

# Radiotherapy Does Not Impact Long-term Function Following Resection of Soft-tissue Sarcomas of the Hand

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**Abstract.** *Background/Aim:* Radiotherapy for soft tissue sarcomas (STS) of the hand is thought to be associated with poor function. The aim of this study was to compare the long-term functional outcome in patients with and without radiotherapy. *Patients and Methods:* At long-term follow-up (mean 10±5 years), 33 (13 males, 20 female) patients, were alive for review. The mean patient age at surgery was 33±17 years and 13 (39%) patients received radiotherapy (mean dose 55±6 Gy). *Results:* Postoperatively, the mean QuickDASH and MST93 were 7±8 and 92±8%, respectively. Comparing patients with and without radiotherapy, there was no difference ( $p>0.05$ ) between the mean QuickDASH (5±5 vs. 8±9) or MST93 (93±9% vs. 91±8%). Surgical complication occurred more commonly in patients with radiotherapy (46% vs. 15%,  $p=0.10$ ). *Conclusion:* The use of radiotherapy was associated with a higher rate of complications, however, was not associated with a worse long-term functional outcome in patients with hand STS.

Soft tissue sarcomas (STS) of the hand are typically treated with a combination of radiotherapy and surgery (1-19). Often, radiotherapy aids in achieving local tumor control by diminishing microscopic tumor near the surgical bed, and allowing for a planned close margin excision along critical structures (20). However, the use of radiotherapy in this context has been associated with early and late complication rates including wound dehiscence, fibrosis, stiffness/adhesions, edema and potential for radiation associated fractures (2, 4, 5, 7, 9, 15, 17). Furthermore, neoadjuvant radiotherapy is often associated with wound complications whereas adjuvant

radiotherapy is associated with fibrosis, edema, and stiffness (3, 4, 8, 9).

Given the potential for a high complication rate associated with radiotherapy, it has been presumed that the hand would be at risk for complications secondary to its complex anatomy, need for soft tissue gliding and multiple joints which are required for appropriate hand function (1, 3, 4, 9, 17). Although pre- and post-operative radiotherapy are associated with different complications, neither has been definitively shown to have worse functional outcome compared to the other (3, 9). In contrast, there are other reports which demonstrate good functional outcome for the treatment of STS of the distal extremities with radiotherapy (2, 5, 11, 12).

Consequently, there is a paucity of data regarding the long-term functional outcome after excision of an STS of the hand with or without radiotherapy. Therefore, the aim of this study was to compare the functional outcome of the treatment in patients with STS of the hand with and without radiotherapy.

## Patients and Methods

Following institutional review board approval, we reviewed the records of 46 patients with an STS of the hand between 1992 and 2013. Pertinent demographics as well as information regarding the surgical procedures and disease status at latest follow-up were reviewed. Patients were contacted *via* phone interview to determine if they had any tumor recurrence or further operative interventions and to obtain the QuickDASH and MST93 scores to assess hand function (21, 22).

*Patient groups.* Of the 46 patients, at the most recent follow-up, 33 (72%) (13 male, 20 female) were alive and available to be contacted and be involved in the study. Mean age at diagnosis was 33±17 years with a mean follow-up of 10±5 years. The sarcoma location included hand (n=17, 52%), finger (n=9, 27%), or thumb (n=7, 21%). It was located on the volar surface in 18 (55%) patients and on the dorsal surface in 15 (45%). The most common pathologies were synovial sarcoma (n=8, 24%) and epithelioid sarcoma (n=7,

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21%). Thirteen (39%) patients received radiotherapy as a part of their treatment protocol, with a mean total dose of  $55\pm 6$  Gy. Radiotherapy was given as a neoadjuvant only ( $n=6$ ; total dose of 50 Gy), adjuvant only ( $n=1$ , total dose of 60 Gy), neoadjuvant and intraoperative ( $n=4$ ; mean total dose  $60.9\pm 3.8$  Gy), neoadjuvant with brachytherapy ( $n=1$ , total dose 62 Gy), and neoadjuvant and adjuvant ( $n=1$ , total dose 65 Gy). The entire group of long-term survivors was included in our analysis of complications.

Of these patients, 22 (67%) agreed to participate in the survey and assessed using the MST93 and QuickDASH scores. This group included 10 males and 12 females with a mean age of  $38\pm 18$  years and a mean follow-up of  $11\pm 6$  years. Eight (36%) patients received radiotherapy as a part of their treatment protocol, with a mean total dose of  $55\pm 8$  Gy. The radiotherapy was given as a neoadjuvant only ( $n=5$ ; total dose of 50 Gy), neoadjuvant and intraoperative ( $n=1$ ; total dose 66.4 Gy), neoadjuvant with brachytherapy ( $n=1$ , total dose 62 Gy), and neoadjuvant and adjuvant ( $n=1$ , total dose 65 Gy).

*Statistical analysis.* Continuous variables were analyzed using unpaired Student *t*-tests and the Fisher exact test was used to compare categorical variables; with values are reported as mean $\pm$ standard deviation (SD). Spearman's  $\rho$  tests were used to examine the correlation between the DASH, MST93 score and radiation dosing. A *p*-value of  $<0.05$  was considered significant.

## Results

Surgical complications occurred in 9 (9/33, 27%) patients, more commonly in patients with radiotherapy ( $n=6$ , 46% vs.  $n=3$ , 15%,  $p=0.10$ ). Of these patients, 3 had multiple complications, all in patients who received radiotherapy. Complications associated with radiotherapy included soft-tissue contracture ( $n=4$ ), skin necrosis ( $n=3$ ), neuralgia in the fingers ( $n=2$ ), and fibrosis leading to carpal tunnel syndrome and subsequent release ( $n=1$ ). One patient also developed a neuroma. One of the 4 patients with soft tissue contracture required contracture release with first web space flap advancement. In addition, one of the patients with skin necrosis required irrigation and debridement with split thickness skin grafting.

At the most recent follow-up, the mean QuickDASH and MST93 scores were  $7\pm 8$  and  $92\pm 8\%$ , respectively. When comparing patients with and without radiotherapy, there was no difference between the mean QuickDASH ( $5\pm 5$  vs.  $8\pm 9$ ,  $p=0.43$ ) or MST93 ( $93\pm 9\%$  vs.  $91\pm 8\%$ ,  $p=0.58$ ). Higher MST93 scores were correlated with lower QuickDASH scores ( $\rho -0.756$ , (95%CI= $-0.923- -0.609$ )  $p<0.001$ ); however, increasing radiotherapy doses were not correlated with MST93 ( $\rho 0.115$  (95%CI= $-0.316-0.516$ ),  $p=0.61$ ) or QuickDASH scores ( $\rho -0.181$  (95%CI= $-0.559-0.261$ ),  $p=0.64$ ). In addition, when comparing tumor location, patients with sarcomas in the finger were noted to have lower QuickDASH scores compared to sarcomas in the hand and thumb ( $4\pm 4$  vs.  $9\pm 8$  vs.  $15\pm 13$ ,  $p=0.054$ ) and higher MST93 scores ( $95\pm 6\%$  vs.  $88\pm 10\%$  vs.  $88\pm 12\%$ ,  $p=0.13$ ),

however this failed to be statistically significant. Likewise, there was no difference in the QuickDASH ( $7\pm 8$  vs.  $8\pm 9$ ,  $p=0.71$ ) or MST93 ( $93\pm 7\%$  vs.  $88\pm 10\%$ ,  $p=0.22$ ) scores if the tumor was superficial or deep to the fascia. When comparing patients with a volar *versus* dorsal sarcoma there was no difference in the mean DASH ( $5\pm 3$  vs.  $8\pm 9$ ,  $p=0.43$ ) or MST93 scores ( $90\pm 6\%$  vs.  $90\pm 9\%$ ,  $p=0.70$ ).

## Discussion

Treatment of soft tissue sarcomas of the hand can be particularly difficult due to the complex anatomy with multiple joints and neurovascular structures, which are often in close proximity to the tumor making it difficult to achieve a wide margin. As such, radiotherapy is used to assist with margin control. Although radiotherapy is important for margin control, it has been associated with long-term complications including stiffness and fibrosis. Contrary to previous series, the results of the current series indicate no difference in long-term hand function following the use of radiotherapy.

There have been differences reported in the functional outcome following surgical resection of STS of the hand with or without radiotherapy. Radiotherapy is needed to enhance the close margin of resection for these tumors; however, the need for gliding tissue planes for optimal hand function can be hampered by radiotherapy. In the hand, significant radiation toxicity has been found to be minimal to none and that the functional effects of radiotherapy were insignificant (2). Previous reports have shown that even with surgical resection with radiotherapy, the majority of patients are able to return to employment and activities of daily living (2). The results of the current study are in agreement with this, with a mean QuickDASH and MST93 scores were  $7\pm 8$  and  $92\pm 8\%$ , respectively. There was no difference between the mean QuickDASH ( $5\pm 5$  vs.  $8\pm 9$ ,  $p=0.43$ ) or MST93 ( $93\pm 9\%$  vs.  $91\pm 8\%$ ,  $p=0.58$ ) when comparing patients with and without radiotherapy, respectively. Not surprising, patients where the surgery involved the thumb, had worse functional outcome, owing to the importance of the thumb for activities of daily living.

The incidence of complications following radiation therapy to the hand has historically been shown to be high, ranging from minor complications such as edema or tendon adhesions to major complications such as fracture (15, 16). Our study had similar complication rates to those previously reported (2) and an increased complication rate was noted in patients who received radiotherapy compared to those who did not (46% vs. 15%, respectively). Despite this, however, it did not seem to affect the functional outcome (15). Long term complications associated with stiffness and fibrosis are often associated with postoperative radiotherapy (4), however there is data to suggest this can be safe with lower

target volumes to the distal extremities; without increasing complications (23). The low incidence of these long-term complications in the current study is likely associated with the low utilization of this form of radiotherapy. In addition, the higher use of preoperative complications likely accounts for the complications commonly observed in this series, namely wound complications.

There are several limitations to this study. This was a retrospective study that included telephone follow up for MST93 and QuickDASH scores. Therefore, the amount of data obtained from the medical chart was limited. Of the initial group of patients, only 33 were alive and able to be contacted for follow up, and of these, 22 were contacted by telephone, leading to selection bias. Although this represents only part of the cohort, the mean follow up for all patients was 10 years, and for those who were reached by phone was 11 years, which is one of the longest follow up studies in the literature on this topic. Lastly, the data come from a single institution with multiple surgeons performing the operations, however all surgeries were multidisciplinary involving musculoskeletal oncology trained surgeons for resection and fellowship trained hand and plastic surgeons involved in the reconstruction.

Overall, the use of radiotherapy was not associated with a worse long-term functional outcome in patients with STS of the hand. The results of this study indicate that if patients have an STS of the hand, and radiotherapy is needed, they should expect excellent hand function at final follow-up, however complications remain common.

### Conflicts of Interest

The Authors have no conflicts of interest to declare regarding this study.

### Authors' Contributions

Munaretto, Logli: Drafting of initial and final manuscript, data collection, data analysis; Rose, Petersen, Ahmed, Bakri: Review and editing of final manuscript; Moran, Steven: Review and editing of final manuscript, supervision; Houdek, Matthew: Drafting of initial and final manuscript, data analysis, supervision.

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