THE AMERICAN SOCIETY FOR RECONSTRUCTIVE MICROSURGERY

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RECONSTRUCTIVE MICROSURGERY

A Look at What's New in Reconstructive Microsurgery in 1997

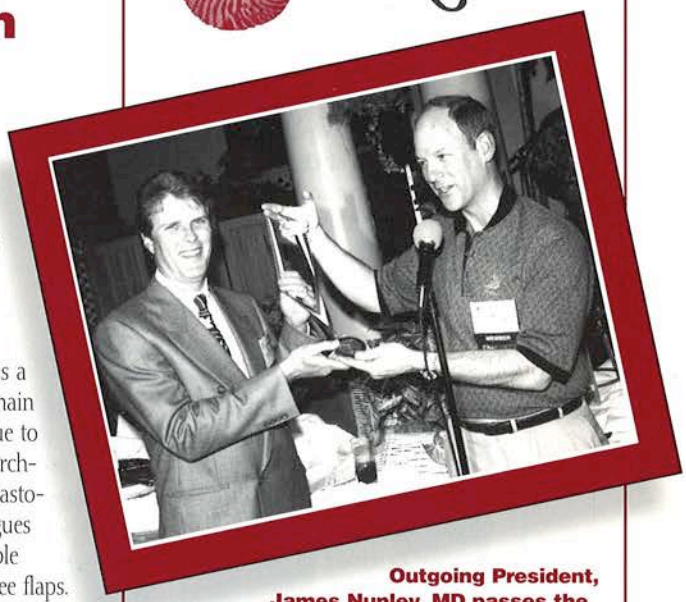
By L. Scott Levin, MD

As evidenced by the attendance and scientific program of the 1997 American Society for Reconstructive Microsurgery Meeting in Boca Raton, Florida this past January, it is evident that Reconstructive Microsurgery is a vibrant part of surgery today, and will remain so as research and clinical practice continue to develop. Microsurgeons are constantly searching for a new way to perform vascular anastomoses. Professor Willie Boeckx and colleagues from Leuven, Belgium presented V.C.S. stable microvascular anastomoses in lower leg free flaps. The V.C.S. auto suture is a modification of the Kirsch staple. Boeckx and colleagues performed 25 free flaps to the lower leg after confirming the technique on the rabbit carotid artery. A special forceps was developed to evert the intima and medial layers of the vessel wall. Average anastomosis time was 2 to 3 minutes.

Osteonecrosis of the femoral head prior to a decade ago was a devastating problem particularly in young adults. Subsequently, microvascular reconstruction of the femoral head using a free vascular fibular graft provides an alternative to total hip arthroplasty. Mahoney and colleagues from St. Michaels Hospital and the University of Toronto presented their results in their first 64 hips (55 patients). Hip scores improved. Final follow up 28% of these patients had conversion of total hip arthroplasty. However, this procedure reduced symptoms, increased function, and if unsuccessful

(continued on page 6)

Boca Raton



Outgoing President, James Nunley, MD passes the presidential medallion to Incoming President William Swartz, MD.

Lucy sings Happy Birthday to Outgoing President James Nunley, MD.

Opening the Lines

I would like to thank the Society for the opportunity to serve as Secretary and as such the editor of *Reconstructive Microsurgery*. Dr. Sal Shenaq has done a superb job as editor and I hope that I will be able to maintain the high standards that he has set.

In each newsletter, we will try to present articles of interest that reflect the progress in reconstructive microsurgery. This may focus on one particular aspect of development or outline a number of improvements that hopefully will be of interest to our readers and perhaps some value.

In addition to this, coding has become a significant problem. Dr. Dan Nagle has put forth an enormous effort in re-writing the microsurgical schedule and this is outlined in this issue. In further issues, Dr. Mark Buehler will provide us with an update on coding and address some problem areas. If there are issues that arise, I would appreciate hearing about them so that Mark can address them.

Lastly, I would like the newsletter to be a format for recording the history of microsurgery. The personal experiences of the founders of microsurgery need a home and *Reconstructive Microsurgery* could provide that service. To start off the series, Zoran Arnez, MD provides a brief history of microsurgery in Slovenia, and how one of our specialty's pioneers, Marko Godina, MD and his colleagues played a major role in its development in the Microsurgery Overseas column on page 10 of this issue.

I would like to emphasize that the format and content of the newsletter is open to input from you. I look forward to the opportunity of editing the newsletter and would welcome any suggestions you may have. **RM**

EDITOR'S MESSAGE

Ronald M. Zuker, MD

The personal experiences of the founders of microsurgery need a home and Reconstructive Microsurgery *could provide that service.*

RECONSTRUCTIVE MICROSURGERY

The mission of the American Society for Reconstructive Microsurgery is to promote, encourage, foster and advance the art and science of reconstructive micro-neurovascular surgery; and to establish a forum for teaching, research and free discussion of reconstructive microsurgical methods and principles among members.

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ASRM *Reconstructive Microsurgery*
444 East Algonquin Road, Suite 150
Arlington Heights, Illinois 60005
(847) 228-9717

Meeting, Speakers Leave Lasting Impression

PRESIDENT'S LETTER

William M. Swartz, MD, FACS

The recent meeting of the American Society for Reconstructive Microsurgery held at the Boca Raton Resort was a resounding success. Special thanks are in order to our Past President, Jim Nunley, MD and to Scott Levin, MD, our Program Chairman. Together they provided our membership with an outstanding scientific symposium in a setting that everyone thoroughly enjoyed. There were 296 registrants and 36 exhibitors. Eleven instructional courses were provided by our members, and residents were treated to the second Residents' and Fellows' Symposium. Both the instructional courses and the symposium were organized by Randy Sherman.

Dr. Zoran Arnez gave the third Marko Godina Lecture. Dr. Arnez is Chief of Plastic Surgery at the University Medical Center in Lublijana, Slovenia, the post that Marko Godina once held, thereby providing first-hand appreciation of his legacy. Dr. Arnez's work has continued in the Godina tradition providing early microsurgical reconstructions of traumatized lower extremities. Additionally, Dr. Arnez demonstrated his outstanding results in free flap breast reconstruction.

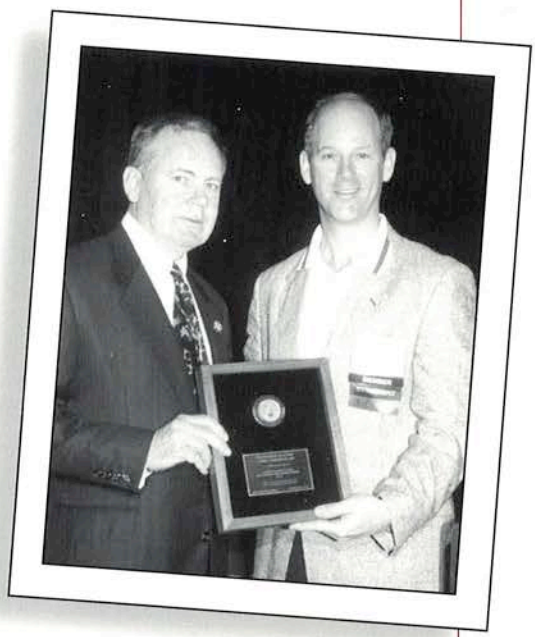
The Founders' Lecture was delivered by James Urbaniak, Past President of the ASRM in 1985. Dr. Urbaniak's talk was highly stimulating. It caused us to reflect on indications for free toe transfer following traumatic thumb loss. He pointed out with great eloquence Paul Brown's essential paper, Surgeons with Less than Ten, where physicians–even with the loss of a thumb–can function in a completely normal manner. More importantly, he assessed the donor site problems associated with great toe and second toe transfers. While toe-to-thumb transfer is one of his favorite operations, his insights into the indications for this operation were most instructive.

While toe-to-thumb transfer is one of [Dr. Urbaniak's] favorite operations, his insights into the indications for this operation were most instructive.

After listening to Dr. Urbaniak's talk, I have thought a great deal about the problems of donor site complications following our microsurgical procedures. Great advances have been made in the identification of new donor sites for free tissue transfer. In our journals, these operations have been heralded as advancements for reconstruction of a variety of unique surgical problems. Yet it isn't until some years later, after many surgeons have tried these procedures, that the true donor site morbidity is revealed. Whether it is a groin hernia following a vascularized iliac crest bone flap, a chronic non-healing wound of the foot following a dorsalis pedis flap or winging of the scapula following a serratus muscle harvest, each of these donor site problems could most likely have been avoided by the selection of another equally effective procedure.

No donor site is totally free from morbidity. Even the ubiquitous latissimus dorsi flap has a high seroma rate, and most of us have stopped looking for any demonstrable shoulder weakness following removal of this muscle, taking for granted that the patient will compensate. And what about the scars of the radial forearm flap, one of the easiest flaps to elevate? In all but the elderly, this is a cosmetically vulnerable area–particularly in women. While we all have our favorite flaps to perform, it behooves each of us to consider with great care the effect of the donor site on our patients. I have come to learn the hard way that there is no such thing as a "free" flap.

By now all of you are beginning to receive abstract forms for next year's meeting which will be held January 10-13, 1998, at the Phoenician Resort in Scottsdale, Arizona—a most wonderful location! Our format will be similar to the meeting held at Marco Island with an overlap day to be shared with the American Association for Hand Surgery. Mark Schusterman, as Program Chairman, will be eagerly awaiting your abstracts. I look forward to seeing you there. **RM**



Founder's Lecturer James Urbaniak, MD (left) accepts congratulations from James Nunley, MD.

CODING CORNER

New Microsurgical Codes for 1997

By Daniel J. Nagle, MD

The new 1997 CPT Manual is now available. Eleven new microsurgical codes have been added to the 1997 CPT nomenclature. The generic code 15755, Free flap (microvascular transfer), has been eliminated and replaced with these codes. These codes were developed through the efforts of the American Society for Reconstructive Microsurgery, the American Society for Surgery of the Hand, the American Society of Plastic and Reconstructive Surgeons, the American Academy of Otolaryngologists-Head and Neck Surgeons, and the American Academy of Orthopaedic Surgeons.

The generic code 15755, Free flap (microvascular transfer), has been eliminated and replaced with these codes.

The new codes have been divided into families. The first family contains the codes dealing with the free tissue transfer of skin, muscle, and fascia. The second family of new codes has to do with free microvascular transfer of bone. The third family has codes dealing with toe-to-hand transfer and free toe joint transfer. Finally, the last family deals with free omental and free jejunal transfer.

The new skin, muscle, and fascia codes are as follows:

15756 Free muscle flap with or without skin graft with microvascular anastomosis

15757 Free skin flap with microvascular anastomosis

15758 Free fascial flap with microvascular anastomosis

The combination of the free myofascial flap with the myocutaneous flap was thought to be appropriate in view of the fact a survey of microsurgeons revealed the amount of work involved with these two procedures was not significantly different.

The work included in these procedures is the harvesting of the flap including flap dissection and microdissection of the vessels, the transfer of the flap and insetting of the flap, and the microanastomoses of one artery and two veins. If more vascular anastomoses are needed or if vein grafts are needed they would be coded separately. The direct closure of the donor site is also included.

What is not included is the preparation of the recipient site including the debridement. This can include the standard debridement codes 11040 to 11044 and also the new open fracture debridement codes 11010 to 11012 if one is dealing with an open fracture. Should the donor site require a skin graft for closure, that would be coded separately as 15100 or a variation of that code. The inclusion of nerve tissue in the transfer such as in an innervated gracilis or serratus transfer would necessitate the use of additional codes such as 64830 for micro-dissection of both the recipient and donor nerves and also microsurgical repair using one of the codes in the family 64831 to 64865. In a similar fashion, the inclusion of tendons for the reanimation of a hand, for example, would dictate the use of a code such as 26483 in addition to the microsurgical code.

In the case of a fasciocutaneous free flap that is combined with a bone graft, the code 15757 would not be used, but rather the osteocutaneous microsurgical codes in the family 20970 through 20972 would be used. If, on the other hand, bone is harvested along with a myofascial flap or a fascial flap without overlying skin, the code 20902, that is a bone graft code, would be used in addition to 15756 or 15758, depending upon the tissue that is transferred.

The use of a split-thickness skin graft to cover a muscle flap is coded separately (15100) in the case of 15756 if a muscle flap (without skin) is being transferred. The same is true if a free fascial flap, 15758, is being transferred and requires a split thickness skin graft for coverage. The rationale behind this is that many microsurgeons do not place the split-thickness skin graft on the transferred muscle until several days after the initial procedure. In the case of the free fascial flap, not all fascial flaps require a split-thickness skin graft, i.e., when the flap is used to fill a dead space beneath intact skin.

Two new codes were added to the free bone transfers. These were meant to complete the free bone transfer codes and to create parallelism between the codes that deal with transfer of bone without skin with those codes describing transfer of bone with skin. The new codes are:

20956 Bone graft with microvascular anastomosis; iliac crest

20957 metatarsal

These two codes were missing in this section, but were already included in the section of microvascular transfer of bone with skin, that is, the osteocutaneous flaps. In both the osteocutaneous free flap section as well as the section of bone graft with microvascular anastomosis without skin, you will notice the rib codes have been deleted. It was the consensus of the microsurgeons who were surveyed that the free rib transfer is no longer performed and should be eliminated from the nomenclature.

Four new codes were added to describe the transfer of toes to hand. There were also editorial changes.

~~26552~~ ~~Reconstruction thumb with toe~~

~~26557~~ ~~Toe to finger transfer; first stage~~

~~26558~~ ~~each delay~~

~~26559~~ ~~second stage~~

The above-listed codes were eliminated as they refer to procedures that are no longer done.

While 20973, Free osteocutaneous flap with microvascular anastomosis; gx-eat toe with web space, has remained behind with

the other free osteocutaneous flaps, the new toe-to-hand codes were placed in the 26000 series of codes. These codes are relatively self-explanatory.

20973 Free osteocutaneous flap with microvascular anastomosis; great toe with space

26551 Toe-to-hand transfer with microvacular anastomosis; great toe "wrap-around" with bone graft

26553 other than great toe, single

26554 other than great toe, double

26556 Free toe joint transfer with microvascular anastomosis

The toe-to-hand transfers include the following work:

- Dissection of the flap
- Microdissection of flap, vessels, and nerves
- Dissection of tendons
- Donor site osteotomies
- In the case of 26551 harvesting of the iliac bone graft is included
- Transfer of the flap
- Insetting of the flap
- Osteosynthesis
- Microanastomoses of vessels and nerves
- Tendon repairs
- Primary closure of the donor site

What is <u>not</u> included is:

- Preparation of the recipient site including the debridement of the recipient site using the appropriate debridement codes including the codes for open fractures. These codes are 11040 through 11044 and 11010 through 11012.
- Microdissection of the recipient nerves
- Application of a split-thickness skin graft to the recipient site or the creation of local skin flaps at the recipient site
- Application of a skin graft to the donor site
- Cross-toe flap

One question that has been raised is whether or not there is a code for the microdissection of recipient vessels. Currently there is no such code. We are currently working with the AMA CPT Editorial Panel to see whether or not one of the existing vascular codes could be used for this and if this proves to not be the case a new code will have to be developed.

Finally, the last two codes to be created were the free omental and free jejunal codes.

49006 Free omental flap with microvascular anastomosis

43496 Free jejunum transfer with microvascular anastomosis

These codes were created to complete the new codes. Because of the significant variability in the amount of physician work involved in these cases, it was impossible to assign relative values to these procedures during the Relative Value Update Committee meeting. Therefore, the reimbursement for these procedures will be "by report."

One question that has been raised is whether or not there is a code for the microdissection of recipient vessels.

The variability in these codes stems from the fact that various combinations of surgeons are involved in the procedures that utilize these free tissue transfers. For example, in the case of esophageal reconstruction, a general surgeon occasionally is called upon to deliver the bowel from the abdomen while the microsurgeon will perform the microanastomosis and the head and neck oncology surgeon will perform the extirpation of the tumor. This combination, however, can vary depending upon the expertise of the microsurgeon; he or she may or may not actually perform the laparotomy and harvest the flap him/herself.

It is hoped these new codes will allow you to keep track of your microsurgical procedures more accurately.

Microvascular Surgery

Free Flap Grafts (Microvascular Transfer)

~~15755~~ ~~Free flap (microsvascular transfer)~~
(15755 has been deleted. To report, see 15756-15758)

15756 Free muscle flap with or without skin graft with microvascular anastomosis

15757 Free skin flap with microvascular anastomosis

15758 Free fascial flap with microvascular anastomosis

Bone Grafts (Microvascular Anastomosis)

20955 Bone graft with microvascular anastomosis; fibula

20956 iliac crest

20957 metatarsal

~~20962~~ ~~rib~~
(20960 has been deleted. To report, see 20962)

20962 other ~~bone graft (specify)~~ <u>than fibula, iliac crest,or metatarsal</u>

Osteocutaneous Grafts (Microvascular Anastomosis)

20969 Free osteocutaneous flap with microvascular anastomosis; other than iliac crest, ~~rib,~~ metatarsal, or great toe

20970 ~~Free osteocutaneous flap with microvascular anastomosis;~~ iliac crest

~~20971~~ ~~rib~~
<u>(20971 has been deleted. To report, see 20969)</u>

20972 metatarsal

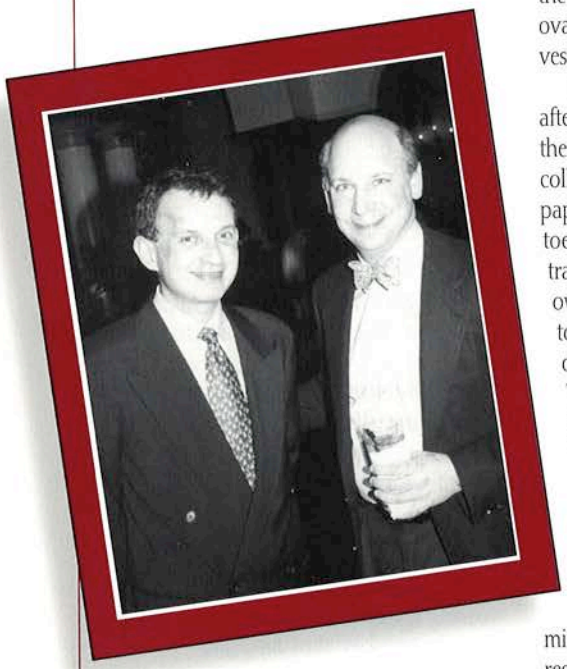
continued on page 14

What's New in Reconstructive Microsurgery

continued from page 1

did result in the relatively easy conversion to total hip arthroplasty. The fibula is a versatile transplant and was used extensively in the pediatric patient population as reported by the group from the Mayo Clinic, and can be used as a free vascularized epiphysial transfer by the Korea group from Seoul, Korea. The anterior tibial artery in the epiphyseal transfer was felt to be the most reliable vessel in 21 cases.

Despite our ability to replant major limbs, probably the sole determinate of functional outcome is neural regeneration.



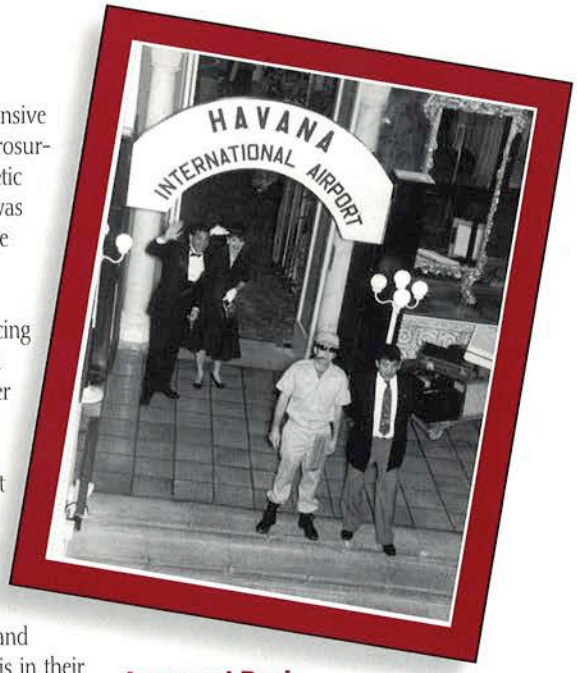
Godina Lecturer Zoran Arnez, MD and Program Chair Scott Levin, MD enjoy a moment of relaxation at the Havana Beach Party.

Lawrence Colen has done extensive research and clinical work in microsurgical free flap salvage of the diabetic lower extremity. Wound closure was able to be achieved in 100% of the patients he reported on, which included 106 free flaps. The team approach and the need for balancing procedures as well as fusions and osteotomities was stressed in order for the free tissue transfer to be successful in the diabetic foot.

The use of growth factors as it relates to wound healing has been studied extensively in the last decade. Growth factors are now being considered to augment free tissue transfers. Bayati and colleagues from Springfield, Illinois in their presentation , Fasciocutaneous Flaps Revisited, used basic (BFGF) to improve survival of prefabricated flaps through vascularization. There was a statistically significant increase in the area of flaps treated with BFGF in their experimental model in the rat. The BFGF is infused into the arteriovascular pedicle at the time of flap harvest.

The goal of returning patients to work after mutilating upper extremity injuries is the concept of all microsurgeons. Wei and colleagues from Taipei, Taiwan presented a paper comparing primary and secondary toe to hand transplantation. Primary toe transplantation was felt to shorten the overall recovery time and allow patients to return to work sooner. This was based on their study of 176 toe transplants. These included 32 primary toe transplants and 144 secondary transplants. Overall survival was 96%. The primary toe transfers were done within 7 days as compared to 19 months in secondary transplantation.

Despite our ability to replant major limbs, probably the sole determinate of functional outcome is neural regeneration. Nicolaidis from Montreal presented work on the preservation of denervated muscle following nerve injury using an implantable electrostimulator. This electrical "babysitter" may be an effective means of preserving muscle integrity during periods of denervation offering new



Lucy and Desi greet attendees as they enter the Havana Beach Party.

hope to patients with facial and peripheral nerve injuries. Dellon has been a leader in peripheral neurosurgery through over two decades. His recent interests include nerve decompression in the diabetic. A perspective blinded study was done that basically confirmed the decompression of peripheral nerve in a diabetic with symptoms will result in improvement in sensibility both in the upper and lower extremities.

Failure of free tissue transfer can be multifactorial but when a thrombus threatens microvascular anastomosis this is a significant clinical problem. Roger Khouri presented the perspective multicenter study of efficacy and safety of topical TFPI in microvascular free flaps. This is basically new data that really showed the TFPI did not impart a protective effect to the anastomosis compared to low dose or high dose bolus of Heparin. Interpreting this data it supports the concept that microsurgical anastomoses is still dependent on technique and not necessarily exogenous agents to prevent vascular thrombosis.

Some clinical work is taking place described by Chris Peterson and others to arterialize the venous system in upper extremity ischemia. Lineaweaver, Buncke and colleagues from San Francisco have taken the problem to the laboratory. They

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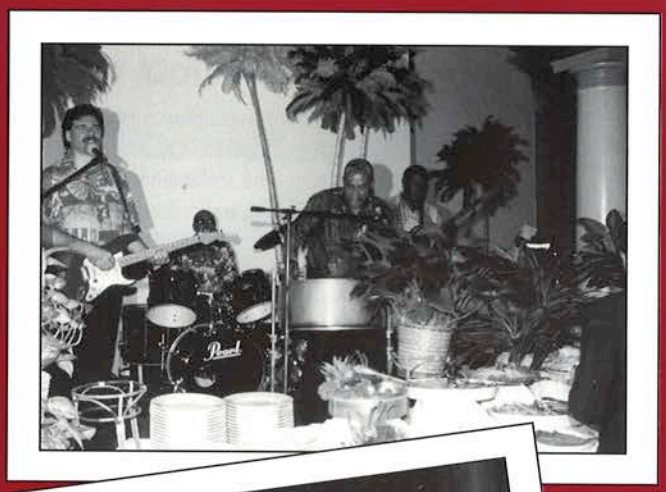
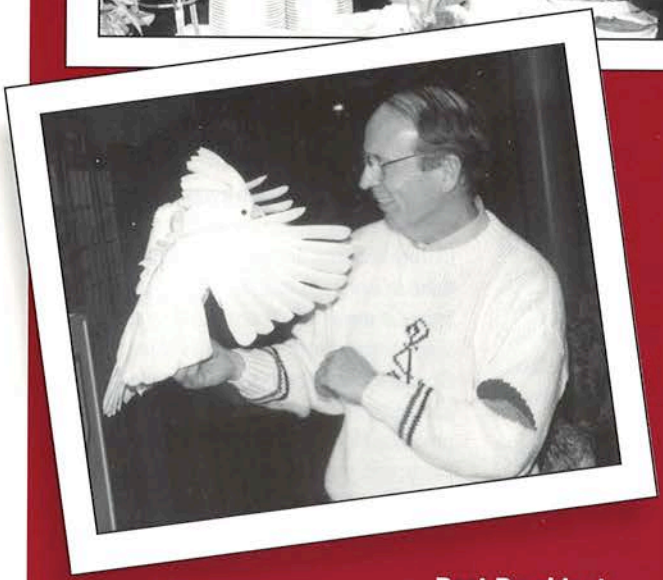
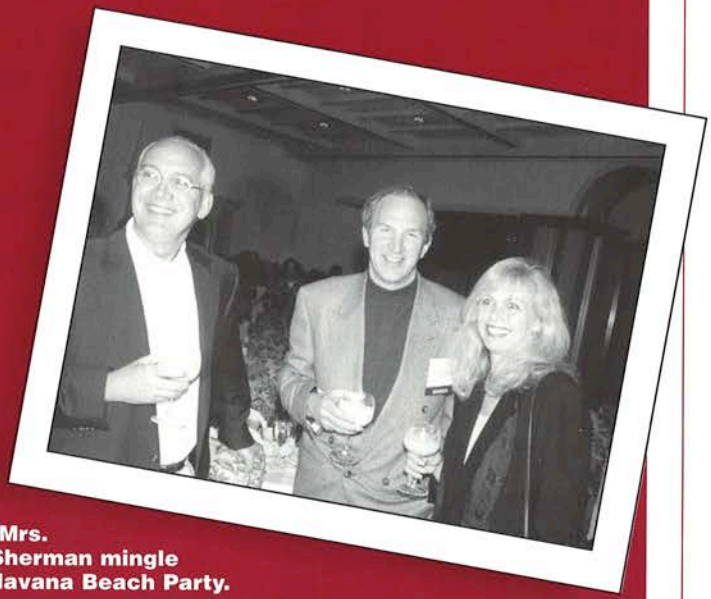


The band captures the festive mood during the Havana Beach Party.

Winners of the First Annual ASRM Golf Tournament Joseph Upton, MD, Mitek representative David Disciorio and James J. Black, MD.



Past President Ralph Manktelow makes a new friend.



Dr. and Mrs. Randy Sherman mingle at the Havana Beach Party.

Desi and Lucy were the center of attention at the Havana Beach Party.

The majority of the '96 Council poses for a snapshot. From left, Saleh Shenaq, MD, Ralph Manktelow, MD, James Nunley, William Swartz, MD, David T. W. Chiu, MD and Daniel Nagle, MD.

What's New in Reconstructive Microsurgery

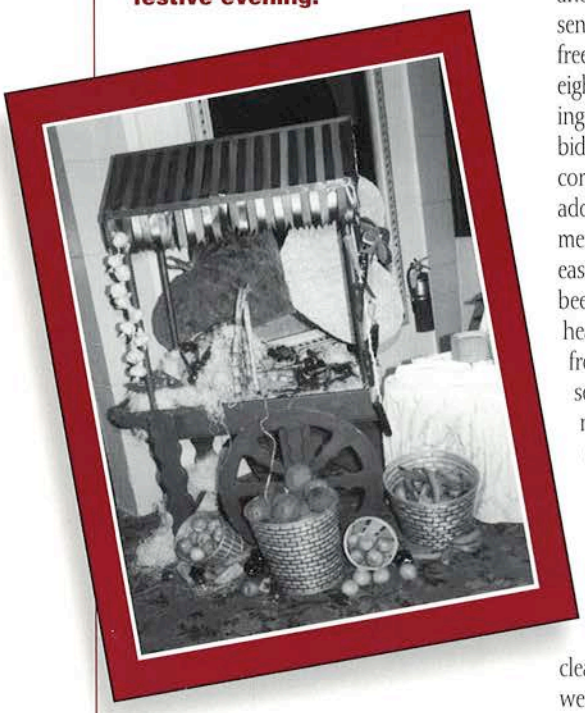
continued from page 6

arterialized the venous system in a rat limb model and studied this with angiographic as well as latex and India Ink injection studies. They demonstrated that arterialization of the venous system can significantly curb ischemic injury to extremity muscle which has suffered loss of its arterial system.

The MD Anderson Group continues to provide us information based on a large, well controlled series assessing flap success. They reviewed all free flaps performed at MD Anderson over an eight year period, asking the question, "Does prior radiation increase total or part free flap loss?" This was not felt to be a significant risk factor. It led to an increase in the risk of total or partial flap loss in free tissue transfers to such patients.

Reconstructive microsurgery is constantly interfacing with all surgical disciplines. Yueh Bih Tang Chen from Taipei, Taiwan, presented her work on revascularization of turnover sternum—a definitive treatment for intractable funnel chest. The thoracic surgeons would have great interest, I am sure, in this paper. Twelve intractable funnel chest deformities were treated by sternal osteotomy and revascularization of the sternum. This was based on the internal mammary vessels. The technique was beautifully presented by Dr. Chen. Vein grafts were used in three cases. This procedure was performed in patients with cardiopulmonary symptoms, which is unusual in the Polands syndrome patient. Despite it being usually a cosmetic operation in North America, there certainly is a place for the vascular anastomosis to aid with growth and viability of large bone and cartilage flaps.

The colorful scenery at the Havana Beach Party made for a festive evening.



The MD Anderson Group continues to provide us information based on a large, well controlled series regarding questions of flap success.

Progress continues to be made in the area of head and neck microsurgery. Miller and colleagues from MD Anderson presented laparoscopic harvesting of jejunal free flaps for esophageal reconstruction in eight patients. Laparoscopic jejunal harvesting is reliable and safe and decreased morbidity and discomfort to patients with comparative conventional approaches. In addition, it further enhances cost containment by reducing hospital stay. In the far east there is a large population that has been afflicted by lye ingestion or extensive head and neck cancers. Hung Chi Chen from Taipei, Taiwan presented a large series of patients that had undergone microsurgical reconstruction in the esophagus in intractable cases. Turbo charging the jejunum, radial forearm flaps in series and prefabrication of free flaps for extra thoracic bypass were presented. This series represented the state of the art in the world for jejunal reconstruction and is clearly an innovative approach to what were thought to be intractable problems.

The relationship between smoking and vessel spasm has been a question in microsurgery and replantation free tissue transfer. Feldman and colleagues from Bowman Gray School of Medicine studied transdermal nicotine and its effect on digital microvascular flow during acute cigarette withdrawal. They found using vital capillarioscopy that transdermal nicotine did not decrease digital microvascular flow thus could be used to ameliorate withdrawal from cigarette smoking without decreasing digital microvascular perfusion. This is an important step forward, something that can be incorporated in a clinical practice.

The world of microsurgery is on the verge of doing allogeneic tissue transplantations (this has already been clinically done in one case that the author of this article is aware of). Potential allografts are single tissue structures such as skin, muscle, vessel, and nerves, or composite tissue allografts. These all require immunosuppression. Hoehnke and colleagues from Pittsburgh presented the induction of immunosuppression via gene therapy. Immunosuppressive cytokines specifically IL10 is a cytokine with strong immunosuppressive activity. Transfixion efficacy was tested and was felt to have the potential of promoting local immunosuppression in a variety of settings especially tissue transplantation. Implications of this are encouraging to truly someday be able to take tissue parts off the shelf rather than from another part of the body.

Siemionow from Cleveland presented in viva work on the robot assisted microsurgery work station. This was originally developed by NASA to the precision position of 20 microns. The robot is controlled by the surgeons hands. The implications for using this device perhaps in the battlefield or in a remote site from the actual surgeon is a fascinating concept. Lanzetta from Milan, Italy presented synthetic alternatives to microvascular vein grafts using small PTFE grafts. These were 1.0 or 1.5 diameter grafts done at the wrist level and represented an advance forward. All of the prostheses were patent at 12 weeks.

Monitoring of free transfers is still a debated subject. Dunn and colleagues pre-

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sented a microelectronic reduction of PH drift and free flap monitoring. Tissue PH monitoring of free tissue transfer, they felt, provided an accurate and reliable technique to assess viability of transfers in all tissue types. Clearly the authors agree that nothing substitutes for clinical observation and perhaps this will take its place in the armentarium of monitoring techniques with more clinical experience.

Minoru Shibata is a true innovator and presented his work on the venoadipofascial flap in 13 flaps in 12 patients. Clearly without a major arterial pedicle, these flaps are technically demanding and are prone to partial necrosis or venous insufficiency at times. Nevertheless, they are alternatives to conventional free tissue transfer and as we gain more and more knowledge of anatomy in the neurocutaneous territories they may take their place as part of our armentarium in microsurgery.

In summary, progress is being made in the areas of vessel coaptation, flap refinement, improving efficiency as well as investigations in molecular biology and genetics as well as investigations in transplantation, molecular biology, and genetics to improve the microsurgeons ability to transplant tissues **RM**

L. Scott Levin, MD, FACS, serves as Chief, Division of Plastic, Reconstructive, Maxillofacial and Oral Surgery, and Associate Professor, Division of Orthopaedic and Plastic and Reconstructive Surgery at Duke University Medical Center, North Carolina.

MICROSURGERY OVERSEAS

Microsurgery Pioneered by Godina Continues in Slovenia

By Zoran M. Arnež, MD, PhD

Microsurgery in Slovenia (at that time a part of former Yugoslavia) started in the University Medical Center in Ljubljana by two pioneers, Vinko Dolenc, MD and Marko Godina, MD.

1973 is the year in which Professor Dolenc began microsurgery with his work on peripheral nerve repair. In that same year, after learning the technique from Robert Acland in Glasgow, Scotland, microvascular surgery was started by Marko Godina. In 1974, Godina successfully performed the first replant and, in 1976, the first free flap transfer. In 1977, he founded the Microsurgical Service, offering continuous microsurgical services at an expert level to the entire population of Yugoslavia, which at that time was 22 million people. All Slovenian, Yugoslav and many international surgeons were educated in microsurgery by Godina. His pupils also introduced microsurgery in other Slovenian towns, such as Nova Gorica (Krunoslav Margić), Novo mesto (Franek Dolšek) and Jesenice (Marjan Fabjan).

From left to right: seated, Matjaž Šolinc, Cvetka Testen, Professor Zoran M. Arnež, Franci Planinšek, Uroš Ahčan: standing, Aleš Leskovšek and Tomaž Janežič.

Marko Godina's primary interest was reconstruction of extremities following trauma. He showed first the clear advantages of early reconstruction (within 72 hours of injury following initial radical primary debridement) over a delayed one. He popularized the use of the end-to-side arterial anastomosis, advocated early mobilization of replanted fingers, "posterior approach" to the posterior tibial artery, the recipient of choice in the lower leg. Godina also instituted the use of arterial vascular grafts and performed the first "heterotopic transplantation" of a hand into the axilla where it was temporarily stored to be replanted later to the forearm stump after the necrosis there had been eliminated. He performed one of the first free latissimus dorsi flap transfers and was involved with the research and clinical application of the saphenous and the lateral arm free flaps.

The University Medical Center in Ljubljana, where microsurgery in Slovenia had its origins.

After Godina's tragic death in 1986, the work in Ljubljana continued. Early reconstruction of traumatic injuries was gradually replaced by emergency free tissue transfer. The same principles were applied in pediatric patients by Zoran M. Arnež.

In 1986, building on Godina's legacy, Arnež performed the first series of the TRAM flaps for breast reconstruction following mastectomy, popularizing the method first in Europe and later in the United States as the procedure of choice for breast reconstruction. His other contributions in free TRAM flap breast reconstruction include selection of the subscapular vascular axis as the recipient of choice for free TRAM flap and the use of the bipedicled free TRAM in presence of a mid abdominal scar. He also introduced reconstructive microsurgery into burns reconstruction in Ljubljana.

In 1990, some of the older surgeons in Ljubljana retired and some of the young ones left for other countries. Zoran M. Arnež became the head of the University Department of Plastic Surgery and Burns in Ljubljana. In 1991, when Slovenia became independent, Ljubljana became the only referral center for all of Slovenia (population: 2 million).

Under those conditions, Arnež attracted and educated young and perspective microsurgeons and replaced the great loss in the number of trauma patients by directing the principal interest of the Department towards reconstruction following cancer. Esophagus, intraoral and mandible reconstructions were started as well as reconstructions following ablative operations of sarcomas.

Research was also started by Zoran M. Arnež. The principle areas of interest were the effects of smoking and cold on microcirculation, anatomy studies of the internal mammary vein, lateral extension of the free scapular flap, the mega flap, studies of sympathetic fiber regeneration by sympathetic fiber regeneration by sympathetic skin response, classification of soft tissue defects and the advantages of the arterial vascular grafts.

At present there are 11 surgeons at the University Department of Plastic Surgery and Burns, Ljubljana. All of them routinely perform microsurgical operations. They perform all major reconstructive procedures in Slovenia and represent the only microsurgical center in the country. Elective microsurgery is also performed in other hospitals. In Slovenia, reconstructive microsurgery is performed only by plastic surgeons. **RM**

Professor Zoran M. Arnež, MD, PhD is Head of the Department of Plastic Surgery and Burns at the University Medical Center Ljubljana, Slovenia, and was the Invited Speaker for the Marko Godina Lecture at the recently concluded ASRM Annual Meeting.

YOUNG MICROSURGEON'S PERSPECTIVE

Peripheral Nerve Regeneration: The Use of Tissue Engineered Conduits

By Gregory R. D. Evans, MD

Tumor extirpation, traumatic injuries and congenital anomalies often result in injury to or sacrifice of critical nerves. Failure to restore injured nerves can result in the loss of muscle function, impaired sensation and/or painful neuropathies. Functional nerve defects have traditionally been reconstructed by the surgical transfer and sacrifice of healthy normal nerve or muscle from an uninjured location (donor site) to the injured site. Although these surgical techniques are still valid today and have advanced nerve restorative outcomes, clinicians are still limited by the requirements for using noninjured donor nerve for nerve grafting because of its resultant donor site morbidity. The use of allografts with immunosuppression for nerve grafting is an option. However, outcomes of nerve reconstruction with the use of allografts have not currently approached results utilizing autografts. Further, oncologic and traumatic considerations frequently preclude the use of allografts with immunosuppression. For these reasons, tissue engineering holds great promise in the treatment of nerve defects following surgical ablation. The focus on engineering a bioactive, biodegradable nerve conduit as a nerve equivalent could eliminate the morbidity associated with autogenous grafts or the use of allografts with immunosuppression.

The idea for the development of a nerve conduit is not new. Glück (1880) initially utilized decalcified bone as a conduit for nerve regeneration. A variety of other substances have been used including fascia, vein grafts and fallopian tubes. The problem encountered with the use of conduits is their current limitations to small nerve defects. Clinically, nerve defects up to 20 cm may require repair for restoration of function. From an engineering design standpoint, the ideal conduits should be easily fabricated, be biodegradable, have low antigenicity, have sufficient porosity to promote vascularization and O2 transport, be able to be fabricated into various diameters and lengths, and provide adequate mechanical support to resist fracturing upon nerve movement.

A variety of studies have focused on developing polymer nerve conduits. Previous nerve guides prepared from polyesters, specifically poly (DL-lactic acid), have demonstrated regeneration. Innervation of the distal nerve stump occurred in conduits, provided the nerve gap was 10 mm or less (Seckel, 1984). In another study, bioabsorable polyglycolic acid nerve conduits were compared with the classical sural nerve graft in 16 monkeys 1 year after implantation. The nerve conduits appeared to act as a scaffold for nerve regeneration (Dellon and Mackinnon, 1988).

A biodegradable, bioactive polymer that serves as a conduit for peripheral nerve regeneration would be superior to what is currently available to clinicians today.

Despite some encouraging results with the use of conduits alone, peripheral nerve regeneration through conduits still falls short from the gold standard of autografting, especially for the re-establishment of function. Several studies have attempted to enhance this growth by filling the conduits with various materials such as collagen, laminin and fibronectin. Although improved results have been obtained over small defects, results still fall short compared to autografts (Keeley, et al, 1993; Rosen, et al, 1992; Tong, 1994).

It is becoming evident that SCs play a unique and dynamic role during nerve repair and are largely responsible for the PNS's unique ability to regenerate. In axonal regeneration following a peripheral nerve injury or transection, SCs proliferate and migrate from proximal and distal nerve ends and form a continuous tissue bridge across the nerve gap. Although the exact underlying mechanisms regulating dynamic axon/SC apposition are unknown, experiments support the concept that SCs offer a highly preferred substrate for axon migration and release bioactive factors which further enhance nerve migration (Martini, 1994; Tonge, 1993).

The first requirement for nerve regeneration through a biodegradable conduit is a porous scaffold for axonal migration. Design requirements are for 1) a fully degradable conduit to be replaced by myelinated axons over a several month period, 2) a porous structure to allow vascularization, and 3) a conduit in which the length and luminal diameter can vary while maintaining structural integrity and flexibility. PLGA polymers are attractive candidates for fabricating conduits because they are biocompatible, able to hold suture, biodegradable into naturally metabolized products, and approved for human implantation by the FDA (Holland et.al., 1986). Three-dimensional porous PLGA foams may be fashioned using a solvent casting and particulate (salt) leaching technique (Mikos et.al., 1994) and are degraded by simple, nonenzymatic hydrolysis at a rate related to the crystallinity and copolymer ratio (Reed and Guilding, 1981; Thomson et.al., 1995). PLGA constructs with specific porosity, surface/volume ratio, pore size, and crystallinity may be produced to meet specific engineering requirements.

Each year, the prolonged recovery from traditionally treated nerve injuries, results in millions of dollars in lost revenue and increased compensation benefits. Our current technology involving nerve repair is limited by the availability of donor tissue and the morbidity related to the sacrifice of donor nerve. A biodegradable, bioactive polymer that serves as a conduit for peripheral nerve regeneration would be superior to what is currently available to clinicians today and has the potential to lead to more cost-effective and less morbid strategies for nerve replacement. **RM**

Gregory R. D. Evans, MD is an Assistant Professor, Department of Plastic Surgery at the University of Texas, MD Anderson Cancer Center, in Houston.

COUNTER PERSPECTIVE

Brachial Plexus Obstetrical Palsy: Nerve Transfer

By Rahul K. Nath, MD

Brachial plexus injury is a complex entity with unpredictable consequences. Relatively few centers manage brachial plexus injuries, and the complexity of each case defies easy definition of cohort groups, so that randomized treatment protocols have not been established.

In the context of obstetrical brachial palsy, the most widely used treatment for the most common injury, rupture of the upper roots, is excision of neuromas and interpositional nerve grafting. This technique attempts to reconstruct anatomic neuronal pathways. Gilbert and Tassin established the value of early surgical intervention using high nerve grafting in altering the natural history of obstetrical palsy[1]. Many additional studies have reiterated Gilbert's findings that return of biceps flexion and shoulder abduction is more predictable than recovery of hand function. Upper trunk lesions can approach 70-80% good or acceptable function, while lower root injuries may only achieve 40-50% recovery to useful levels.

Neurotization... seeks to maximize functional outcome by decreasing the distance/time element of neural regeneration and by increasing specificity of donor inflow.

Given the nature and extent of most plexus injuries, functional outcomes after high anatomic reconstruction are certainly reasonable, but are significantly worse than those of low nerve injuries. Low injuries, of course, are closer to the end organ and therefore have lesser distance/time impediments to recovery. Additionally, distal fascicular architecture is distinctly organized into functional units, so that dedicated motor and sensory reconstruction is easier to plan and achieve.

Neurotization, or more correctly, nerve transfer, to injured elements of the brachial plexus at distal levels seeks to maximize functional outcome by decreasing the distance/time element of neural regeneration, and by increasing specificity of donor inflow. In essence, nerve transfers attempt to convert high nerve injuries to low nerve injuries, hopefully to reflect the more favorable prognosis and time to recovery of low nerve injuries.

Nerve transfer is a management philosophy which is based upon several principles:

1) Preservation of the motor end plate. Return of motor function is dependent upon time and distance. After approximately 12 months or 12 inches of denervation, the end-plate becomes refractory to reinnervation. This 12 month/12 inch limit defines one primary consideration in designing nerve transfers: donor nerves are transected distally at their muscular insertions, then co-apted to recipient nerves as close as practicable to the recipient end-plate. This shortens the distance and the time, to end-organ reinnervation.
2) Avoidance of nerve grafting. Nerve grafting introduces an extra repair site interface for regenerating units to cross. This theoretically increases misdirection and dropout of regenerating units proceeding distally. Correctly designed ipsilateral nerve transfers generally do not require nerve grafts; if grafts are required, they are short. Chuang has recently demonstrated the clinical utility of nerve transfer principles in 99 adult and obstetrical brachial palsy patients, achieving consistently good outcomes in transfers performed without nerve grafting[2]. Transfers requiring interpositional grafts did not achieve similarly satisfactory results.
3) Dedicated function: Axonal plexus formation is maximal at the level of the spinal roots and decreases distally. Therefore, grafting at the cervical root level will increase the chances of sensorimotor and antagonistic muscle group fiber mixing. In contrast, nerve transfers provide relatively pure motor or sensory inflow. The medical pectoral nerve provides strong motor drive to the musculocutaneous nerve without notable functional deficits[3]. Oberlin has had excellent results with transfer of normal ulnar nerve fascicles to the immediately adjacent musculocutaneous nerve, without resultant ulnar deficits[4]. The thoracodorsal nerve will easily reach suprascapular, axillary, and lateral cord elements without interpositional nerve grafts. Fourth webspace transfers to the thumb-index webspace provide rapid sensibility for pinch activities in high median nerve injury.

Nerve grafting introduces an extra repair site interface for regenerating units to cross. This theoretically increases misdirection and dropout of regenerating units proceeding distally.

continued on page 14

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3 Brandt K. E., MacKinnon, S. E., A Technique for Maximizing Biceps Recovery in Brachial Plexus Reconstruction. J Hand Surg. 18A: 726-733 1993.

4 Oberlin C, Beal D, Leechavengvongs S, Salon A, Dauge MC, Sarcy JJ. Nerve transfer to biceps muscle using a part of ulnar nerve for CS-G6 avulsion of the brachial plexus: Anatomical study and report of four cases. J Hand Surg 19A: 232-237,1994.

Direct Nerve Grafting Preferred for Primary Reconstruction in Obstetrical Brachial Plexus Palsy

By Howard M. Clarke, MD, PhD, FRCS(C), FACS

The early treatment of obstetrical lesions of the brachial plexus was largely non-operative. It was only in the 1920's that serious effort was directed at the possibility of surgical intervention. Even these efforts were not widely appreciated until the advent of microsurgery in the 1960's led to a re-exploration of the surgical treatment of these difficult cases. Microsurgical reconstruction has now become routine in many centers and we must endeavor to provide the best surgical options for our patients.

The key to this discussion is that the nerve regeneration following surgery in infants is not the same as in adults. The distances for re-growth into the extremity are shorter, the plasticity of the nervous system in infancy is astounding and the motor end plates do not appear to become refractory as rapidly. The maturation of latency and conduction velocity is even more rapid during regeneration than during normal infant development.[1] For these reasons, we must suspend the usual guidelines developed in adult plexus surgery and treat infant lesions differently. For obstetrical cases, I believe that resection of the ruptured or avulsed segments or resection of even a conducting neuroma-in-continuity should be followed by direct repair via nerve grafting from the proximal stumps for the following reasons:

For obstetrical cases... resection of the ruptured or avulsed segments or resection of even a conducting neuroma-in-continuity should be followed by direct repair via nerve grafting from the proximal stumps....

1. Resection of the neuroma-in-continuity does not downgrade the function of the limb except in the immediate post-operative period. We have shown this in a cohort of patients in whom limb function statistically returned to baseline within three months following surgery despite resection (and grafting) of the neuroma.[2] In essence, discarding the neuroma does no harm.
2. Direct nerve grafting allows any viable axons in the proximal stump a route for re-innervation of the extremity. Leaving the neuroma in place and neurotizing the distal branches from alternate sources leaves the original scar as an impediment to re-growth of potentially useful nerve fibres.
3. The neural reconstruction is more anatomic in that fibers originally intended to innervate the limb are re-directed into it. Neurotization from intercostals, for example, brings nerve fibers originally programmed for quite a different task.
4. In most cases the entire plexus or all but the suprascapular nerve can be directly reconstructed. If distal neurotization is undertaken only specific distal targets can be addressed, leaving the patient with a less than full potential for recovery of all limb functions. Indeed, in obstetrical cases our aim should be to attempt complete restoration of limb function rather than specifically aiming for elbow or shoulder function as undertaken in adult cases.
5. No secondary donor deficit is left from the harvest of other nerves which already innervate the limb, such as the medial pectoral or thoracodorsal nerves, again maximizing the possibilities for the extremity.
6. Direct nerve grafting may be the best answer for the difficult problem of reconstruction of lower trunk deficits where hand function is seriously compromised. While the results of grafting are variable, neither neurotization nor secondary tendon transfers offers good results in this situation.
7. Finally, direct nerve grafting works. At least 90% of our patients undergoing direct interposition nerve grafting for obstetrical plexus lesions have measurably improved strength and function.

In most cases, the entire plexus or all but the suprascapular nerve can be directly reconstructed. If distal neurotization is undertaken, only specific distal targets can be addressed....

Nonetheless there are downsides to direct grafting. The most difficult situation to treat by grafting is that in which there is a paucity of viable proximal axons either because there are multiple levels of root avulsion, or because of an in-continuity lesion which extends to the intervertebral foramen with sufficient disruption to negate substantial sprouting into the grafts.

continued on page 14

1 Kwast O. Electrophysiological assessment of maturation of regenerating motor nerve fibres in infants with brachial plexus palsy. Developmental Medicine and Child Neurology 1989; 31:56-65.

2 Capek L, Clarke HM, Curtis CG. Neuroma-in-continuity resection: Early outcome in obstetrical brachial plexus palsy. In: Vastamäki M, Vilkki S, Göransson H, Jaroma H, Raatikainen T, Viljakka T, eds. 6th Congress of the International Federation of Societies for Surgery of the Hand (IFSSH). Bologna: Monduzzi Editore, 1995:777-80.

Godina Memorial Lecturer

Applications are now welcome for individuals interested in presenting the Godina Lecture at the Thirteenth Annual Meeting. The lecturer must be a member of ASRM and under the age of 43 when the lecture is given. He or she will receive an honorarium of $500 and the Godina Memorial Medal.

Members interested should submit a single paragraph outline of a 30 minute lecture, by May 31, 1997 to:
President William Swartz, MD
Suite 180
5750 Centre Avenue
Pittsburgh, PA 15206

The Godina Memorial Lecture, as established by the trustees of the Marko Godina Fund, is in honor of Marko Godina, MD who died in 1986 at age 43, in the prime of a very successful career in microsurgery. **RM**

New Microsurgical Coding

continued from page 5

20973 great toe with web space

(For great toe, wrap-around procedure, use 26551)

Toe-to-Hand Transfers (Microvascular Anastomosis)

~~26552~~ ~~Reconstruction thumb with toe~~

(26522 has been deleted. To report, see 20973 or 26551, 26553, 26554)

~~26557~~ ~~Toe-to-finger transfer; first stage~~

~~26558~~ ~~each delay~~

~~26559~~ ~~second stage~~

(26557-26559 have been deleted. To report, see 20973 or 26551, 26553, 26554)

20973 Free osteocutaneous flap with microvascular anastomosis; great toe with web space

26551 Toe-to-hand transfer with microvascular anastomosis; great toe "wrap-around" with bone graft

(For great toe with web space, use 20973)

26553 other than great toe, single

26554 other than great toe, double

26556 Free toe joint transfer with microvascular anastomosis

Digestive System Free Tissue Transfers (Microvascular Anastomosis)

49006 Free omental flap with microvascular anastomosis

43496 Free jejunum transfer with microvascular anastomosis **RM**

Daniel J. Nagle, MD serves as the ASSH CPT/RUC Liaison and ASRM Advisor to the ASPRS RUC Subcommittee.

Nerve Transfer

continued from page 12

> Many other transfers are, of course, feasible. Experience has shown that synergisism is not necessary when matching donor and recipient nerves, and that patients receiving ipsilateral nerve transfers do not need extensive retraining.

Based on these precepts, application of nerve transfer techniques to obstetrical palsy has the potential to improve functional results by targeting the most important recipient nerves of the shoulder, arm, and hand and innervating them as distally as possible. Nerve transfer does not preclude trans-root grafting for additional recovery, but does attempt to ensure that critical functions are addressed primarily. **RM**

Rahul K. Nath, MD is an Assistant Professor in the Department of Surgery, Division of Plastic Surgery at Baylor College of Medicine, Houston and practices at Texas Children's Hospital.

Nerve Grafting

continued from page 13

These are the 10% of cases which are not improved by grafting in our experience.

In addition, we use bilateral sural nerve grafts the total available length of which may limit the number of grafts which can be utilized. This is rarely a problem in isolated upper trunk lesions but may prove difficult in an extensive lesion of the upper and middle trunks or in a total plexus lesion.

Our approach is to repair the injury directly. This involves resection of the damaged tissue and reconstruction as far as possible from the relevant proximal stumps. We will readily add a neurotization from the distal accessory nerve to the suprascapular nerve if donor stumps or nerve graft material is limited. This is often the case in combined reconstruction of the upper and middle trunks. In this situation the distance from the C5 stump to the suprascapular nerve is often 4.5-5 cm and the total amount of graft material from both legs only 25 cm. I feel that this same piece of graft can more usefully be divided to provide two grafts from C7 to the middle trunk.

To conclude, the challenge of reconstruction of the deficit following obstetrical brachial plexus trauma deserves an approach which maximizes the opportunities for all the available proximal axons to reach the distal extremity and an approach which does not limit any of the options for later reconstruction. This approach is resection of the lesion followed by direct nerve grafting. **RM**

Howard M. Clarke, MD, PhD, FRCS(C), FACS is an Associate Professor in the Division of Plastic Surgery, Department of Surgery, University of Toronto and practices at the Hospital for Sick Children in Toronto.

Good Picture Quality is Key

By Keith E. Brandt, MD

Immediate Breast Reconstruction Using the Free TRAM Flap

Author: James C. Grotting, MD

Intended Audience: Plastic Surgeons, Plastic Surgery Residents

Length: 20 min

Rating: 3 fingers

Summary: Dr. Grotting presents an excellent discussion of the operative planning and performance of the free TRAM flap. Included are details about how to determine the size of flap that will be needed, minimize the amount of rectus muscle harvested and shape the new breast. He even provides considerable detail about how to close the abdominal wall defect and how to add shape to the abdomin by advancing bilateral external oblique fascial flaps.

The video was given only a three finger replant rating because of the narcoleptic cameraman. There was very little attempt made to zoom in or focus better to provide the viewer a better picture. The surgeon's attempt to demonstrate the rectus perforators was lost in large red blur. Nearly the whole presentation is shot from overhead which is not necessarily the best view, especially when showing how to shape a three dimensional breast. In addition, the video is hampered by obscuring shadows and poor contrast. I say we get Spielberg to go to Birmingham and have Grotting do it again.

The Radial Forearm Osteo-fascio-cutaneous Flap Revisited

Authors: Norman Weinzweig, MD, Harry K. Moon, MD and Jeffrey Weinzweig, MD

Intended Audience: Plastic Surgeons, Head and Neck Surgeons, ENT Surgeons

Length: 17 min

Rating: 4 fingers

Summary: This video demonstrates the technique of harvesting a radial forearm osteo-fascio-cutaneous flap utilizing a curvilinear cut of the radius. The tape discusses the advantages of the radial forearm harvest site including the possibility of; multiple osteotomies to better contour the bone, dual skin paddles for intra or extra oral coverage and a thin relatively hairless skin paddle. The major disadvantage is the risk of fracture at the harvest site and thus the impetus to excise a keel shaped bone flap and hopefully reduce the risk of fracture. The authors recommend harvesting the bone with a sagittal saw for better control. The authors also emphasize that no more than 35% of the cross section of the radius should be harvested and that the patient should be maintained in a long arm cast for 6 weeks.

The picture quality is very good during the dissection of the flap because of the minimal blood staining while operating under tourniquet control. The cameraman was awake and moved positions to achieve the best angle and utilized zoom and focus appropriately. While the pictures are good, the narration was less so. I know that my Texas accent would disqualify me from ever narrating a production and so it should be for the northeasterner on this tape. **RM**

Video Rating Scale

5 Finger Replant
Excellent

4 Finger Replant
Good

3 Finger Replant
Fair

1 Finger Replant
Poor

ASRM Microsurgery Calendar

June 6-8, 1997
New England Society of Plastic and Reconstructive Surgeons
Woodstock, VT
Contact: Charlotte Constantian
(603) 880-4385

July 24-27, 1997
Conjoint Symposium on Nasal Reconstruction
Boston, MA
Contact: AA-HNSF
(703) 519-1542

September 20–24, 1997
ASPRS/PSEF/ASMS Annual Meeting
San Francisco, California
Contact: ASPRS
(800) 766-4955

January 7–10, 1998
AAHS 28th Annual Meeting
Scottsdale, Arizona
Contact: AAHS
(847) 228-9758

January 10–13, 1998
ASRM 13th Annual Meeting
Scottsdale, Arizona
Contact: ASRM
(847) 228-9717

LETTER TO THE EDITOR

The Search is On for Microsurgical Experts to Set Up Model Clinics

Dear ASRM Colleague,

I would like the opportunity to discuss or correspond with you concerning your ideas, advise and professional feedback for setting up an ideal model micro surgical center, including an educational division for medical students and surgery residents, a clinical unit inside a hospital and a laboratory area for practice and investigation.

Our community in Monterrey, Mexico has a great need for an exemplary micro surgical medical center. Approximately 100 plastic surgeons serve a community of 4 million people in the Monterrey metropolitan area. Monterrey is located 125 miles south of the Texas border. We have the financial resources and a great number of doctors waiting for the opportunity to learn and work in a microsurgical clinic, but we still lack an initial model clinic and education unit in Monterrey.

Concerning the educational division, if you have prior microsurgical didactical experience or perhaps you have developed thematic programs or have written class materials pertaining microsurgery, you could be an asset for our initial development planning for the teaching of the residents.

The clinical and laboratory units must be state of the art, not only in the machinery but also the surgeons' knowledge and technique in knowing how to perform and excel in microsurgery.

Please lend a hand by helping me in the set up of our new micro surgical multi-medical unit. Please feel free to contact me at the following numbers, and let's make an academic, investigation and friendship bridge between our cities.

Thank you for your kind attention.

Sincerely,

Eugenio Pacelli-Chapa, MD
Monterrey, Nuevo Leon, Mexico

Listed below are addresses where you may send your response to Dr. Pacelli's letter.

Monterrey, Nuevo Leon, Mexico:

Eugenio Pacelli-Chapa, MD
Bosques de Pirineos #439 pte.
Col. Bosques del Valle
Garza Garcia, Nuevo Leon,
Mexico 66250
Phone (52) (8) 3-56-11-88

Mailing address for letters, catalogs, small boxes:

Eugenio Pacelli-Chapa, MD
Suite 7-606
14422 Industry Avenue
I.T.C. Park
Laredo, Texas 78041
USA

E-Mail address:

EugenioP@intercable.net *or*
gabyro@intercable.net

RECONSTRUCTIVE MICROSURGERY

444 East Algonquin Road
Arlington Heights, Illinois 60005

Inside this issue: