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TITLE PAGE

Cutaneous Leiomyosarcoma: Dermal and Subcutaneous

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Keywords: leiomyosarcoma, skin, soft tissue tumours, atypical smooth muscle neoplasm, cutaneous oncology, dermatologic surgery

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Cutaneous Leiomyosarcoma: Dermal and Subcutaneous

ABSTRACT

Background and objectives: Leiomyosarcoma of skin (LMS) can be sub-classified on pathology appearances as Dermal or Subcutaneous. The aim of this study was to provide treatment recommendations for these uncommon tumours.

Methods: A retrospective review of all patients with dermal and subcutaneous LMS managed at the Peter MacCallum Cancer Centre, Australia from January 2003 to December 2018 was performed. 83 patients were identified (64 dermal LMS, 19 subcutaneous LMS).

Results: Subcutaneous LMS were larger (median size 14mm dermal, 49mm subcutaneous, p=0.01). No patient with a dermal LMS developed metastatic disease compared to 4 of the 19 subcutaneous LMS (5 year overall survivals, 98% and 88%, respectively p = 0.03). The most common site of metastasis was to the lung. No difference in risk of local recurrence was apparent (5 year recurrence free survivals were 85% and 78% respectively, p=0.17). Adjuvant radiotherapy was used in 16 (25%) dermal LMS patients and 13 (68%) subcutaneous LMS patients (p<0.001). Local recurrence was uncommon in both tumour subtypes when patients received definitive surgical excision (minimum histological margins of 10mm as per institutional protocol) regardless of whether radiotherapy was used. The 5 year local recurrence free survival for dermal LMS treated with radiotherapy was

93% versus 83% without radiotherapy (p=0.7) and for subcutaneous LMS was 69% and 100% respectively (p=0.9).

Conclusions: Dermal LMS have an excellent prognosis, particularly after definitive surgical excision with margins of at least 10mm. Subcutaneous LMS have poorer outcomes and should be managed by wider excision and considered for adjuvant radiotherapy.

Key Words: leiomyosarcoma, skin, soft tissue tumours, atypical smooth muscle neoplasm, cutaneous oncology, dermatologic surgery

INTRODUCTION

Primary leiomyosarcoma of skin (LMS) is a rare tumour, accounting for only 2-3% of all soft tissue sarcomas.[1] LMS of the skin can be divided into 2 main subtypes: primary dermal LMS and subcutaneous LMS.[2–4] Dermal LMS originate from the erector pili muscles in the dermis whilst subcutaneous LMS originates probably from vascular smooth muscle of subcutaneous adipose tissue.[5] The International Agency for Research on Cancer (IARC) World Health Organisation (WHO) classification of tumours specifies that although the major portion of the tumour in cutaneous LMS is in the dermis, subcutaneous extension can be present in some cases.[6] As the differences between cutaneous and subcutaneous LMS have been recognised, more refined approaches to management have been reported.[1] The absence of clear treatment recommendations reflects the rarity of these tumours. Generally complete wide surgical excision is recommended, as inadequate margins may result in local recurrence.[2,3,7] The literature provides little guidance as to what is an appropriate margin of excision or the role of adjuvant radiotherapy.[3]

This study was designed to explore differences in presentation, management and outcomes between dermal and subcutaneous LMS in order to formulate a management approach.

METHODS

Patient Population

This study was a retrospective review of all patients with dermal and subcutaneous LMS managed at the Peter MacCallum Cancer Centre, Australia from January 2003 to December 2018. Human

Research Ethics Committee approval was obtained (HREC no: 18/141R). Patients were identified from the hospital master patient record index and Pathology Department database. Data was extracted from the electronic medical record. All patients had their pathology reviewed prior to treatment to confirm the diagnosis and type of LMS by an experienced soft tissue tumour pathologist. Tumours were classified according to the WHO classification.[6] Tumours predominantly involving the dermis with or without limited spread into the subcutaneous tissue were classified as dermal LMS. Tumours arising in the subcutaneous tissue superficial to the deep fascia even if there was limited dermal extension were classified as subcutaneous LMS. Tumours arising from beneath the deep fascia even if there was subcutaneous or dermal extension were excluded from this study. A total of 83 patients were identified including two who were referred with metastatic disease.

Data collected included standard patient demographic data, details of pathology including immunohistochemical staining and surgical margins, management including the type and extent of surgery, use of adjuvant therapy and outcomes. During the period of the study the unit policy was to widely excise these lesions with a minimum 10 mm margin and consider radiotherapy for larger lesions after discussion in a multidisciplinary team panel. In general, factors considered included tumour location, depth of invasion, size and histologic grade and patient performance status, as many were elderly. Preoperative radiotherapy was the preferred method of delivery. The standard radiation dose was 50.4Gy in 1.8Gy/fraction over 5.5 weeks. The reported margin of excision was obtained from the pathology report of the definitive surgery. Where there was no residual tumour identified in the operative specimen from the definitive procedure following a previous excision biopsy, the measurement from the scar to the edge of the excision was recorded as the margin measured in millimetres. For larger tumours where the deep fascia and underlying tissues including muscle, tendon, periosteum et cetera were resected this information was recorded. The site of the lesion was recorded but classified for this study as head and neck, trunk or extremity.

Statistical Analysis

The data was analysed using the R statistical program (Base, Survival and Survminer packages).[8] Continuous data was described using means and interquartile ranges and compared with a t-test or Kruskal Wallis test. The Fisher exact test was used to compare frequency data. Kaplan Meier survival curves were created for examination of overall survival, local recurrence free survival, and disease-free survival and compared with the log-rank test. For all comparisons a P value of 0.05 was considered significant.

RESULTS

There were a total of 83 patients who met the inclusion criteria. 32 patients had tumours located completely in the dermis and 32 in the dermis with minor subcutaneous invasion. These 64 patients were classified as having dermal LMS. Thirteen patients had tumours that were purely subcutaneous and 6 patients had tumours that occupied the entire subcutaneous tissue plane with direct spread to dermis and deeper structures. This latter group of 19 patients were classified as having subcutaneous LMS. Demographic details are shown in Table 1 broken down by type of LMS. In summary the median age of onset was 58 with a marked male predilection. Dermal LMS were considerably smaller than subcutaneous LMS, 14 mm and 49 mm respectively ($p = 0.001$). When recorded, the commonest presentation was of a slowly growing nodule of non-specific appearance, ranging in colour from pale grey, tan, pink and red, enlarging over a protracted period of months to years (median 24 months, IQR 48 months, n=15). The majority of lesions were asymptomatic (61 patients, 95%) whilst only a few were particularly tender (3 patients, 5%). Diagnosis was made on the basis of a complete excision (81%) rather than a more limited procedure such as punch biopsy, incision biopsy or needle biopsy prior to definitive treatment. Subcutaneous LMS tended to occur more commonly on the extremities compared with other sites. The median length of follow-up was 24 months.

Preoperative staging investigations included chest computed tomography scanning (CT) in 47 patients (57%), combined CT and positron emission tomography scanning (CT-PET) scan in 20 patients (24%), magnetic resonance imaging (MRI) in 33 patients (40%) and ultrasonography in 9 (11%) (some patients had more than one staging investigation). Overall pre-operative imaging to assess the presence of distant disease was performed more commonly in subcutaneous than dermal LMS (82% versus 60% respectively, $p<0.001$). Two patients had evidence of metastatic disease at the time of presentation; both had large subcutaneous LMS.

Primary tumour pathology features are also shown in Table 1. The majority of tumours had a mitotic rate of less than 10 per high-power field (64%). Immunohistochemical staining for alpha smooth muscle actin (α-SMA), desmin and h-caldesmon were performed infrequently if required for diagnostic purposes. The median excision margin for both groups was 20 mm and the proportion of patients with margins less than 10 mm was similar (9% and 6%). The majority of patients were managed by wide local excision (82%). In 8 cases the resection involved deeper structures including

muscle, tendon or periosteum due to the extent of the tumour. Four patients were managed only by excisional biopsy in view of age, site of lesion (ear and scalp) and other medical comorbidities. Adjuvant radiotherapy was used in 29 patients most commonly preoperatively (72%, 21 patients). Patients with subcutaneous LMS were much more likely to receive adjuvant radiotherapy than patients with dermal LMS (68% and 25% respectively, $p < 0.001$).

9 patients had local recurrence (6 dermal, 3 subcutaneous) of which 7 were treated with a further wide local excision and are alive and free of disease. Of the other 2 patients, the patient who was 101 years old at diagnosis had no further treatment after an initial incomplete excisional biopsy and died with disease. The other patient with a local recurrence had poorly differentiated LMS of the axilla involving muscle that was treated only with palliative pain management and died with disease. Four patients developed metastatic disease and in all cases lung was involved. Other sites included brain (two cases) and adrenals (two cases). Two patients managed by chemotherapy and pulmonary metastectomy remain alive without evidence of disease 48 and 156 months later.

Of the 83 patients six have died, four with disease and two due to other causes. The deaths due to LMS included two patients who were aged 97 and 101 at time of presentation; both had extensive dermal LMS and elected for no further treatment after excisional biopsy. One of these patients developed local recurrence but neither died as a consequence of their LMS. The youngest patient in the series aged 21 presented with a subcutaneous LMS in the groin and extensive metastases to brain, skin, adrenals and lung and subsequently died of disease eight years after diagnosis. A further patient aged 50 with a large dermal LMS of the axilla developed both local and distant recurrence and died two years later as a consequence of his tumour.

5 year overall survival for dermal LMS was 98% (95% confidence interval, 95 - 100%) and for subcutaneous LMS was 88% (95% confidence interval, 73 -100%) (Figure 1). Local recurrence free survival by type of LMS is shown in Figure 2. No difference in the risk of local recurrence was apparent, with 5 year local recurrence free survivals of 85% (95% confidence interval, 73 - 95%) for dermal LMS and 78% (95% confidence interval, 59 – 100%) for subcutaneous LMS ($p = 0.17$). No patient with dermal LMS developed metastatic disease compared to 4 of the 13 subcutaneous LMS. Distant disease free survival was 100% and 83% at 5 years for dermal and subcutaneous LMS respectively ($p = 0.001$) (Figure 3).

Adjuvant radiotherapy was used in 25% of patients with dermal LMS and 68% of patients with subcutaneous LMS ($p < 0.001$). There were no statistically significant differences in either local

recurrence or overall survival for either tumour type. Radiotherapy had no significant effect on the risk of local recurrence for patients with subcutaneous LMS (5 year local recurrence free survivals 100% and 69% for the no radiotherapy and radiotherapy groups respectively, p = 0.9) (Figure 4). Although the number of patients was small, 6 in the no radiotherapy and 13 in the radiotherapy groups, the latter tended to have larger tumours (median size 28mm and 40 mm respectively) and an excess of more deeply invading tumours (1 and 5 patients respectively).

DISCUSSION

In this study of 83 patients with cutaneous LMS, the majority were found to be small and arising from the dermis and overall had an excellent prognosis. Subcutaneous LMS were larger and appeared to have a higher rate of local recurrence and metastasis, with lower 5 year overall survivals. Despite the rarity of this tumour, this is one of the largest studies reported to date, with our data largely in keeping with previous studies (Table 2).

As noted previously, dermal LMS rarely metastasise and there has been debate within the literature as to whether purely dermal LMS has metastatic potential. The majority of studies found that LMS confined to the dermis have no metastatic potential.[3,7,9,12,14,16,17,21] In fact a number of studies suggest designating purely dermal smooth muscle tumours with mitotic activity and cytological atypia as 'atypical smooth muscle tumours' as this would avoid the unnecessary and worrisome label of malignancy for purely dermal lesions, reserving the term cutaneous LMS for dermal lesions with extension into the subcutis or LMS predominately occurring in the subcutis.[3,11,14,21] Our data support this hypothesis, with none of the 32 purely dermal LMS metastasising. In contrast only two studies report purely dermal LMS metastasising. Winchester et al report 4 out of 48 purely dermal LMS metastasising, with these treated initially with narrow margins [10] whilst Fauth et al describe 2 out of 14 cases of LMS confined to the dermis metastasising.[15] The current study is noteworthy in that all patients had their pathology reviewed prior to definitive treatment by a senior pathologist with extensive experience in soft tissue tumours.

Some concern must be raised about the modest proportion of patients (19%) who had shave or punch biopsies as they may provide inadequate material for complete assessment. Shave biopsies in particular may transect the base of the lesion and can lead to misdiagnosis and inappropriate initial management, as low-grade features may be found in the superficial component of the tumour with higher-grade findings in the deeper component.[15] In our study, pathological appearance, mitotic

rate, immunohistochemistry with α-sma, desmin, h-caldesmon was of no value in differentiating between dermal and subcutaneous LMS. This is similar to other studies, where the majority of both dermal and subcutaneous LMS were positive for α-sma, and no difference in expression of desmin and h-caldsemon between dermal and subcutaneous LMS was noted.[7,14,15]

There is little mention in the literature regarding the utility and relevance of pre-operative staging or imaging. One of the few series to touch upon this topic, Deneve et al concluded that preoperative staging with cross-sectional imaging (CT of the thorax, PET imaging, or both) appeared to add minimal clinical impact; more than half of the patients in that series underwent imaging with all imaging results being negative.[12] In our study, 2 patients with subcutaneous LMS had metastatic disease on presentation that was picked up on pre-operative CT and PET imaging. Based on these findings, it would be prudent to recommend that patients with subcutaneous LMS be staged preoperatively with CT chest and upper abdomen, in particular patients with larger lesions.

A number of prognostic factors such as tumour size[7], malignancy grade [15], margin status [10,11,13], tumour depth[7,14,15], mitotic rate[20] have been described. In our study, the median excision margin for both groups was 20 mm and the proportion of patients with margins less than 10 mm was similar (9% and 6%). Some studies have found tumour depth to be a poor prognostic indicator[7,14,15] whilst others were unable to confirm any association – Winchester et al found that dermal LMS had a predictably lower 5-year recurrence rate (18%) than subcutaneous LMS (28%) however this was not statistically significant.[10] Our study found tumour depth to be a statistically significant poor prognostic indicator, with subcutaneous LMS having lower 5 year overall survival (98% for dermal LMS, 88% for subcutaneous LMS, p=0.03) and lower distant disease free survival (100% for dermal LMS, 83% for subcutaneous LMS at 5 years, p=0.001). There was however was no statistically significant difference in risk of local recurrence between dermal and subcutaneous LMS. The data from this study is consistent with other reports that generally radiotherapy is not required for patients with dermal LMS who have undergone an appropriate wide excision. Our unit protocol recommended a minimum 10 mm margin which resulted in a high rate of local control. For patients with subcutaeneous LMS, the local recurrence free survival was 100% and 69% at 5 years for patients not receiving or receiving radiotherapy, but given the small number of patients and a significant selection bias (larger and more extensive tumours in the radiotherapy group), it is not possible to make a definitive recommendation regarding radiotherapy. However, given the experience with other soft tissue sarcomas, complete wide surgical excision in combination with radiotherapy should be considered particularly for large and/or extensive lesions.

Most recurrences are described as developing slowly over a 1 to 5 year period.[3] The general consensus for follow up period is at least 5 years after initial diagnosis of superficial LMS given the relatively long mean period between initial treatment and the development of local recurrences.[3,9,16] As with other soft tissue tumors, the lung was the commonest site of distant metastasis.[7,15,20] Our findings are consistent with the existing literature, with local recurrences mostly occurring within 1 to 3 years, but one recurrence occurring 13 years after initial diagnosis. Based on this data completely excised dermal LMS are followed for at least 3 years and subcutaneous LMS for a minimum of 5 years. For subcutaneous LMS, surveillance imaging with CT chest and primary is recommended 6 monthly for the first 2 years and then annually for 3 years.

The major limitation of this study apart from its retrospective nature is the small number of patients particularly within some of the subgroups. Nevertheless this is one of the largest studies to date and is characterised by a standard management protocol, review of all pathology by an experienced pathologist and close follow-up of patients.

In summary, LMS arising from skin is rare, generally presenting as a slowly growing nodule of variable appearance. It is critical that biopsy techniques allow tumour depth to be determined, as this has implications for accurate diagnosis, appropriate management and prognosis. For dermal LMS, pre-operative imaging and adjuvant therapy is generally not indicated. Dermal LMS should be excised with a margin of 10mm and overall have an excellent prognosis. Subcutaneous LMS on the other hand, tend to be larger and appear to have a higher rate of local recurrence and metastasis, with lower 5 year overall survival, local recurrence free survival and distant disease free survival. Patients with subcutaneous LMS should be strongly considered for preoperative imaging to exclude the presence of metastatic disease. A minimum margin of 10 mm is indicated and wider margins should be considered for larger lesions. The combination of surgery and selective use of radiotherapy confers reasonable rates of local control in patients with cutaneous LMS. Future research could provide greater clarity on the role of radiotherapy and surveillance imaging in cutaneous LMS.

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Figure 1 Dermal and subcutaneous leiomyosarcoma overall survival

Combined dermal and subcutaneous LMS survival was 93% at 5 years and 79% at 10 years. 5 year overall survival for dermal LMS was 98% (95% confidence interval, 95% - 100%) and for subcutaneous LMS was 88% (95% confidence interval, 73% - 100%) (p= 0.034).

Figure 2 Leiomyosarcoma local recurrence

No difference in the risk of local recurrence was apparent, with 5 year survivals OF 85% for dermal LMS and 78% for subcutaneous LMS (p = 0.17)

Figure 3 Leiomyosarcoma distant disease free survival

Distant disease free survival was 100% for dermal LMS and 83% for subcutaneous LMS at 5 years (p = 0.001)

Figure 4 Leiomyosarcoma local recurrence free survival

A) Dermal LMS local recurrence free survival and B) subcutaneous LMS local recurrence free survival, broken down by use of radiotherapy.

There were no statistically significant differences between radiotherapy and no radiotherapy groups with regards to either local recurrence in either tumour type; 93% versus 83% (p = 0.7) for dermal LMS and 69% versus 100% (p = 0.9) for subcutaneous LMS.

Table 1: Patient demographics and primary tumour characteristics			
	Dermal LMS (n=64)	**Subcutaneous LMS (n=19)**	**P value**
Median age, y (IQR)	60 (46-68)	54 (47-61)	0.3
Male: female	46:18	15:4	0.8
Tumour size, median (mm) and IQR	14 (7.5 – 18)	49 (22 – 57)	0.001
Location, no (%)			0.9
Head/neck	34 (53%)	3 (16%)	
Trunk	14 (22%)	4 (21%)	
Extremity	16 (25%)	12 (63%)	
Biopsy			0.3
Excision	53 (84%)	14 (74%)	
Partial (core, needle, incisional)	10 (16%)	5 (26%)	
Desmin immunostaining	8 (30) 27%	0 (11) 0%	0.2
H-caldesmon immunostaining	12 (12) 100%	1 (1) 100%	1
Smooth Muscle Actin immunostaining	48 (50) 96%	17 (17) 100%	1
Pre-operative Imaging (CT or PET)	33 (58) 58%	14 (17) 82%	0.9
Radiotherapy	16 (25%)	13 (68%)	<0.001
Mitoses			0.11
<10 per high power field	44 (77%)	9(56%)	
≥ 10 per high power field	13 (23%)	7(44%)	

Margin (mm) median and interquartile range)	20 (10-20)	20(20-25)	0.1
<10 mm	5 (9%)	1 (7%)	
≥10mm	50 (91%)	14 (93%)	

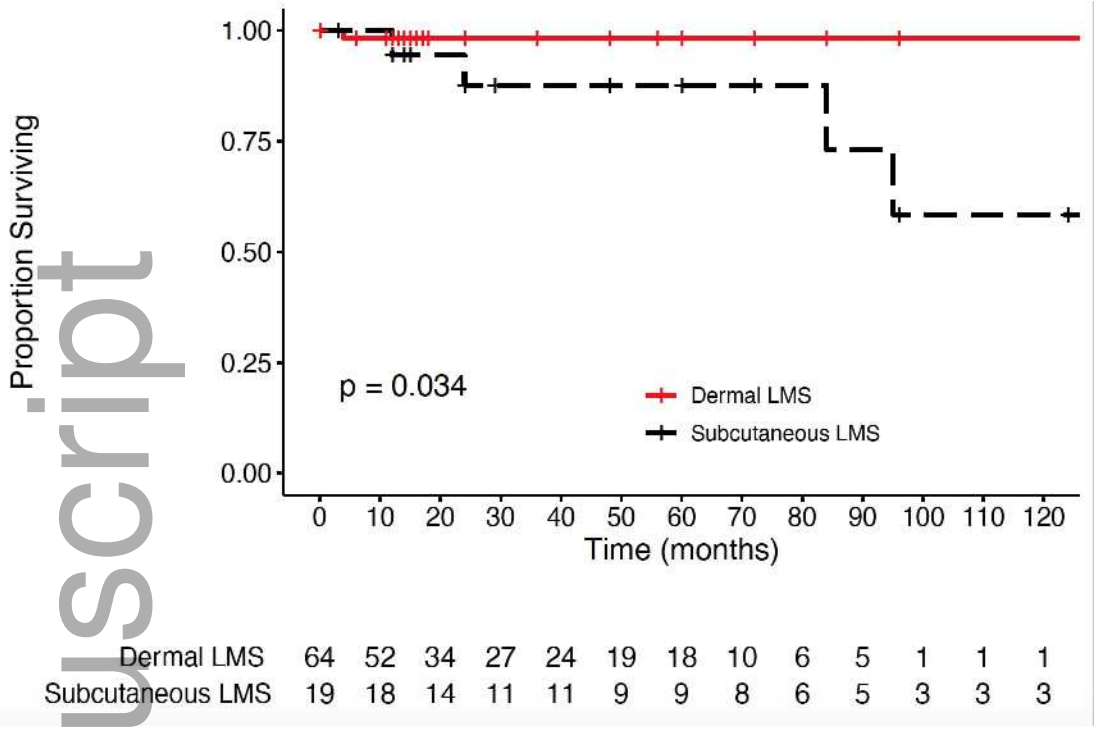
IQR, interquartile range

Table 2: Studies on dermal and subcutaneous leiomyosarcoma to date (with at least 10 cases)

Author	Year	No. cases	Type of LMS	Margins	Radiotherapy	Recurrences	Metastases	Mortality	Follow up duration
This study	2018	83	D 64 SQ 13	≥10mm n=64	35%	9.3% 23.1%	0.0% 30.8%	3.1% 30.8%	Median 2 y
Liao et al [9]	2017	16	D 16	2-5cm n=16	31%	19%	0.0%	0.0%	Median 13.7y
Winchester et al [10]	2014	71	D 48 SQ 23	<10mm n=10, ≥10mm n=21	8.5%	18% 28%	12% 51%	6.0% 40.0%	Mean 8.0 y
Hall et al [11]	2013	20	D 20	Clear margins n=16	15%	10.52%	0.0%	0.0%	Mean 2.91 y
Deneve et al [12]	2013	33	D 33	10mm n=22	15%	0%	0.0%	0.0%	Mean 1.29 y
Kraft and Fletcher [13]	2011	84	D 84	Clear margins n = 27	NR	35%	0.0%	0.0%	52 cases, mean 4.25 y
Massi et al [14]	2010	36	D 36 (21 pure D, 15 D with SQ extension)	NR	NR	11.1% (2/4 cases were excised with narrow margins only)	2.7% (D with SQ extension)	0.0%	Mean 3.41 y
Fauth et al [15]	2010	25	D 14 SQ 11	2cm n=18, Mohs n=5	20%	21.4% 18.2% (only 2/5 cases had adequate resection margins)	14.3% 27.3%	7.1% 9.1%	NR
Pijpe et al [16]	2002	14	D10 SQ 4	NR	NR	14.3% 0%	0% 75%	0.0% 0.0%	Median 2.17 y
Kaddu et al	1997	19	D 19	NR	NR	26.31%	0.0%	0.0%	Mean

[17]									4 y
Jensen et al [7]	1996	41	D 7 SQ 34	NR	12%	0% NR	0.0% 41.2%	0.0% 41.2%	Mean 5y
Bernstein and Roenigk [18]	1996	34	D 21 SQ 13	3-5cm n=23, Mohs n=2	5.8%	14.3% 46%	4.8% (dermal with SQ extension) 62%	0.0% 38.5%	Median 8 y
Hashimoto et al [19]	1986	11	D 3 SQ 8	Simple excision n=25, WLE n=2	NR	66.7% 44.4%	NR NR	0.0% 0.0%	12.4y 9.25y
Fields and Helwig [3]	1981	80	D 65 SQ 15	NR	3.75%	42% 50%	0.0% 33.0%	0.0% 25%	3.75y
Dahl and Angervall [2]	1974	27	D 17 SQ 20	NR	NR	52.9% 30.0%	11.8% 40.0%	23.5% 70.0%	Median 6 y
Stout and Hill [20]	1958	36	SQ 36	NR	NR	60.6%	50%	30.6	< 5 y

D, dermal; SQ, subcutaneous; NR, not recorded; N/A, not applicable; y, year



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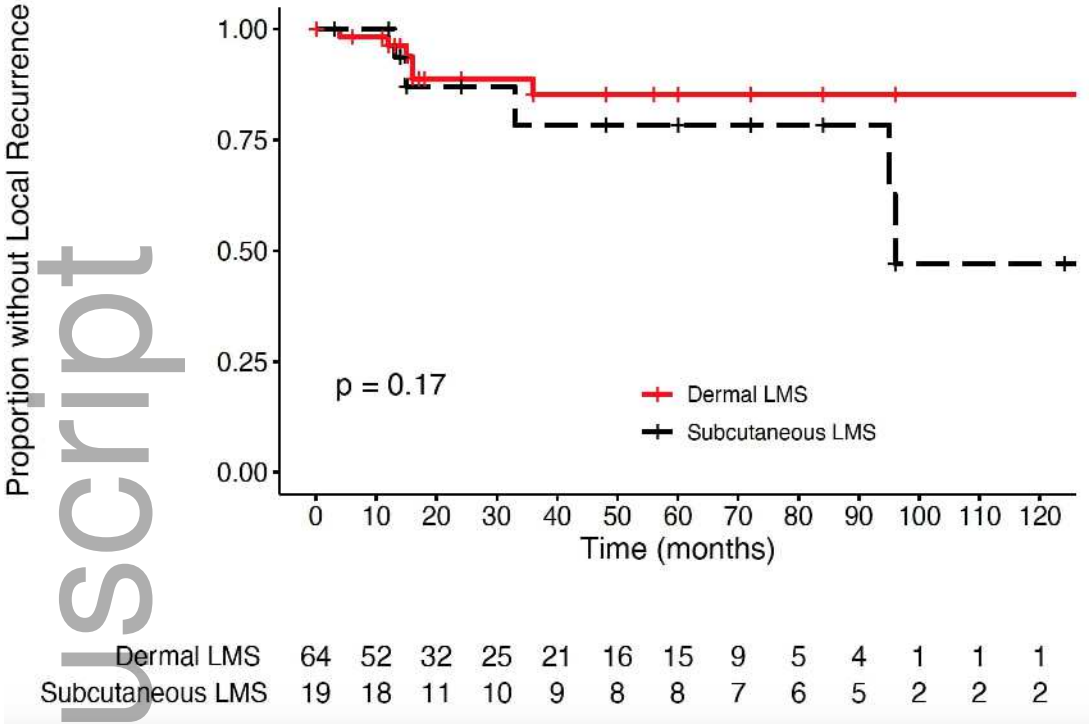

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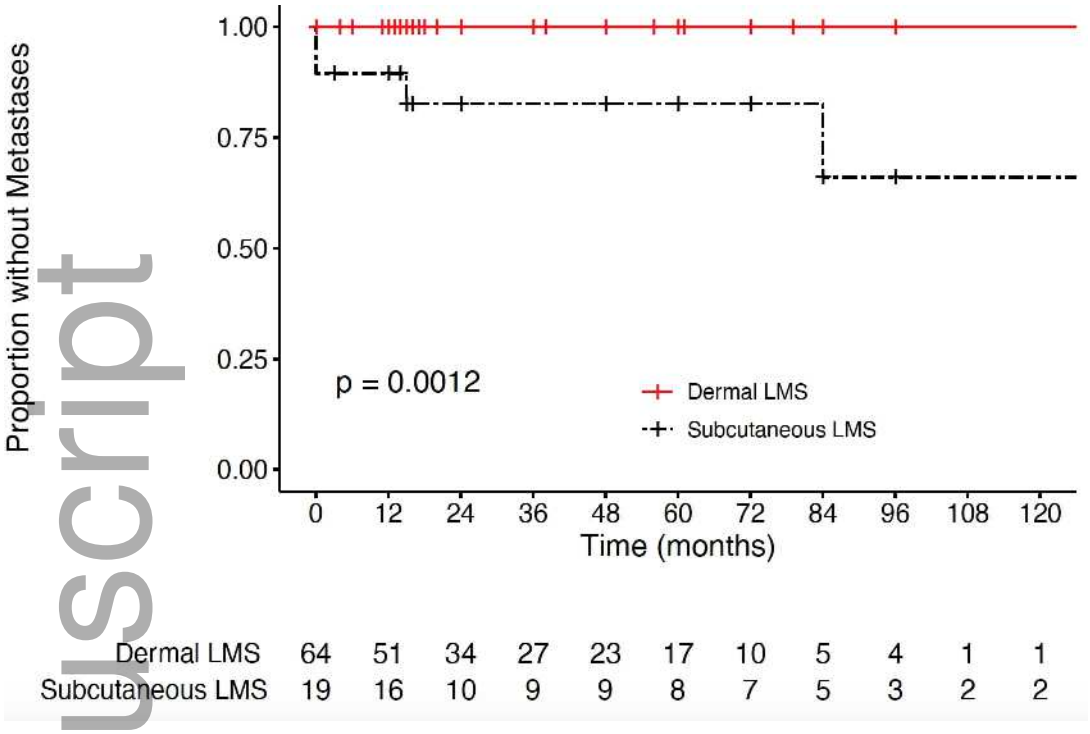

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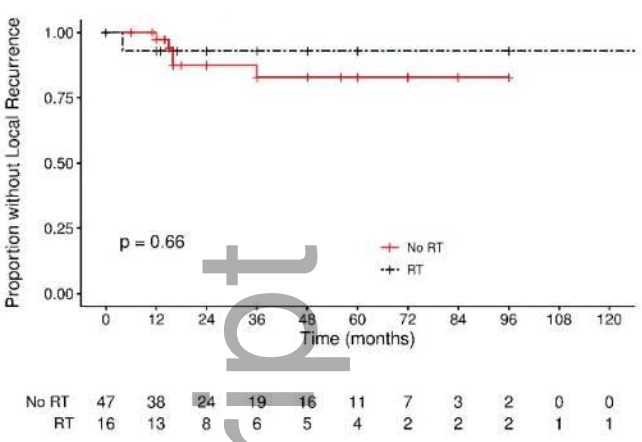

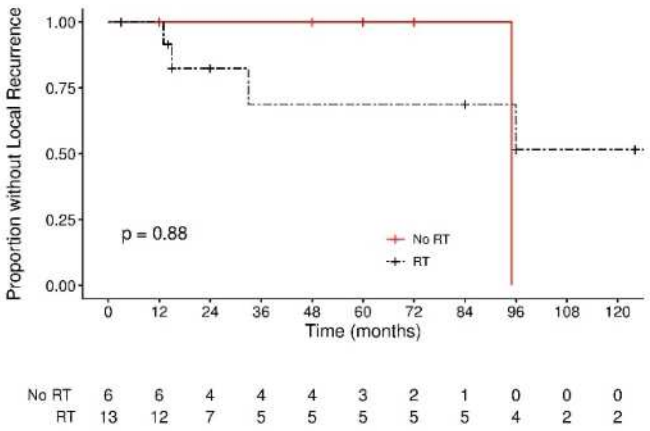

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