma requiring reconstruction after resection were included in this study.

All selected patients provided written informed consent, and all underwent a preoperative evaluation of function using the Musculoskeletal Tumor Society (MSTS) score. All patients had a wide local resection, immediate reconstruction with pedicled or free flap including adjunctive procedures like nerve reconstruction, tendon transfer, vascular reconstruction and adjuvant chemotherapy or radiotherapy was done when indicated. After the reconstruction, patients were clinically evaluated by the Consultant Plastic Surgeon twice weekly for the first month and then once weekly for the next six months. To assess functional outcomes during follow-up visits, MSTS Score was used. This Scoring system was 6 categories pain, function, emotional acceptance, hand positioning, manual dexterity and lifting ability. Each category has a scale of 0 to 5, with 5 showing the maximum and 0 showing no function and on aggregate. They will be labeled as excellent (>25 score), Good (20-25 Score), Satisfactory (10-19 Score) and Poor (< 10 score).

Statistical Package for Social Sciences (SPSS) version 23.0 was used to conduct the statistical analysis. Concerning quantitative data, mean+SD was computed. Qualitative variables were recorded as frequencies and percentages. Cross-tabulation analysis was performed for comparison of functional outcome and type of reconstruction. The quantitative and qualitative variables were analyzed using the independent samples t-test and chi-square test, with p-values < 0.05 indicating significance.

Results

This study comprised of a total fifty-five patients. The patient's mean age was 53.38±8.601 years. Total number of male patients was 31 (56.4%) and female were 24 (43.6%). The mean baseline MSTS Score was 7.78±2.105 while the Mean follow-up MSTS Score was 23.53±3.829. Fifty-one (92.7%) patients had no complications while only 01 (1.8%) patient had partial flap loss and 03 (5.5%) patients had minor complications including delayed wound healing and wound infection, which were managed non-invasively in an OPD setup. Between the pre-and post-operative MSTS Scores, there was a statistically significant difference (p-value < 0.001). (Table-I)

Table 1: *Demographic and Clinical characteristics of patients (n=55)*

Quantitative Variables	Mean+SD	p-value
• Age (Years)	53.38 ±8.601	
• Baseline MSTS Score	7.78 ±2.10	<0.001
• Follow up MSTS Score	23.53 ±3.829	
Qualitative Variables		
Gender,	**n (%)**	
• Male	31 (56.4%)	
• Female	24 (43.6%)	
Anatomical Region,	**n (%)**	
• Shoulder	18 (32.7%)	
• Elbow and Arm	13 (23.6%)	
• Forearm and Wrist	15 (27.3%)	
• Hand	09 (16.4%)	
Complications,	**n (%)**	
• Partial flap loss	01 (1.8%)	
• Wound infection	03 (5.5%)	
• Non	51 (92.7%)	

Twenty-four (43.62%) had excellent functional outcomes followed by 21 (38.2%) patients with good and 09 (16.4%) patients with satisfactory functional outcomes. However, only 01 (1.8%) patient with poor functional outcome was recorded due to complication of partial pedicled flap loss. (Table-II)

Thirty-one (56%) patients had neoadjuvant radio/chemotherapy. No significant difference in total functional outcome was observed but Patients who received preop radiotherapy had post-op delayed wound healing. Table III shows the type of reconstruction done and also compares their MSTS scores.

Table 2: *Functional Outcome of Patients (n=55)*

Functional outcome	n (%)
Excellent	24 (43.6%)
Good	21 (38.2%)
Satisfactory	9 (16.4%)
Poor	1 (1.8%)
Total	**55 (100.0%)**

The pre-op MSTS Score and post-op MSTS Score of STS of upper extremity reconstruction with free flaps were compared with a pedicled flap and are tabulated in Table III. There was no significant difference in pre- and post-op MSTS scores in the free flap and pedicled flap groups.

Table 3: *Type of soft tissue reconstruction done (n=55)*

Type of Reconstruction	n (%)	Mean Pre-op MSTS Score	Mean Follow-up MSTS Score
Free Flap	35 (63.6%)	8.29+2.094	24.31+2.898
Pedicled Flap	20 (36.4%)	6.90+1.861	22.15+4.848
Total	55 (100%)	7.78+2.105	23.53+3.829

This study further investigated the relationship between the type of reconstruction and the functional outcome. Free flaps had 51.4% of Excellent functional outcomes, 40.0% of Good functional outcomes, 8.6% of satisfactory and 0.0% of poor functional outcome. While the pedicled flaps had 30.0% of Excellent, 35% of Good, 30% of Satisfactory and 5% of Poor functional outcome. (Table-IV)

However, the p-value 0f 0.081 indicates that these observed differences in functional outcomes between free flap and pedicled flaps are not statistically significant.

Table 4: *Association of Functional Outcome with Type of Reconstruction (n=55)*

			Functional Outcome				Total	p-value
			Excellent	Good	Satisfactory	Poor		
Type Of Reconstruction	Free flap	Count	18	14	3	0	35	0.081
		% within Type Of Reconstruction	51.40%	40.00%	8.60%	0.00%	100.00%	
	Pedicled Flap	Count	6	7	6	1	20	
		% within Type Of Reconstruction	30.00%	35.00%	30.00%	5.00%	100.00%	
Total		Count	24	21	9	1	55	
		% within Type Of Reconstruction	43.60%	38.20%	16.40%	1.80%	100.00%	

Discussion

According to the reconstructive ladder, primary closure is considered first in the complex management of wounds. After achieving clear margins, definitive and immediate reconstruction should be followed.[12,13] Our study investigated the functional outcomes of upper limb reconstruction after resection of STS in 55 patients. The type of reconstruction was dependent on the defect size after the excision, its type, depth, proximity of a local flap and also the patient factors like age, history of radiation and comorbidities. Tumors at the wrist and hand required free flap because of anatomic position, structures involved and extensive resection to obtain clear margins[14]. Free flaps are more desirable when the available local flaps are of a radiated nature which makes it difficult for flap designing and elevation.[15,16]

On the other hand, primary amputation should be considered for irresectable tumors where clear margins cannot be achieved based on pre-op imaging. A primary amputation should be considered for those cases where tumor resection will result in severe soft tissue loss and severe functional deficit that cannot be restored with available surgical procedures or the anticipated high complication rate.[17]

The mainstay of the best functional outcome is the achievement of disease-free margins of STS, selection of the best available reconstructive option and following post-op rehabilitation regime.

The patients in our study had a low baseline Musculoskeletal Tumor Society (MSTS) Score (7.78), indicating poor functional outcomes before surgery. After upper limb reconstruction, there was a significant improvement in functional outcomes, with a mean follow-up MSTS Score of 23.53 (p-value < 0.001). This suggests that the surgical intervention led to substantial enhancements in functional status. The majority of patients (43.6%) achieved excellent functional outcomes, followed by 38.2% with good outcomes, and 16.4% with satisfactory outcomes. Only 1 had poor outcomes and this was the patient that had partial flap loss. Gender did not significantly influence functional outcomes. These findings provide valuable insights into the effectiveness of surgery procedure in improving the standard of living for those suffering from soft tissue sarcoma.

High-grade tumors involving the wrist and hand required free flap reconstruction because of the anatomic positions and structures involved. Delayed wound healing and infections were noted in the majority of those patients who had received radiation preoperatively. A previous study[18] assessed the functional outcome of upper extremity following wide local excision of STS in 72 patients over a period of 9 years with reconstruction and adjuvant therapy as required. The Toronto Extremity Salvage Score (TESS) was scored for the functional outcome and achieved good to excellent function (TESS mean of 87 out of 100).[18]

Our study revealed that there was no discernible difference in the functional outcome between the groups with pedicled and free flaps. Caroline et al compared the pre-and post-operative upper extremity function after STS excision with pedicled and free flap reconstruction in 113 patients,.[19] showed similar results. The Toronto Extremity Salvage Score (TESS) and the Musculoskeletal Tumor Society (MSTS) score were used to evaluate the functional results.[19]

Another study by kim et al.[20] assessed the functional outcome of upper extremity reconstruction after resection of STS in 83 reconstructions in 81 patients, including 16 microvascular and 67 non-microvascular reconstructions. The mean total functional score was 23.1 (Good) and indicating that limb-sparing surgery is effective in producing favorable functional results.

When performing limb salvage procedures for upper extremity sarcomas, free and pedicled flaps are an essential component of the reconstructive toolbox. The complex and intricate anatomy of the upper extremity should not discourage us from aiming for limb salvage. A reasonable treatment option for individuals with primary STS of the upper extremities is limb reconstruction surgery as in our study excellent functional outcomes with both free and pedicled flap reconstructions were noted. Free flaps create well-vascularized tissue that promotes wound healing and tolerates radiation well.

STSs are relatively rare, and the small sample size of this study can affect the generalizability of the findings to a broader population. Therefore, it's essential to acknowledge that these results may not apply to all STS patients.

Conclusion

Excellent functional outcome was achieved with appropriate immediate reconstruction of the soft tissue defect following sarcoma resection in the upper limb.

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Source of funding: None

Author's Contribution

Shah Zaib Aslam: Conception and design of the study, data analysis and interpretation, agreement to be accountable for all aspects of the work and final approval of the version to be published
Rashmeen Khan Afridi: substantial contribution to acquisition of data, concept and design and final approval of the version to be published
Adeela Hussain Khan: Interpretation of data, Critical revision of the article and final approval of the study.
Farwa Shabbir: Interpretation of data Critical, revision of the article and final approval of the study
Maimoona Goher: Concept and design, substantial contribution to acquisition of data, critical review and final approval of the study.

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