

A Systematic Review of Functional Outcomes after Nerve Reconstruction in Extremity Soft Tissue Sarcomas: a Need for General Implementation

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Background

Resection of nerves in extremity soft tissue sarcomas (STS) can lead to large functional deficits. Nerve reconstructions are rarely performed and little is known on their outcomes and indications for their use even though they are essential in restoring sensation in limb salvage procedures (LSS). This study investigated current knowledge on functional outcomes and considerations to be taken before performing such reconstructions after sarcoma resection.

Methods

A systematic search was performed in July 2018 in PubMed and Embase databases according to PRISMA guidelines. Search terms related to 'soft tissue sarcoma' and 'nerve reconstruction' were used. Studies evaluating functional outcomes after nerve grafting or nerve transfers in extremity soft tissue sarcomas were included. Qualitative synthesis was performed on all studies.

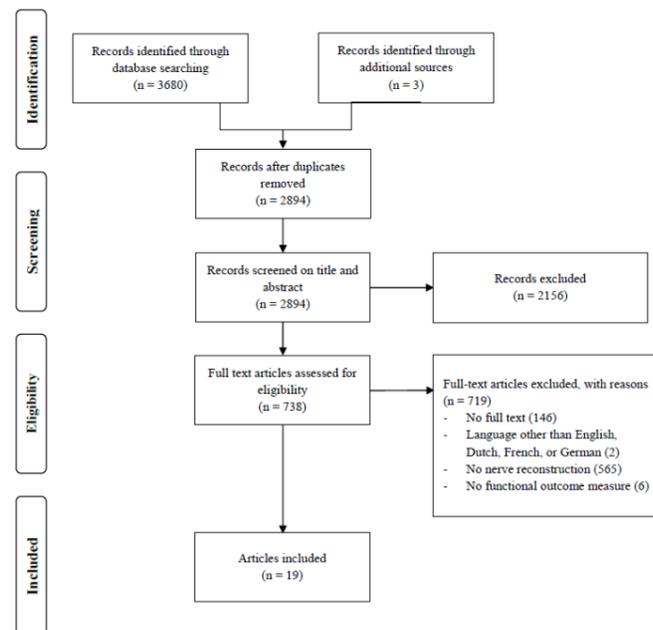


Fig. 1 Flowchart depicting study selection

Results

Nineteen studies were included after full-text screening, describing 26 patients (Fig. 1). The majority of patients had a nerve reconstruction in the upper extremity (65% Table 1 and 2). Perioperative radiotherapy was administered in 67% of patients and perioperative chemotherapy in 29%. Nerve grafting was most commonly performed (n=23) and nerve transfers were performed in six patients. A wide variety of outcome measures were used. Most patients recovered at least some motor function and sensation, but success rates were higher after upper than lower extremity defects. Multimodal treatment did not preclude successful reconstructions.

Conclusion

Nerve reconstructions in extremity STS have rarely been described, yet may yield good results in LSS. Restoration of sensation in LSS is possible when performing nerve reconstruction and best results are seen after upper extremity defects. Reconstruction of motor nerves can also restore satisfactory motor function without the use of free functioning muscle flaps. The use of multimodal therapy does not seem to preclude failure. Therefore nerve reconstructions should be considered as part of a reconstructive surgeon's armamentarium after STS resection.

Abbreviations in tables

aCTx = adjuvant chemotherapy; ADUT = anterior division of upper trunk; ALT = anterolateral thigh flap; AN = axillary nerve; aRTx = adjuvant radiotherapy; BRt = brachiotherapy; CFF = chinese forearm flap; DASH = disabilities of arm, shoulder and hand (score); D = digit; FRFF = free radial forearm flap; FU = follow-up; GF = gracilis flap; IN = intercostal nerve; kg = kilogram; LABCN = lateral antebrachial cutaneous nerve; LD = latissimus dorsi flap; MABCN = medial antebrachial cutaneous nerve; M = Medical Research Council muscle grade; MCN = musculocutaneous nerve; MN = median nerve; MPNST = malignant peripheral nerve sheath tumour; MSTS = musculoskeletal tumor society score; NA = not available; nCTx = neoadjuvant chemotherapy; nRTx = neoadjuvant radiotherapy; ON = obturator nerve; PBMN = palmar cutaneous branch of median nerve; RAF = rectus abdominis flap; RDN = radial digital nerve; RN = radial nerve; ROM = range of motion; RRF = reverse radial forearm flap; RSN = radial sensory nerve; S = sensation; SAN = spinal accessory nerve; SCN = sciatic nerve; SN = sural nerve; SSN = suprascapular nerve; STSG = split-thickness skin graft; TN = tibial nerve; UAD = use of ambulatory devices; UDN = ulnar digital nerve; UN = ulnar nerve

Table 1 Functional outcomes upper extremity reconstructions

Study, year	Reconstruction	Histology type	Functional outcome					Adjuvant therapy & FU (months)	
			Objective measures			Subjective measures			
Brachial plexus									
Strength									
ROM									
Sensation									
MSTS									
DASH									
VAS									
Spiliopoulos et al, 2011	C5 to ADUT with SN grafts + SAN transfer to SSN + triceps branch transfer to AN	MPNST	Shoulder abduction: M4 Elbow flexion: M5 Elbow extension: M5	40° abduction	C5 & C6: S2			nRTx; 20	
Tan et al, 2003	GF + C5 & C7 to RN with UN graft + C5 to MN with SN graft + DN to MCN	Fibrosarcoma	Paralysis					aCTx; 144	
Median nerve									
Fujii et al, 2009	Tendon transfers + RSN transfer to MN	Epithelioid sarcoma	50% grasp power of contralateral hand		50% of contralateral hand		22.5	aCTx & aRTx; 42	
Koshima et al, 2003	ALT + FN graft for MN + UN graft to forearm flexors	Rhabdomyosarcoma			MN: S3+			NA; 30	
Koulaxouzidis et al, 2016	MN to ON branch of GF + tendon transfer + SN grafts for sensation	Epithelioid sarcoma		Full finger flexion	MN: Protective			nRTx; 60	
Rinehart et al, 1989	RAF + SN graft for MN	Synovial sarcoma		Full finger flexion/extension	D1-3: S3+ D4-5: S4 and S3+			NA; 8	
Radial nerve									
Cugola et al, 1985	SN graft for RN	Synovial sarcoma	Wrist extension: M4 Finger extension: M4		RN: S3			None; 8	
Lohman et al, 1998	RRF + tendon grafts + LABCN to split RSN	Malignant fibrous histiocytoma	8.6 kg (wrist); 3.3 kg (key); 2.9 kg (D1-np)	Wrist flexion: 50° Wrist extension: 30°	Flap: S3+	Excellent		nRTx; 8	
Mehanna et al, 2008	RRF + LABCN graft for RSN	Epithelioid sarcoma				97%		BRT; mean 47	
Ulnar nerve									
Nicoli et al, 2015	Compound LD and groin flap + SN graft for UN	High-grade liposarcoma	Elbow extension: M4 Wrist flexion: M3 Finger flexion: M3		UN: S3			aRTx; 12	
Digital nerve(s)									
Anyeh et al, 1996	FRFF + LABCN transfer to UDN D1	Fibrosarcoma		Thumb full ROM	Protective			aRTx; 12	
Boorman et al, 1987	CFF + LABCN graft for D1	Myxoid liposarcoma			UDN: S4 RDN: S0			NA; 9	
Mehanna et al, 2008	RRF + tendon transfers + LABCN grafts for digital nerves	Epithelioid sarcoma				100%		None; mean 47	
Mehanna et al, 2008	RRF + SN graft for D1-2	Myofibroblastic tumor				97%		None; mean 47	
Mirous et al, 2016	2-stage Hunter + SN grafts for D1-2 + RDN D3-4	MPNST				53%	43	0	aRTx; 66
Mirous et al, 2016	2-stage Hunter + SN grafts for D1-2 + RDN D3	Synovial sarcoma				80%	21	0	aCTx & aRTx; 132
Seal et al, 2005	FRFF + LABCN to PBMN + SN graft for D3-5, silicon rods D4-5	Epithelioid sarcoma		D4&D5: 90-30-30°	D3-5 & flap: S3-S4				nRTx; 16

Table 2 Functional outcomes upper lower extremity reconstructions

Study, year	Reconstruction	Histology type	Functional outcome					Adjuvant therapy & FU (months)	
			Objective measures			Subjective measures			
Strength									
ROM									
UAD									
Sensation									
MSTS									
Sciatic nerve									
Lee et al, 1993	SN & superficial PN grafts for SCN	High-grade spindle cell sarcoma	Dorsiflexion: M3			Positive Tinell's sign 18cm below nerve repair site		nRTx & aRTx; 12	
Melendez et al, 2001	SN & PN grafts for SCN	Spindle cell sarcoma	Dorsiflexion: M0		Ankle device	Slight protective (dorsal surface)		nRTx; 4,5	
Melendez et al, 2001	PN grafts for SCN	Spindle cell sarcoma	Dorsiflexion/plantar flexion: M3/M4		Ankle device	Slight protective (dorsal surface)		nCTx & aRTx; 12	
Melendez et al, 2001	PN grafts for SCN	Spindle cell histiocytoma	Dorsiflexion/plantar flexion: M3/M3		Ankle device	Slight protective (dorsal & plantar surfaces)		nRTx & aCTx; 12	
Melendez et al, 2001	SN & PN grafts for SCN	Fibromyxoid sarcoma	Knee flexion/extension: M3/M5 Dorsiflexion/plantar flexion: M0/M1 Eversion/inversion: M0/M0 Toe flexion/extension: M0/M0		None	Protective (dorsal and lateral plantar surfaces)		nRTx; mean 24	
Melendez et al, 2001	SN & PN grafts for SCN	Unclassified sarcoma	Knee flexion/extension: M5/M5 Dorsiflexion/plantar flexion: M0/M0 Eversion/inversion: M0/M0 Toe flexion/extension: M0/M0		Ankle device	Protective (mediodorsal surface)		nRTx & aCTx; 8	
Tokumoto et al, 2018	SN grafts for SCN	MPNST	Knee flexion/extension: M4/M4 Dorsiflexion/plantar flexion: M1/M1			Slight protective (plantar surface of foot)		NA; 24	
Peroneal nerve									
Deune et al, 2001	GF + anterior branch ON graft for deep PN	Sarcoma, indeterminate type	Full weight-bearing		Full (ankle & great toe extension)	None	Protective (1" web space)		NA; 7
Tibial nerve									
Nishio et al, 2012	ALT & fascia lata + SN graft for TN	Myxoid liposarcoma					97%	None; 84	