

Centralization of Sarcoma Care Improves Outcomes Despite Poorer Presentation: A Systematic Review and Meta-Analysis

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INTRODUCTION: Soft tissue sarcoma (STS) and bone sarcoma (BS) are rare, highly heterogeneous groups of malignant tumors of mesenchymal origin. They often present as high-grade tumors and are therefore associated with poorer outcomes. With the recent development of new treatment modalities that emphasize a multidisciplinary approach to sarcoma treatment, centralization of treatment at high-volume centers (HVC) has been suggested to offer advantages over low-volume centers (LVC). The purpose of this systematic review was to report on the differences in tumor presentation, treatment offered, and treatment outcomes of primary BS and STS patients treated at HVC and LVC. Classification criteria of HVC and LVC utilized in the included studies were also reported in an effort to move towards standardizing the definitions of HVC and LVC.

METHODS: The PubMed and Embase databases were queried to conduct a systematic review of articles from inception to October 2024. A total of 16 studies were included: 12 STS, 4 BS. Study characteristics, HVC/LVC definition, tumor histology, primary anatomic location, tumor presentation (size, grade), treatment (surgery, amputation, chemotherapy, radiotherapy), margin status, and survival outcomes (5-year overall survival, Kaplan-Meier hazard ratio) were analyzed. A subsequent meta-analysis was conducted to compare survival outcomes between HVC and LVC using reported Kaplan-Meier hazard ratios.

RESULTS: There was substantial heterogeneity in the definition of HVC and LVC applied in the included studies, generally left to the author's discretion (Table 1). Presenting tumor histology and primary anatomic location were comparable between HVC and LVC. Analysis of tumor grade and size demonstrated substantially higher grade and larger size tumor in patients presenting at HVC, mostly without statistical significance (Table 2). HVC were significantly more likely to offer radiotherapy and chemotherapy and achieve negative margins at surgery (Table 2). Despite presenting with poorer prognosis, patients treated at HVC demonstrated significantly superior survivorship than patients treated at LVC (Table 3).

DISCUSSION AND CONCLUSION: Both BS and STS patients at HVC displayed poorer presentation than patients at LVC. However, treatment at HVC still resulted in superior outcomes compared to treatment at LVC, highlighting the importance and efficacy of centralization of sarcoma care. In addition, our study identified a substantial heterogeneity in definitions of HVC and LVC in the literature. This variability underscores the need for standardized definitions to promote equitable access to care and enable informed healthcare policy and resource allocation.

Table 1. Study characteristics and HVC/LVC classification

Author (Year)	PMID	Country of Study	Origin of Sarcoma	Sarcoma Case Volumes	
				High Volume Center (≥ cases per year)	Low Volume Center (< cases per year)
Abarca (2018)	29633281	USA	Soft tissue	10	10
Bagaria (2018)	2989479	USA	Soft tissue	11	4
Biongo (2021)	36260345	Italy	Soft tissue	3.33*	0.83*
Gutierrez (2007)	17522521	USA	Soft tissue	5	5
Lazarides (2019)	30485258	USA	Soft tissue	20	20
Lin (2020)	32881378	USA	Soft tissue	75 th percentile	25 th percentile
Sampo (2012)	22229745	Finland	Soft tissue	> 17	≤ 2
Song (2019)	31196484	USA	Soft tissue	> 90 th percentile	≤ 90 th percentile
Venigalla (2018)	29485042	USA	Soft tissue	8	8
Vidri (2021)	33891137	USA	Soft tissue	> 12	3
Vos (2019)	30770758	Netherlands	Soft tissue	20	≤ 9
Yeo (2023)	37296824	Canada	Soft tissue	20	20
Fujiwara (2022)	35730765	USA	Bone	20	≤ 5
Lazarides (2020)	32145357	USA	Bone	5	5
Malik (2020)	31744413	USA	Bone	20	20
Ogura (2024)	38854229	Japan	Bone	39.75*	12.25*

* Indicates values calculated by dividing total patients during study period over number of years

* Annual case volume includes patients with soft tissue and bone sarcoma.

Table 2. Sarcoma treatment presentation and modality

Author (Year)	Origin of Sarcoma	HVC/LVC	Tumor Size		Tumor Grade			Radiotherapy Offered (%)	Chemotherapy Offered (%)	Positive Surgical Margin (%)
			<5cm (n)	>5cm (n)	Grad e1 (%)	Grad e2 (%)	Grad e3 (%)			
Abarca (2018)	Soft tissue	HVC	-	-	-	-	-	55	22	12
		LVC	-	-	-	-	-	52	17*	17*
Bagaria (2018)	Soft tissue	HVC	33.5	66.5	21.5	12	26.5	21.4	41.9	19.7
		LVC	46.1	53.9	21	11.9	21.1	11.5	30.6*	10.3*
Biongo (2021)	Soft tissue	HVC	39.7	59.6	-	-	-	91.7	86.8	38.9
		LVC	40.3	58.6	-	-	-	89.7	75.8	51.9
Gutierrez (2007)	Soft tissue	HVC	-	-	46.2	53.8	43	14.7	-	-
		LVC	-	-	55.7*	44.3*	24.2*	6.3*	-	-
Lazarides (2019)	Soft tissue	HVC	76	16	18	14	74	79	40	10
		LVC	28	56	21	14	27	14	49	17
Sampo (2012)	Soft tissue	HVC	-	-	78.4	21.6	75.2	16.3	-	-
		LVC	-	-	66.7	33.3	31.6*	4.5*	-	-
Song (2019)	Soft tissue	HVC	-	-	-	-	40.1	57.8	-	-
		LVC	-	-	-	-	24.4*	39*	-	-
Venigalla (2018)	Soft tissue	HVC	26	70	10	12	68	-	23	14
		LVC	33	62	13	14	54	-	13*	22*
Vos (2019)	Soft tissue	HVC	30	70	27	73	45.7	9	19	-
		LVC	54	46	44	56	22.5	2.1	14*	-
Yeo (2023)	Soft tissue	HVC	-	-	-	-	-	88	-	-
		LVC	-	-	-	-	-	67*	-	-
Lazarides (2020)	Bone	HVC	-	45	-	-	-	48	15	32
		LVC	-	52	-	-	-	42	16	39
Malik (2020)	Bone	HVC	-	13	13	24	26	13	57	4
		LVC	-	14	12	24	17	17	57	8

* Indicates statistically significant difference compared to its HVC/LVC counterpart.

Table 3. Sarcoma treatment outcomes

Author (Year)	Origin of Sarcoma	HVC/LVC	5-year OS (%)	Kaplan-Meier Hazard Ratio for Survival
Abarca (2018)	Soft tissue	HVC	72.7	Reference
		LVC	68.1*	1.24*
Bagaria (2018)	Soft tissue	HVC	71.5	0.92
		LVC	68.5*	Reference
Gutierrez (2007)	Soft tissue	HVC	37.4	-
		LVC	33.2*	-
Lazarides (2019)	Soft tissue	HVC	-	0.79*
		LVC	-	Reference
Lin (2020)	Soft tissue	HVC	79.4	-
		LVC	60*	-
Sampo (2012)	Soft tissue	HVC	71	-
		LVC	66	-
Song (2019)	Soft tissue	HVC	-	0.92*
		LVC	-	Reference
Venigalla (2018)	Soft tissue	HVC	72.2	0.81*
		LVC	57.1*	Reference
Vidri (2021)	Soft tissue	HVC	-	0.65*
		LVC	-	Reference
Vos (2019)	Soft tissue	HVC	-	Reference
		LVC	-	1.01
Fujiwara (2022)	Bone	HVC	-	0.72*
		LVC	-	Reference
Lazarides (2020)	Bone	HVC	71	0.75*
		LVC	58*	Reference
Malik (2020)	Bone	HVC	65	0.85*
		LVC	61*	Reference
Ogura (2024)	Bone	HVC	-	Reference
		LVC	-	1.3*

* Indicates statistically significant difference compared to its HVC/LVC counterpart.