

Hand/Upper Extremity & Education
Sunday January 25, 2015
7:15am-8:15am
Grand Ballroom EFG
Moderators: Jason Ko, MD; Randy Sherman, MD

7:15 AM - 7:19 AM

Motion Analysis for Microsurgical Training: Objective Measures of Dexterity and Economy of Movement

Stanford University Medical Center, Palo Alto, CA, USA

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Background: The traditional surgical apprenticeship structure of ‘*see one, do one, teach one*’ has been educationally criticized in an attempt to improve the quality of healthcare delivery, create efficient training environments, and maximize patient safety. Evaluation of skill acquisition in microsurgery has traditionally been based on subjective opinions of senior faculty but is shifting towards early competency based training on validated models. No objective measures of dexterity, economy of movement or ability exist. We propose a novel video instrument motion analysis scoring system to objectively measure motion.

Methods: Expert microsurgery video was motion analyzed and used to develop a resident motion analysis scoring system based on a mathematical model using logistic regression and cubic splines. Motion analysis scores were compared to blinded, global rating scores of the same videos using the Stanford Microsurgery and Resident Training (SMaRT) scale.

Results: 85 video segments of a single task from 16 residents ranging from PGY1-6 and experience 0-80 arterial anastomoses were analyzed. Composite motion analysis score for each segmented video correlated positively to arterial anastomotic experience (Rho +0.77 and $P < 0.001$). SMaRT inter-rater reliability was consistent between expert assessors and mean composite motion analysis overall performance and SMaRT scores were well matched for each level of experience. Composite motion analysis scores correlated significantly with combined SMaRT instrument handling (Rho + 0.66, $P < 0.01$), efficiency (Rho + 0.59, $P < 0.01$), suture

handling (Rho +0.83, P< 0.001), operative flow (Rho + 0.67, P< 0.001) and overall performance (Rho +0.89, P<0.001) motion components of the SMaRT scale.

Conclusions: The ideal microsurgical training model and assessment modality is yet to be elucidated. Hand motion analysis has been shown to be a reliable index of technical performance for open, laproscopic and microsurgical procedure training. However, to our knowledge this is the first application of instrument motion analysis to microsurgical training. It provides a novel but reliable and consistent objective assessment for residents. The assessment has an associated cost in set up but is timely, repeatable, senior physician independent and exposes patients to zero risk.

7:19 AM - 7:23 AM

Microsurgery Simulation Training – A new system to complement every training programme

Microsurgery Institute 4, Guys & St Thomas' Hospital, London, , United Kingdom

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Introduction

Microsurgical techniques are essential in Plastic Surgery but with changes in training, acquiring these skills can be difficult. To address this, we have designed a standardised laboratory-based microsurgical training programme, which allows trainees to develop their dexterity, visuospatial ability, operative flow and judgement as separate components.

Method

Thirty trainees completed an initial microsurgical anastomosis on a chicken femoral artery assessed using the Structured Assessment of Microsurgical Skills (SAMS) method. The study group (n=15) then completed a three-month training programme, designed by the authors, whilst the control group (n=15) did not. A final anastomosis was completed by all trainees (n=30).

Results

The study group showed a significant improvement in their SAMS scores (mean score 4 verses 7, Wilcoxon rank test p<0.05), the control group did not (mean score, 4 verses 4, Wilcoxon rank test p>0.05). There was also a significant difference in the final SAMS score between the control and study group (mean score 10 verses 4, Mann Whitney U test p<0.05)

Conclusion

This validated programme is a safe, cost-effective and flexible method of allowing trainees to develop microsurgical skills in a non-pressured environment. In addition the objectified skills allow trainers to assess the trainees' level of proficiency before operating on patients.

7:23 AM - 7:27 AM

Learning Curve of Three Dimensional Stereoscopic Monitor Assisted Microvascular Anastomosis in a Rat Model

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Alexander Shin, MD; Allen T. Bishop, MD; Mayo Clinic

INTRODUCTION

Three-dimensional (3D) high definition (HD) video devices paired to operating microscopes have recently been developed to display detailed images for operating personnel and teaching purposes. The images may also permit microsurgery using a large 3D monitor instead of a binocular surgical microscope. This study tests the potential to perform rat femoral artery anastomoses solely with a 3D-HD video system. Results were assessed based on surgeon experience and in comparison to the conventional binocular technique.

MATERIALS & METHODS

Two novice and two experienced microsurgeons each performed 22 rat femoral arterial anastomoses, half using a 3D-video system (Trenion; Zeiss Medical Technology) and half, a conventional microscope. We evaluated the quality of microsurgical anastomosis using an Objective Structured Assessment of Technical Skills (OSATS) score as well as patency rates after 24 hours. Learning rate, defined as the number of trials required to reach 80% of the learning plateau, was measured. Participants were surveyed to determine technical ease, comfort and image adequacy.

RESULTS

Experienced microsurgeons rapidly improved their anastomosis time and quality. Anastomosis time plateaued after 9.5 ± 1.3 anastomoses and technical quality after 1.8 ± 0.1 anastomoses. Novice microsurgeons continued to improve, but did not reach a time or quality plateau. In both groups, use of the 3D-viewing system required 59% more time than a conventional operating microscope (17.9 ± 2 versus 10.7 ± 3 minutes). Mean 3D video OSATS scores did not differ significantly from the binocular microscopes (26.7 versus 28.3 respectively). Anastomotic patency in novices was highest with the conventional microscope (68% versus 59%). All vessels repaired by experienced microsurgeons were patent regardless of method. The optical microscope was preferred by all microsurgeons, as it provided a brighter, more detailed image with greater depth of field.

CONCLUSION

Three-D HD video microsurgery systems have been used primarily for OR assistants and as teaching tools. This study demonstrates their potential to eventually replace current operating microscopes. While experienced microsurgeons were able to perform technically-equivalent microvascular anastomoses using the 3D-video system, it remained more time consuming and challenging. Future technological advances with better optics may pave the way for replacement of current binocular microscopes.

7:27 AM - 7:33 AM

Discussion

7:33 AM - 7:37 AM

Severity grading and estimation of hand quality in radial club hand evaluation

Tampere University Hospital , Tampere, , Finland

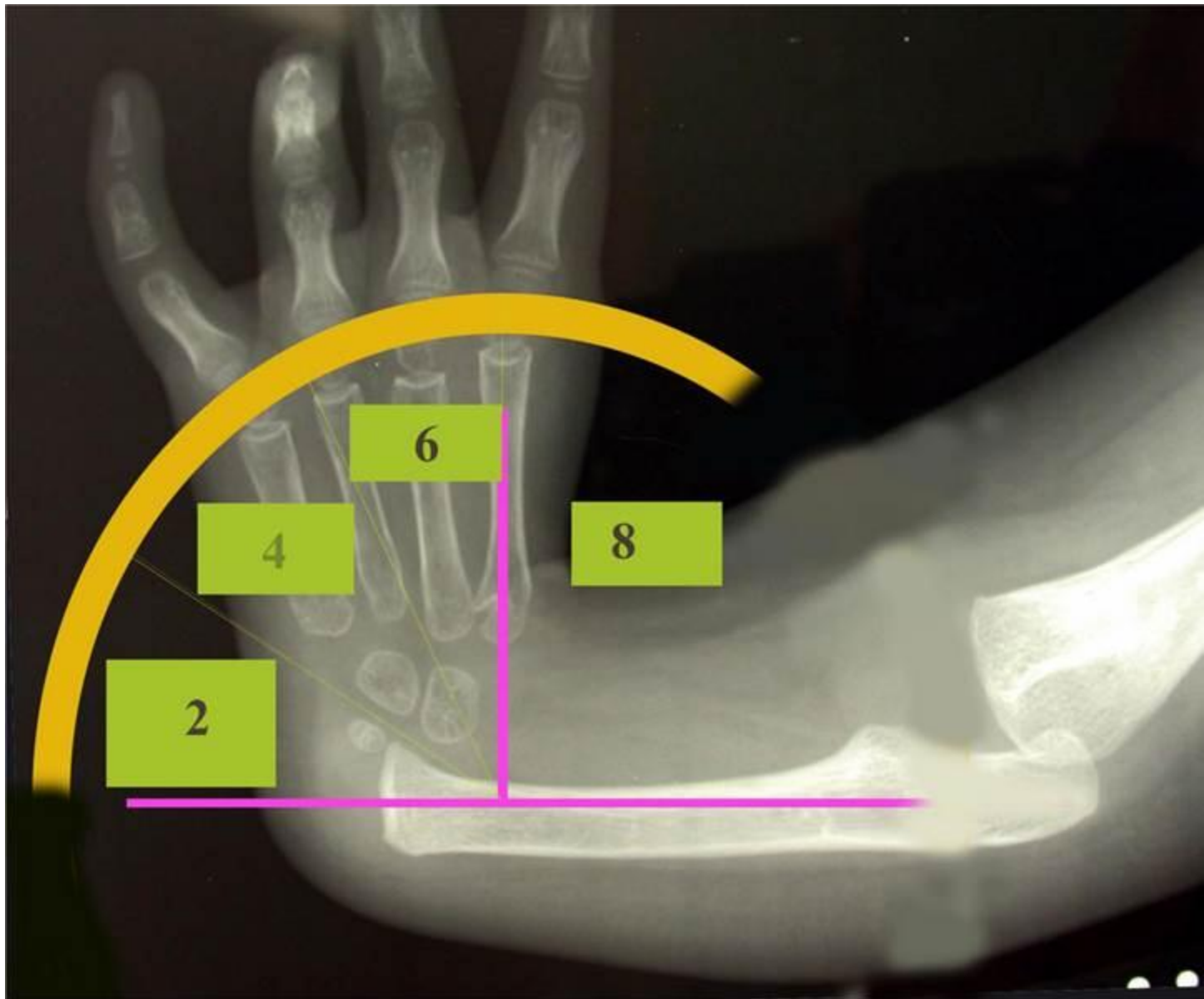
Simo K. Vilkki, MD, PhD; Tampere University Hospital

HYPOTHESIS: Bayne Klug classification for Radial Club Hands is based on skeletal defects. Hand quality and functional capacity differs considerably inside Bayne-Klug types III and IV. A detailed Severity Grading is the key for proper evaluation of radial longitudinal deficiency (RLD). **METHODS:** Systematic preoperative assessment was used in a series of 44 radial club hands, in 32 patients. There were 34 Bayne-Klug Type IV hands, 7 Type III hands and 3 Type II hands according to x-ray findings. Analysis of the function of fingers, hand, wrist, elbow and shoulder was done. A chart (Fig. 1) was filled assuming that severity of different findings is negatively related to hand quality and to all over functional capacity. Presented Severity Grading gives 10 severity points for Hand quality (H), 10 points for Wrist tightness (W see Fig 2.) and 10 points for Proximal functional defects (P). Combined severity scores, named as Severity Index for Radial Club Hand, are comparable when using the sum of Hand and Wrist scoring and adding the value of proximal lesions separately. **RESULTS:** Radial Club Hands could be scored into three groups: 1) Mild: H+W+P gave 4-8 severity points (in mean 5.8). There were 8 (18 %) RCH extremities. Proximal (P points in mean = 1.1) lesions were very rare in these extremities . 2) Moderate: H+W+P gave 9- 16 severity points (in mean 11.5). There were 21 (48 %) RCH extremities. Mild proximal (P points in mean =2.2) lesions were found. 3) Severe: H+W+P gave 17-30 severity points (in mean 21.1). This group had 15 (34%) RCH extremities. Proximal (P points in mean =5.4) lesions were found in all extremities. In repeated x-ray studies a weakness in Bayne-Klug classification was noticed as the type IV will change during the growth very often into type III. In our series the change due to ossification of the early invisible proximal radius occurred in 41% of forearms in the group of 19 patients followed over 11-year. **SUMMARY POINTS:** Severity Index, a sum of severity points for Hand quality, Wrist tightness and Proximal lesions, is a new evaluation criteria for RCH. Severity grading of Radial Club Hands improves assessment of functional prognosis, treatment planning and comparison of similar extremity groups before and after treatment. Bayne-Klug classification appears to have particular weakness because type IV will often change into type III during the growth.

Fig 1. The Chart for findings

HAND			points given	severity poin
THUMB		not useful		0
		useful		2
RAY 2	stiff	MCP II flexion <45 dgr		1
	stiff or camptodactylic	PIP ext lag >15 dgr		1
RAY 3	stiff	MCPIII "		1
	stiff or camptodactylic	PIP		1
RAY 4	stiff	MCP IV "		1
	stiff or camptodactylic	PIP		1
RAY 5	stiff	MCP V "		1
	stiff or camptodactylic	PIP		1
ABSENCE OF FINGER or RAY II-V				2.8
SYNDACTYLY between II / III fingers				1
PINCHING PATTERN at ulnar or IV / V web				1
H				max 10
WRIST				
		tightness of radial deviation		
		10-30		2
		35-60		4
		65-90		6
		over 90 degrees		8
neglected early splinting (start >6 months)				2
W				max 10
PROXIMAL				
ELBOW extension lag		>15 degrees		1
weak active elbow flexion:		60 to 90 degrees		1
"	"	below 60 degrees		3
no active elbow flexion				4
SHOULDER: flexion and abduction < 120 dgr				3
intercalary bone defect, shoulder instability				6-10
P				max 10
TOTAL	H+W+P			
SCORE:	Severity index			max 30

Fig 2. Wrist tightness



7:37 AM - 7:41 AM

Free Vascularized Descending Genicular Artery Structural Bone Flaps to Restore Lost Pinch Function Following Osteomyelitis and Extensive Terminal Bone Loss Near the Digital Tip
Hand and Wrist Center of Houston, Houston, TX, USA

Mark Henry, MD; Hand and Wrist Center of Houston

Purpose: To evaluate the clinical outcomes of free vascularized descending genicular artery structural bone flaps to restore lost pinch function following osteomyelitis and extensive terminal bone loss near the digital tip.

Methods: Nine patients (8 males, 1 female) with a mean age of 43 years sustained extensive terminal bone loss near digital tips following osteomyelitis. The mean length of bone defect was

28 mm (+/- 8.4). The patients were reconstructed at a mean of 12 weeks from initial trauma / infection, having undergone a mean of 2 prior surgeries.

Age	25	53	54	53	22	57	58	28	38
Sex	F	M	M	M	M	M	M	M	M
Digit	ring	thumb	thumb	long	long	index	thumb	ring	long
Length of defect (mm)	16	30	45	27	23	22	36	26	28
Number of prior surgeries	1	2	5	1	2	3	2	1	2
Time since initial trauma (weeks)	6	12	15	17	17	6	22	6	6
Time to achieve union (weeks)	6	10	10	6	11	10	11	6	8

Results: All bone flaps incorporated fully, restoring pinch function to the respective digits with a mean time to union of 8.6 (+/- 2.1) weeks.

Conclusions: With few alternative solutions able to address this unique and difficult problem, the structural block of vascularized bone proved able to resist both resorption and reactivation of infection; the two problems normally encountered under this scenario.

Hand/Upper Extremity & Education, Sunday January 25, 2015, 7:15am-8:15am
7:41 AM - 7:45 AM

Upper Extremity Transplantation: Report on Outcomes at 18 months

Massachusetts General Hospital, Boston, MA, USA

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Background

Vascularized composite allotransplantation (VCA) offers unprecedented restoration of function and form following devastating extremity and craniofacial injury. Such cases present numerous technical challenges which must be overcome to achieve a successful outcome. We present a case report 18 months following unilateral upper extremity transplantation.

Methods

The patient is a 44-year-old left hand dominant male, 9 years status-post 50% TBSA burns, resulting in metacarpal level amputation of his left hand with truncated thumb, first web-space contracture, and 45-degree fixed flexion of the wrist. Cutaneous veins suitable for anastomosis were absent. Unilateral left hand transplantation with a volar forearm fasciocutaneous extension (including radial artery and basilic vein) was performed. Metaphyseal osteosynthesis was performed to maximize chances of union. Following stabilization of the wrist with its flexors and extensors, digital extensors were adjusted to place metacarpophalangeal joints in neutral with the wrist in neutral, and no more than 60° flexed with wrist in 30° dorsiflexion. Digital flexor tendons were adjusted to mimic digital cascade. All tenorrhaphies were performed using the single-weave side-to-side technique to achieve high-strength, low-bulk repair.

Results

Immunosuppression with tacrolimus, MMF and rapidly weaned steroids has been well tolerated. Protected active motion therapy commenced on day one. Currently, the patient has grade 5/5 extrinsic function with full range of motion, and return of grade 3+/5 power in intrinsic muscles. He has protective sensibility to the fingertips with static 2-point discrimination 10mm in median and ulnar nerve territories. He remains free of rejection episodes to date.

Conclusions

Achieving optimal outcomes in upper extremity VCA requires meticulous attention to principles of microvascular reconstruction, orthopedic and hand surgery, and close collaboration with transplant specialists.

7:45 AM - 7:52 AM

Discussion

7:52 AM - 7:56 AM

Free Functioning Gracilis Transfer for Upper Limb Reanimation in Children

Assiut University Hospital, Assiut, , Egypt

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Ragheb; Assiut University Hospital

The purpose of the study: to evaluate the outcome following free functioning gracilis transfer for reconstruction of the lost function of the upper extremity in children. Method: retrospective study reviewed 35 child. The average age was eight years (range; 4 to 14 years). 58% of the children had their transfer for treatment of Volkmann's ischemic contracture. 31% for reconstruction of late obstetric palsy. 11% had other indications (late poliomyelitis, traumatic forearm muscle loss, post tumor excision and late traumatic brachial plexus injury). The transferred muscle was used to provide single function in 29 child. The remaining six, the muscle was used to provide two functions (elbow and finger flexion in four, and elbow flexion and wrist extension in two). Results: the mean follow up period was 64 months (range; 24 to 110 months). Using the medical Research Council Scale; 78% of the children reached M4 muscle grade at the late follow up. The highest grade were obtained in children with Volkmann's ischemic contracture followed by the group of other indications and finally by children with late obstetric palsy. The power grade was the highest when the anterior interosseous nerve was used to innervate the muscle. The active range of motion significantly increased from an average of 7.76% to an average of 75% of the available passive range. Conclusions: in pediatric free functioning gracilis transfer, the functional results tend to be less favorable when used for reconstruction of late obstetric palsy compared to other indications. When the muscle is used to provide a double functions, the proximal function gets significantly better results than the distal one.

7:56 AM - 8:00 AM

Hypothenar Hammer Syndrome: Long-Term Results of Vascular Reconstruction

Mayo Clinic, Rochester, MN, USA

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Background: Hypothenar hammer syndrome (HHS) is an uncommon cause of digital ischemia, and many patients ultimately require vascular reconstruction to alleviate critical ischemia. Long-term patency rates and related outcomes are not well established, nor is the need for reconstruction. The purpose of this study is to evaluate the long-term patency rate and outcomes from vascular reconstruction of HHS. Additionally, we aim to identify any patient or treatment related factors that may contribute to differences in outcome

Methods: Color flow ultrasound was utilized to determine the patency of 18 vein graft reconstructions of the ulnar artery at the wrist in 16 patients. Validated questionnaires evaluated patients' functional disability with the Disabilities of the Arm, Shoulder and Hand (DASH) score, pain with the Visual Analog Scale (VAS), and cold intolerance with the Cold Intolerance Symptom Severity survey (CISS). Patient demographics, clinical data, and surgical factors were analyzed for association with graft failure. Patients were asked to grade the result of treatment on a 0-10 scale.

Results: Fourteen of 18 grafts (78%) were occluded at a mean 118 months postoperatively. Patients with patent grafts had significantly less disability related to cold intolerance according to the CISS survey (mean 21.8 versus 55.0) in addition to significantly less pain on the VAS scale. There was no statistical difference in DASH scores between patent and occluded grafts. Patients graded the result significantly higher in patent reconstructions (9.5 versus 6.8).

Conclusions: The present study demonstrates a higher rate of graft occlusion than previously reported at a mean follow-up of 9.8 years, which represents one of the longer duration follow-up studies of surgical treatment of HHS to date. Despite a high percentage of occlusion, patients overall remained very satisfied with low functional disability, and all patients would recommend surgical reconstruction. This study suggests that improved outcomes may result from patent grafts long-term, and further study is required to determine what factors contribute to graft patency.

8:00 AM - 8:04 AM

Re-exploring the Anatomy of the Distal Humerus for its Role in Providing Vascularized Bone in the Repair of Scaphoid Non-union

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Brett Michelotti, MD; Sebastian Brooke, MD; Logan Carr, MD; T. Shane Johnson, MD; Penn State Hershey Medical Center

BACKGROUND: Scaphoid non-union can lead to functionally debilitating wrist arthritis. The medial femoral condyle corticocancellous, vascularized bone graft can be utilized in

microvascular reconstruction of scaphoid non-union in the setting of proximal pole avascular necrosis. Advantages of free vascularized bone grafting include ease of volar placement and correction of humpback deformity as a result of detaching the vascular pedicle.

We hypothesize that a lateral humeral metaphyseal flap, based on the radial collateral artery or its posterior branch, could provide vascularized bone for use in microsurgical correction of scaphoid non-union with humpback deformity and proximal pole avascular necrosis.

METHODS: We sought to re-explore the anatomy of the lateral arm flap, the radial collateral artery and its blood supply to the lateral, distal humerus with the goal of defining the clinically relevant arteriovenous anatomy of the region, ease of dissection, pedicle length and diameter. Ten fresh cadaver dissections were performed – following latex vascular injection - after which arteriovenous anatomy was described and time to complete dissection, pedicle length and diameter and anatomic variability were recorded.

RESULTS: The distal extent of the deltoid, lateral intermuscular septum (LIS) and lateral humeral epicondyle were identified prior to the dissection. Upon incision along the LIS, a septocutaneous perforator was easily identified at approximately 10 cm proximal to the lateral humeral epicondyle. Dissection was carried out toward its bifurcation from the posterior branch of the radial collateral artery (PBRCA) and then along the PBRCA to its terminal periosteal extensions at the lateral humeral metaphysis. An osteotome was then used to complete the harvest of a 1.5 cm x 2 cm vascularized, corticocancellous bone graft. In total, the dissection took an average of 30 minutes to perform; average pedicle length was 5 cm and average pedicle diameter was 1.5 mm.

CONCLUSIONS: Vascularized grafts have been shown to be superior to avascularized bony constructs when bridging a large bony defect or in promoting union in the setting of avascular necrosis. With limited data available, results have been excellent with the medial femoral condyle (MFC) corticocancellous vascularized free flap. Drawbacks to the MFC free flap include: time to harvest, separate operative site and potential donor site morbidity. Understanding the limitations of a cadaver study, we propose that the lateral arm may become a suitable alternative to the MFC for its use in providing vascularized bone because of reliable anatomy, quick dissection, and tourniquet control within the same operative field.

8:04 AM - 8:08 AM

Twenty Years' Experience of Complete Reduction of Arm Lymphedema Following Breast Cancer

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Håkan Brorson, A/Prof, MD, PhD; Lund University, Plastic and Reconstructive Surgery, Skane University Hospital

AIM

Patients with chronic non-pitting lymphedema do not respond to conservative treatment probably because diminished lymph flow and inflammation result in the formation of excess subcutaneous

adipose tissue. Previous surgical treatments utilizing either total excision with skin grafting or reduction plasty seldom achieved acceptable cosmetic and functional results. Microsurgical reconstructions, although attractive as a physiological concept, cannot provide complete reduction in chronic non-pitting lymphedema because they do not eliminate the newly formed subcutaneous adipose tissue collections.

METHODS

142 women with non-pitting edema, a mean age of 64 (range, 39-89) years and a mean duration of arm swelling of 9 (range, 1-38) years underwent liposuction. Mean age at breast cancer operation, mean interval between breast cancer operation and lymphedema start, and duration of lymphedema were 52 years (range, 33-86), 3 years (range, 0-32), and 9 years (range, 1-38) respectively. Aspirate and arm volumes were recorded (Figure 1a, b).

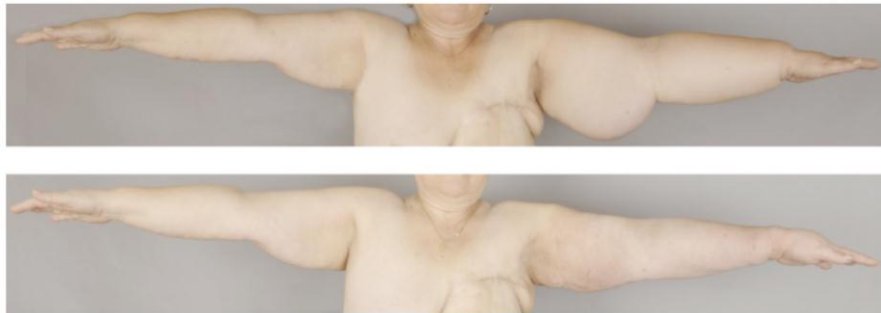


Fig. 1. A 57-years-old woman with a non-pitting secondary leg lymphedema of 4 235 ml since 5 years following breast cancer treatment. Complete reduction 6 months after liposuction (below)

RESULTS

Aspirate mean volume was 1819 ml (range, 650-3850) with an adipose tissue concentration of 94 % (range, 58-100). Preoperative mean excess volume was 1566 ml (range, 545-3915). Postoperative mean reduction was 103 % (range, 50-194) at 3 months and more than 100% during 20 years' follow-up, i.e. the lymphedematous arm was somewhat smaller than the healthy arm. The preoperative mean ratio between the volumes of the edematous and healthy arms was 1.5, rapidly declining to 1.0 at 3 months, and less than 1 after one year (Figure 2).

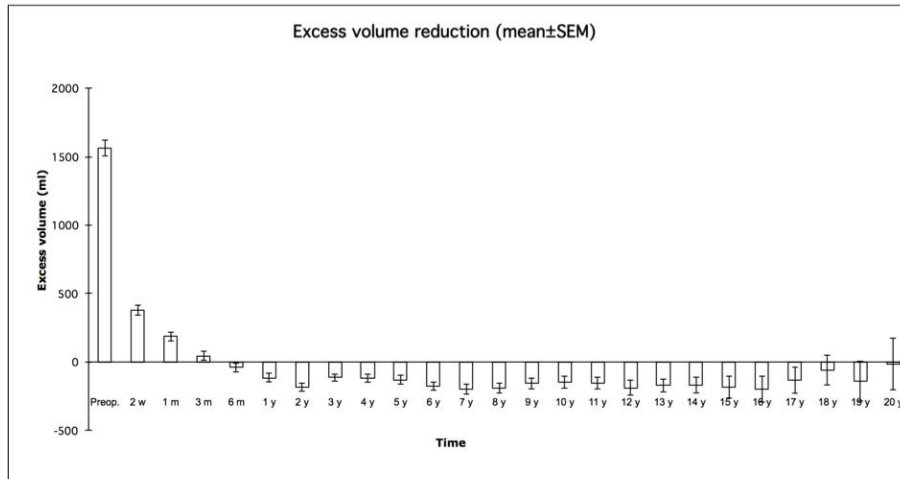


Fig. 2. Mean pre- and postoperative excess volume reduction.

CONCLUSION

These long-term results demonstrate that liposuction is an effective method for treatment of chronic, non-pitting arm lymphedema in patients who have failed conservative treatment. Because of adipose tissue hypertrophy, it is the only known method that completely reduces excess volume at all stages of arm lymphedema. The removal of hypertrophied adipose tissue, induced by inflammation and slow or absent lymph flow is a prerequisite to complete reduction. The newly reduced volume is maintained through constant (24-hour) use of compression garments postoperatively.