Surgical treatment of chronic hand ischemia: a systematic review and case series

David L. Colen, MD[1], Thibaudeau Stephanie, MD[2], Oded Ben-Amotz, MD[3], Martin Carney, BA[3], Patrick A. Gerety, MD[4] and L. Scott Levin, MD[3],

1. Plastic and Reconstructive Surgery, University of Pennsylvania, Philadelphia, PA; 2. McGill University, Montreal, QC, Canada; 3. University of Pennsylvania, Philadelphia, PA; 4. Division of Plastic Surgery, Indiana University School of Medicine, Indianapolis, IN

Background:

Chronic ischemia of the hand is a challenging problem that can cause cold intolerance, pain at rest, ulceration, and tissue necrosis. The hand is perfused by the most diminutive branches of an intricately arborized circulatory system and is thus sensitive to any physical or physiologic impediment to distal circulation. Chronic hand ischemia of nontraumatic origin is commonly the result of either peripheral vascular disease (PVD) or a variety of autoimmune disorders and vasculitides associated with digital vasospasm, also known as Raynaud phenomenon, and can significantly contribute to patient disability.

When conservative measures fail to improve symptoms of chronic hand ischemia, surgical revascularization is the last line of treatment. Operative treatment aims to improve circulation by either removing sympathetic tone with a periarterial sympathectomy or to circumvent occluded arterial inflow with arterial bypass or venous arterialization

Purpose:

Due to the diverse pathology that can lead to hand ischemia, patients may initially present a surgeon, or to a medical provider such as an internist or rheumatologist, who may be unfamiliar with the surgical options and associated outcomes. The purpose of this study is to systematically review published surgical outcomes for chronic hand ischemia as well as present our experience with each surgical technique.

Methods:

Systematic Review:

A systematic review of the literature regarding surgical treatment of chronic ischemia of the hand was done according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement (PRISMA).[41] PubMed/MEDLINE databases were searched thoroughly using the phrases “chronic ischemia,” “hand sympathectomy,” “bypass hand ischemia,” and “venous arterialization.”

Studies were included if they were published between 1990 and 2016 and if they reported clinical outcomes of human subjects with chronic hand ischemia of non-traumatic etiology (ie these studies must identify an autoimmune or peripheral vascular disease etiology). Only sympathectomy studies that included surgical sympathectomies of the distal forearm and hand were included, whereas more proximal sympathectomies or chemical sympathectomies were excluded. Articles that referred to arterial bypass proximal to the brachial artery were also excluded. Identified studies were categorized and evaluated initially by title and abstract prior to full article review and cross referencing.

Articles were reviewed and data were extracted including study design, description of subjects, total number of hands operated upon, number of digits affected, length of follow up, and complications. Primary outcomes were the resolution of ischemic symptoms including pain and/or temperature intolerance and healing or development of digital ulcerations.

Case Series:

A retrospective review was when completed of all patients treated for chronic hand ischemia by the senior author. Charts were reviewed for operative technique, postoperative course and follow up. Primary outcomes included improvement in pain, wound healing, and development of new ulcerations.

Results:

Systematic Review:

Thirty-eight studies that met inclusion criteria were identified and systematically reviewed showing that surgical sympathectomy, arterial bypass, and venous arterialization were all effective in treating chronic ischemia of the hand. (Figure 1, Tables 1,2, 3) Arterialization was both associated with the most consistent improvement in pain (100%) compared to bypass (%) and sympathectomy (94%), (Table 4) whereas arterial bypass had the highest rate of postoperative healing of wounds (89%) (sympathectomy = 85%; arterialization 75%). (Table 4) Sympathectomy was associated with the lowest rate of developing postoperative ulcerations (0.8%; bypass = 8%; arterialization = 8%).

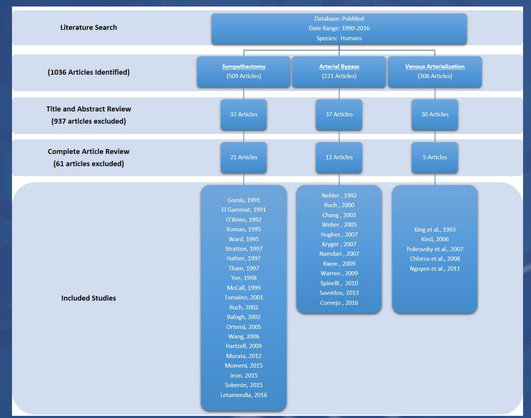

Table 1: Sympathectomy study characteristics

Reference	Study Design	Patients / No. of Male Patients	Autoimmune Patients	Mean Age, yr (range)	Extent of Sympathectomy	No. of Hands	No. of Digits	Mean Follow up, mo. (range)	MINORS criteria (%)
Gomis et al., 1991	Retrospective chart review	6/4	6	NR (NR)	CD, PD	NR	NR	60 (60)	50
el-Gammal and Blair	Case report	2/0	2	39 (37-42)	Wrist, CD, PD	3	10	15 (14-16)	56
O'Brien et al., 1992	Prospective	13/5	13	54 (22-78)	Wrist, arch, CD, PD	17	NR	NR (12-60)	81
Koman et al., 1995	Cross-sectional	6/0	6	40 (32-43)	Wrist, CD, PD	7	7	6 (6)	67
Ward and Van Moore, 1995	Prospective	7/NR	7	42 (27-61)	Arch, CD, PD	9	9	46 (26-64)	69
Hafner et al., 1997	Case report	2/0	2	80 (77, 82)	NR	4	NR	24 (24)	63
Stratton et al., 1997	Retrospective chart review	13/NR	13	NR (NR)	NR	NR	NR	19 (NR)	88
Tham and Grossman, 1997	Retrospective chart review	6/0	6	40 (28-60)	CD, PD	8	17	25 (12-36)	81
Yee, 1998	Retrospective chart review	9/0	9	40 (20-53)	Arch, CD	10	13	28 (10-47)	75
McCall et al., 1999	Retrospective chart review	7/2	5	52 (38-71)	CD	7	23	34 (1-76)	75
Tomaino et al., 2001	Retrospective chart review	6/1	6	45 (31-57)	Wrist, arch, CD, PD	8	20	30 (18-40)	88
Ruch et al., 2002	Cross-sectional	22/4	22	41 (20-59)	Wrist, arch, CD	29	NR	66 (11-108)	71
Balogh et al., 2002	Retrospective chart review	5/1	5	57 (35-70)	Wrist	8	NR	18 (18)	75
Ortensi et al., 2005	Retrospective chart review	22/5	22	37 (19-61)	CD, PD	33	106	60 (60)	75
Wang et al., 2006	Retrospective chart review	6/4	6	50 (30-68)	CD, PD	6	14	63 (5-120)	50
Hartzell et al., 2009	Retrospective chart review	28/9	20	50 (24-79)	Wrist, arch, CD, PD	33	59	96 (23-139)	71
Murata et al., 2012	Retrospective chart review	4/3	4	54 (43-61)	Wrist, CD	7	26	144 (123-157)	75
Momeni et al., 2015	Retrospective chart review	17/2	17	49.8 (33-68)	Wrist, arch, CD	26	NR	13.3 (1-54)	69
Jeon et al. 2015	Retrospective chart review	40/17	NR	53.1 (27-74)	Wrist, arch, CD	NR	NR	NR	59
Soberón et al., 2015	Case report	2/0	2	52 (41-63)	NR	3	7	36 (NR)	50
Letamendia et al., 2016	Prospective study	60/60	NR	53.2 (16-37)	PD	NR	114	24 (18-61)	81

MINORS, Methodological Index for Non-Randomized Studies; CD, common digital artery; NR, not reported, PD, proper digital artery; Arch, palmar arch.

Table 2: Bypass study characteristics

Reference	Study Design	No. of Patients/Male Patients	Mean age, yr (range)	Graft Source	Proximal Anastomosis	Distal Anastomosis	No. of Hands	No. of Digits	Mean Follow-Up mo. (range)	Minors Criteria (%)
Nehler et al., 1992	Retrospective chart review	5/3	45 (30-68)	BV,SV	End-to-side (BA, 1; RA, 3; BA, 2)	End-to-side (RA, 4; 6 UA, 2)	6	13	12 (1-16)	63
Ruch et al., 2000	Retrospective chart review	12/5	46 (18-61)	CV, SV	End-to-side (RA, 12)	End-to-end (DPA, 12)	12	25	24 (3-55)	75
Chang et al., 2003	Retrospective chart review	15/9	52 (32–74)	SV, upper arm V	NR (BA)	NR (RA, 15; UA, 3)	18	NR	18 (30-40)	69
Weber et al., 2005	Case report	10/7	55 (42–66)	CV, SV	End-to-side (BA, 2; RA, 5; UA, 3)	End-to-side (arch, 8; ulnar, 1; UA, 1)	10	NR	10 (3-36)	69
Hughes et al., 2007	Retrospective chart review	6/3	NR (NR)	CV, PTFE, SV	NR (BA, 5; UA, 1)	NR (BA, 1; RA, 3; UA, 2)	6	NR	12 (NR)	69
Krueger et al., 2007	Case report	6/2	NR (NR)	CV, SV, SV plus TDV	End-to-side (RA, 6)	End-to-end (CD, 6)	6	NR	NR (4-40)	63
Namdari et al., 2007	Case report	2/1	54 (46-61)	BV, SV	End-to-side (RA, 1; UA, 1)	End-to-side (arch, 2)	2	5	6 (5-6)	56
Kwon et al., 2009	Case report	1/1	49 (49)	SV	End-to-side (UA, 1)	End-to-side (arch)	1	1	26 (26)	56
Warren et al., 2009	Retrospective chart review	3/2	51 (49-53)	PTFE, SV	NR (BA, 3)	NR (BA, 1; RA, 1; UA, 1)	3	NR	19 (5-43)	63
Spinelli et al., 2010	Retrospective chart review	14/7	NR (NR)	BV, BMV, CV, SV	NR (BA, 12; RA, 2)	NR (arch, 3; RA, 8; UA, 3)	14	NR	28 (1-120)	81
Savvidou and Fau, 2013	Retrospective chart review	22/16	44 (16-63)	NR	NR (NR)	NR (NR)	NR	53	96 (12-180)	81
Cornejo et al., 2016	Retrospective chart review	23/18	61 (NR)	CV, BV	End-to-side (BA, 20; RA, 3; UA, 2)	End-to-end (RA, 22; UA, 3)	25	NR	12.1 (0.3-50.6)	63

MINORS, Methodological Index for Non-Randomized Studies; arch, palmar arch; BA, brachial artery; BAV, bovine anastomotic vein; CD, common digital artery; CV, cephalic vein; NR, not reported; PTFE, polytetrafluoroethylene graft; RA, radial artery; ssaft, anatomical snuffbox; TV, saphenous vein; TDV, thoracodorsal vein; UA, ulnar artery.

Table 3: Venous Arterialization Study Specifications

Reference	Study Design	No. of Patients / Male Patients	Mean Age, yr (range)	Valvulotomy Performed	Proximal Anastomosis	No. of Hands	Mean Follow-Up, mo (range)	MINORS criteria (%)
King et al., 1993	Case report	4/2	50 (33-61)	Yes	End-to-side (BA, 2; RA, 3)	5	19 (3–36)	56
Kind, 2006	Case report	2/1	40 (39-41)	Yes	End-to-side (RA, 4)	4	12 (8–16)	44
Pokrovsky et al., 2007	Retrospective chart review	4/4	40 (NR)	Yes	End-to-side (BA, 5)	5	NR (60–96)	63
Chloros et al., 2008	Case report	1/1	62	Yes	End-to-side (RA, 1)	1	84 (84)	63
Nguyen et al., 2011	Case report	2/2	60 (44-76)	Yes	End-to-side (RA, 3)	3	24 (24)	44

MINORS, Methodological Index for Non-Randomized Studies; BA, brachial artery; NR, not reported; RA, radial artery.

Table 4: Reported Pain improvement, Wound Healing, and New Postoperative Ulceration by Treatment Method

	Pain improvement	Wound Healing	New Ulcerations
Sympathectomy			
%	94.4	84.9	0.8
No.	151/160	180/212	2/254
Bypass			
%	93	88.6	8.3
No.	94/101	62/70	10/121
Arterialization			
%	100	75.0	7.6
No.	23/23	3/4	1/15

Case Series:

Chart review identified 16 patients with 19 affected hands (mean follow up = 9.0 months). Eighteen hands had arterial sympathectomies, 6 hands had ulnar artery bypass with vein graft, and 2 hands had venous arterialization. Seventeen hands (89.5%) had improvement in their chronic wounds and this was highest in the arterialized hands (100%; arterial bypass = 83.3%; sympathectomy = 88.9%). Fifteen hands (78.9%) had improvement in their pain symptoms (sympathectomy = 83.3%; arterial bypass = 83.3%; arterialization = 50%). Two patients (12.5%) were able to reduce antispasmodic medication regimens after surgery. Zero patients developed new ulcerations postoperatively but one patient required secondary amputation after failing to heal chronic wounds.

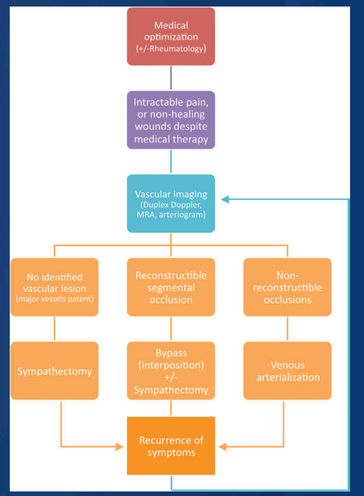

Figure 2

Discussion:

This study demonstrates the effectiveness of the surgical treatment of chronic ischemia of the hand. The treatment of patients with chronic hand ischemia are a significant challenge for hand surgeons. Synthesizing the data from our systematic review and our case series led us to devise an algorithm seen in Figure 2. This begins with medical optimization including non-invasive modalities such as botulinum toxin injections. This is followed by vascular imaging to determine vascular patency, localize vascular lesions and categorize the patients into one of three groups: patients without vascular lesions, patients with discrete vascular interruptions of patency with reconstitution of flow, or occlusive lesions that do not have reconstructible targets. An appropriate surgical modality is then chosen. Patients without discreet vascular lesions, (ie autoimmune) likely suffer from a vasospastic phenomenon that can be treated with surgical sympathectomy. Patients with discrete arterial lesions and decent targets for distal anastomosis benefit from interposition bypass with a vein graft. Patients with no reconstructible occlusive disease may be candidates for venous arterialization.