The WSRM Newsletter
Spring-Summer 2017
Volume 7, Issue 10

World Society for Reconstructive Microsurgery

Message from the Editor

David Chwei-Chin Chuang, M.D.
President WSRM

Dear Members of the WSRM:

This is my last time giving the "Message from the Editor" during my WSRM presidency period (from March 2015 to June 2017). I have been contributing to reconstructive microsurgery for more than 30 years since 1984. As a reconstructive microsurgeon, it is my greatest honor to be the President of this distinguished international Society. I am very proud to be a member of the Society because many world experts continuously put forth their efforts for this Society to become the best and to serve as an umbrella organization. I would like to briefly share with you what our Society has done since the last edition of this newsletter (Spring-Summer 2016) and what we are enthusiastically continuing to move forward with for our society.

(1) Continue to strengthen ties between the WSRM Central Office and Regional Societies

The WSRM has four Regional Societies, North America (ASRM), Latin America (ALAM), Europe (EFSM), and Asian Pacific (APFSRM) that represent for continental societies. Last year, WSRM central office was the first time partnering in either pre-, or post-Congress symposia with four regional societies. The results were very positive and successful. It has achieved a strong mutual confidence, and all four societies have asked for continuous cooperation with future meetings. The next four regional continental meetings are:

- The 3rd ALAM meeting in Cartagena, Colombia, Nov. 29-Dec 2, 2017
- 2018 ASRM meeting in Fajardo, Puerto Rico, Jan 13-16, 2018
- 14th EFSM meeting in Belgrade, Serbia, April 25-28, 2018
- 4th APFSRM meeting in Antalya, Turkey, May 10-13 2018

WSRM will co-coordinate a pre-symposium or panel with the regional society meeting. I sincerely appreciate the President-Elect Prof Isao Koshima, Vice President Dr. David Chang, our council members, and Dr. Marco Innocenti for their enthusiasm and great help to join the pre-symposia and their Society meetings to make the symposia successful and prosperous.

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In this edition

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(2) WSRM Task Force
We established the WSRM Task Force Committee in January, 2016 after the council meeting in Scottsdale, Arizona. The aim of the committee is to look at the governance and financial stability of WSRM, and make a strategic plan with a focused direction for WSRM marketing. The WSRM Task Force Committee has achieved the following:

1. WSRM Dues Collection:
We had a membership dues collection crisis last year (2016). After sending out multiple emails and calls, we have roughly only 42% of our membership who are up to date with their dues payments. Therefore, all council members worked together on contacting their native members that are delinquent in dues and requesting to bring their membership up to date. The collection rate suddenly increased to 49% within months. We have to continuously work for this issue, since it is vitally important to continue to grow our society. I sincerely thank all our council members' for their great assistance, especially our Secretary General Dr. Robert Walton who has put forth a lot of effort for dues collection.

2. WSRM Yearly White Paper
Since the term of "White Paper" is so serious and many bias, to avoid this we changed it to a subject "A Perspective on the Future of Reconstructive Microsurgery". Two hot subjects were selected:

1) From Auto-Transplantation to Allo-Transplantation – A Perspective on the Future of Reconstructive Microsurgery: Dr. Scott Levin, Dr. Andrew Lee, and Dr. Fu-Chan Wei were chosen as authors.

2) Distal Nerve Transfers: Dr. Susan Mackinnon, Dr. K Doi, and Dr. David C Chuang were chosen as authors.

These expert's articles, once collected, will be published in WSRM newsletter and Journal of Reconstructive Microsurgery. The authors will also present their papers during the 2017 Congress Meeting in Seoul, Korea, June 14-17, 2017.

3. WSRM Service Committee
The aim of the WSRM Service Committee is to investigate opportunities for WSRM to engage in clinical and educational service missions to local hospitals, to teach local surgeons and to address patient care. This is a big issue with many challenges related to the medical and legal issues of service work, financing and cost issues to WSRM to name a few. It is now in the very beginning stages and will continue to develop over time.

4. WSRM the Future
There are still some regions that WSRM does not have contact with such as Australia, mid-Asia, south-Asia, Middle East and Africa. To be an umbrella international organization for all microsurgeons around the world, WSRM intends to reach out to these areas to provide any assistance to their region and form a mutual cooperation.

Finally, I remind you to mark your calendar to attend the 2017 WSRM World Congress in Seoul, Korea, June 14-17, 2017. It is a three day meeting with the theme of "Bridging the Gap and Beyond". Please see the website (secretariat@wsrm2017.com) for details. The local Chairmen: Dr. Myong Chul Park, Dr. Goo Hyun Baek, and Scientific Program Chairmen: Dr. JP Hong, Dr. GH Mun and Dr. JW Pak all have worked very hard for this World Congress meeting. There are already 240 confirmed invited faculty from 57 countries. I strongly believe this Congress will be a very meaningful, valuable and unforgettable meeting to those that attend. I look forward to seeing all of you in Seoul.

David CC Chuang, M.D.

WSRM Endorsement Microsurgery Seminars, Meetings & Workshops Worldwide

WSRM is making an effort to show its support of the various microsurgery activities and meetings that take place around the world. Please visit www.wsrm.net to view the endorsement guidelines. A formal request must be submitted addressing the guidelines stated and your qualifications. The WSRM will not endorse a meeting within the same region and within one year of the biennial congress. The WSRM will only endorse national meetings.

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2017 Congress Preview - Seoul, Korea

WSRM 2017

9TH CONGRESS OF WORLD SOCIETY FOR RECONSTRUCTIVE MICROSURGERY

June 14(Wed) - 17(Sat), 2017
COEX, Seoul, Korea

"Bridging the Gap and Beyond"

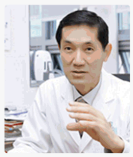
www.wsrm2017.com

The WSRM 2017 is just around the corner !

Make sure you are also on board!

David CC Chuang, M.D.
President, WSRM
2015-2017.

"The WSRM has involved the world's major groups of reconstructive microsurgeons. It provides the most wonderful opportunities and benefits to many microsurgeons to share and change of their thoughts, ideas and techniques, to meet many pioneers in different specialized fields, and to get acquainted with many friends from different countries."



Myong Chul Park, M.D., Ph.D
Chairman
Organizing Committee of WSRM 2017.

"Under the theme of "Bridging the Gap and Beyond", the Organizing Committee of WSRM 2017 is now putting its upmost efforts to put together an excellent scientific program in order to ensure that you are up-to-date with the latest trends and developments by distinguished microsurgeons from around the world."

Pre Congress Video Workshop

Wednesday, June 14, 2017

- Breast: DIEP/TRAM Flap, PAP/four Flaps
- Lymphatic: Supraclavicular LN transfer, LVA
- Transplant: Facial, Bilateral Hand
- Facial Reanimation: Endoscopy Assisted Gracilis, one-stage LD
- Head and Neck : Vascularized Fibular Mandible, Nasal Reconstruction
- Flaps: Keystone, Propeller, Venous, Fibular Head
- Lower Extremity: Neuromusculotendineous Transfer

*** Required the $ 50 registration fee

Call for Best Innovative Case Of the Year

Do not miss the chance to win "Best Innovative Case" Competition!
Send us a short synopsis of the case to program@wsrm2017.com
* Deadline : April 15

Have you decided Where you're going to stay?

Accommodation Reservation
The official Housing Bureau of WSRM 2017 will assist you to book a hotel for your stay in Korea.
* Deadline : May 14

Last Chance to Register with the Discounted Price!

Category	Regular Registration (April 01~ 30, 2017)	Late Registration (May 1, 2017 ~ Onsite)
WSRM Member	US $ 750	US $ 850
WSRM Non Member	US $ 850	US $ 950
Resident/ Fellow / Allied Health Professional	US $ 400	US $ 450
Medical student* (meal ticket)	US $ 250	US $ 300
Accompanying Person	US $ 300	US $ 400
Pre-Congress Video Workshop (June 14, 2017)	US $ 50	US $ 50
Congress Dinner Ticket	US $ 100	US $ 100

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Interesting Case

David Chwei-Chin Chuang, M.D. (Professor)
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Total Brachial Plexus Allotransplantation – Experimental Study in Lewis Brown Norway and Lewis Rats

Introduction

Brachial plexus injuries (BPI) remain a significant concern not only for its devastating morbidity but also for its heavy social cost especially when young, healthy individuals are affected. Current reconstructive methods for BPI remain effective.[1-2] For pan-plexus ruptures of the BPI it can be treated by interposing small diameter of cable nerve grafts as well as large diameter of vascularized ulnar nerve graft autogenously between proximal and distal nerve ends. However, lack of nerve graft resources is always one of the major problems for pan-plexus injury reconstruction. Experimental work still strives to look for the ideal nerve conduit for longer defects. In additional, a vascularized nerve graft has been shown that the tested animals have improved functional outcomes by preventing intraneural fibrosis and providing adequate substrate for rapid axonal regeneration.[3,4]

In nerve allografts, it has been investigated for decades.[20-27] While immunosuppression with cyclosporine (CsA) or tacrolimus (FK506) has beneficial effects on regenerating nerves, there is increasingly interested in the concept of immune tolerance which may be readily induced in allograft recipients. With either the development of immune tolerance or less toxic immunosuppressants nerve allografts could theoretically provide us unlimited amount of donor nerves for extensive and long nerve defects reconstruction such as BPI or sciatic nerve injuries. Evidence of the long-term success of vascularized allograft nerves comes from hand allotransplantation trials, in which intrinsic muscle and sensory nerve recovery were identified one year post-operatively.5,6 Using cadaveric brachial plexus in reconstructing certain specific BPI becomes a potential to provide a short operation time, decrease the donor sites morbidity and achieve a rapidly functional recovery. The purpose of this study was to develop a vascularized brachial plexus model in rats and to determine the role of allotransplantation in the brachial plexus reconstruction.

MATERIALS AND METHODS

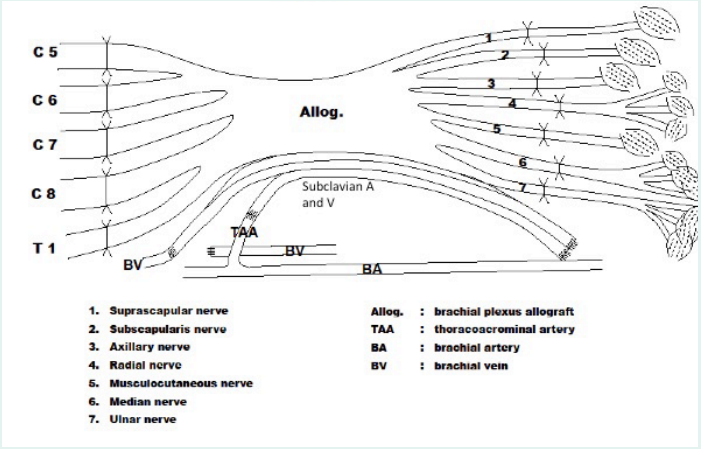
Twenty-four Lewis rats (RT 11) weighing 350 gm to 400 gm were recipients in all treatment groups. Vascularized allogenic brachial plexuses were transplanted from the donor Lewis Brown Norway rats (RT11+n) with the same number and similar weight . Transplantation of tissues from Lewis Brown Norwary to Lewis rats is known to constitute a major histocompatability barrier. All transplantats were orthotopic and replaced the whole brachial plexus of the recipient's left forelimb. All experimental conditions were approved by the Chang Gung Memorial Hospital Animal Care Committee and in accordance with Chang Gung University ethical guidelines.

Animals were divided into four groups and six rats in each:

Group I: En bloc resection of the whole brachial plexus from spinal nerve level to the terminal branches without reconstruction.

Group II: Vascularized brachial plexus allotransplantation with CsA treatment

Fig. 1



Group III: Vascularized brachial plexus allotransplantation without CsA treatment. Group IV: Vascularized brachial plexus auto-transplantation as the control group.

Animals in group II received subcutaneous CsA injection daily starting 24 hours pre-operatively. During the first week CsA was given at a dose of 16 mg/Kg / day. CsA was then reduced in half dose 8 mg/Kg for weeks 2 to 8 before being titrated to 6 mg/Kg/day for maintenance of immunosuppression. The animals were weighed twice a week. The dose was adjusted based on body weight changes. Flaps were daily observed, and animals were carefully monitored for dehydration or drug toxicity.

The operative rat was placed in the supine position and anesthetized with isoflurane (Halocarbon Laboratories) inhalation as induction and subsequent maintenance. The left upper extremity and chest were shaved and prepared in a sterile fashion.

Harvest of Vascularized Brachial Plexus

In Lewis Brown Norway rat a 2 x 1 cm^2 elliptical skin was marked from the upper arm down to the volar medial aspect of the elbow region . Under loope magnification,

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Interesting Case - *continued from pg 4*

the upper border of the marked skin flap was incised first, and extended upward to the clavicle. The pectoralis major and minor muscles were divided to expose the supra- and infraclavicular brachial plexus. Incision along the marked skin flap was continued. Under operating microscope, dissection along the axillary artery, brachial artery down to the elbow region was performed. A constant skin perforator branching from the brachial artery at the groove between the pectoralis major and biceps could be identified and preserved. This septocutaneous perforator skin flap was important for monitoring flap (neurocutaneous flap) perfusion and reaction of the allograft rejection. The distal end of the brachial artery and vein were ligated at the elbow level. The neurocutaneous flap was elevated in retrograde fashion. Seven distal branches were identified, labeled and divided, including suprascapular nerve, branch to the subscapularis, axillary nerve, radial nerve, musculocutaneous nerve, median nerve and ulna nerve. Proximally the five spinal nerves including C5, C6, C7, C8, and T1 were labeled too and divided. The brachial plexus and subclavian artery and vein were isolated en bloc, with care taken not to separate the plexus from its vasculature. The whole plexus was lengthy about 3.5 cm . The vascular pedicle was transected once the Lewis recipient rat was ready for transplantation.

Recipient Site Preparation

In Lewis rat, a lazy S-shaped incision inferior and roughly parallel to the clavicle was made from left mid-clavicle to the proximal arm. The pectoralis major and minor muscles were divided at its tendinous attachment, and tagged with a suture. An about 3.5 cm of brachial plexus was dissected and removed. The all cut ends of the prepared nerves were tagged with 10–0 nylon. The thoracoacromial artery and subclavian vein were dissected and prepared for anastomoses.

Brachial Plexus Reconstruction

The donor brachial plexus and its accompanying monitor skin flap from the prepared Lewis-Brown Norway rat was harvested following transaction of the vessel pedicle, and transferred to the recipient Lewis rat. The donor subclavian artery and vein were anastomosed to the recipient thoracoacromial artery and subclavian vein. The transplanted brachial plexus became vascularized. Coaptation of nerves was performed one by one using 11-O nylon sutures epineurially. The pectoralis major muscle was sutured back at the completion of the nerve repairs. The monitored skin flap was sutured for wound closure with interrupted nylon sutures.

Post-operatively animals were placed under a warming light and monitored closely until emergence from general anesthetic was complete. The transplanted skin flap was monitored carefully for signs of wound infection, self-mutilation or drug toxicity. Animals were housed individually, kept on a 12 hour light/dark cycle and allowed free access to food and water. Skin flaps were monitored daily for signs of flap ischemia, rejection, and wound infection. Functional evaluation started at postoperative 4th week.

Grooming Test

Grooming test was performed every 2 weeks. Animals were observed using digital video recordings as they attempted to remove drops of water from their heads. The test is graded on a 5-point scale: scored 5 if the paw reaches behind the ear; 3 if the paw passes the snout but does not reach the eye; and 1 if the paw moves but does not reach the snout. Video recording allows the movement to be studied in slow motion. Multiple assessments were performed and the best score was recorded. The grooming test allows assessment of shoulder abduction and elbow flexion.

Electrophysiologic Study

At 16 weeks, animals were re-anesthetized with isoflurane inhalation. The previous operative site was explored, and the nerve repair sites were inspected for integrity. The entire brachial plexus, the terminal branches and the innervated muscles were carefully dissected and isolated. The electrophysiological set-up involved two reference electrodes positioned subcutaneously in the lateral chest region on both sides. The stimulating electrode was placed on a motor nerve, and the recording electrode was inserted in the respective target muscle. Musculocutaneous nerve, radial nerve, median nerve, and ulnar nerve were assessed. The respective target muscles included biceps, triceps, forearm extensor group (including all extensor muscles of the wrist and digits), and forearm flexor group (including all flexors of the wrist and digits). Median and ulnar nerves were stimulated simultaneously in assessing the forearm flexor group. Stimulating rectangular pulses of 0.5 msec duration and 50 to 100 V in amplitude were delivered. The test was performed bilaterally so that each animal had its own control data.

Muscle Strength Test

Following electrodiagnostic testing, biceps, triceps, forearm extensor and flexor group were assessed using a force-displacement transducer and computerized recording software. Initially, the resting muscle length of the tendons was determined. The distal tendon of biceps and triceps were severed at their insertions respectively at the elbow. The wrist and digital flexors were isolated en bloc, sutured together and detached distally at the wrist. The same procedures were performed for wrist and digital extensors. Sequentially each muscle group was attached to the force transducer. The shoulder, elbow and wrist joints were immobilized on the operating platform by fixation pins. Prior

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to stimulation the muscle length was adjusted to match its resting length and therefore the resting tension was recorded before stimulation of the nerve. Stimulation of the musculocutaneous nerve was performed for activation of the biceps muscle; radial nerve for triceps and forearm extensors; and median and ulnar nerve simultaneously for the forearm flexor group. The nerve was stimulated at threshold, two times threshold and ten times threshold. Five recordings were made at each level. The outcome was recorded as weight for each threshold stimulated. The right forelimb served as control while the left forelimb was the experimental limb.

Muscle and Nerve Histomorphometry

On completion of EMG and muscle force studies each muscle group was harvested and weighed. Weighing was performed within 2 hours of death in order to prevent water loss from the tissues. Nerve specimens were obtained proximal to the coaptation site, processed in Epon, and cut at 1 mm intervals. The nerves were then stained with hematoxylin and eosin (H&E) and 2% toluidine blue. Image-pro plus 6.0 software was used to evaluate the histological sections and the data was analyzed by Kruskal-Wallis test. A P value below 0.05 was considered significant.

RESULTS

Flap Observation and Grooming Test

Six rats of group I (en bloc resection of the whole brachial plexus without repair) were done but only 4 rats survived. Three rats did not show any return of forelimb function at four months, while one demonstrated some shoulder and elbow function (grooming test score=1) at 8th week. At 16th week the average grooming test score in group I was 0.25.

Six rats of group II (Vascularized brachial plexus allotransplantation with CsA immunosuppression) all showed good in the monitor skin flap (Fig. 2). All animals demonstrated shoulder movement beginning at 4th week. Gradual improvement in shoulder and elbow function was seen in the following weeks. No animal attained a score of five, but most animals could reach the eye. At 16 weeks the average grooming test score in group II was 3.5.

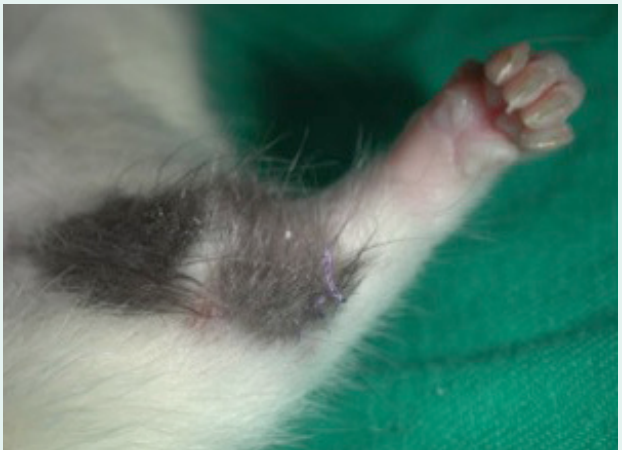


Fig. 2

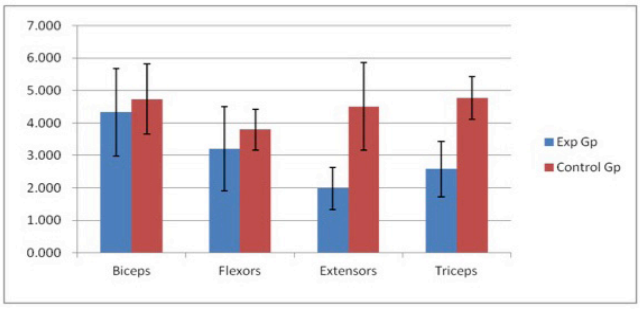
Six rats of group III (Vascularized brachial plexus allotransplantation without CsA immunosuppression) were done but one died and five rats survived. Skin flaps showed signs of rejection between five to seven days post-operatively. The rejected skin paddle shrank and sloughed off between 19 and 22 days. Some animals still regained shoulder movement but with very poor elbow function. At 16 weeks the average grooming test score in group III was 1.4.

Six rats of group IV (vascularized brachial plexus auto-transplantation) were done but one died and five rats survived. In the 8th week group IV rats regained shoulder and elbow function earlier and quicker than rats observed in group II. However, the final grooming test score was similar to the group II. No animal attained a score of five, but most animals could reach eye level. At 16 weeks the average grooming test score in group IV was 3.75.

Electrophysiological Study

In Group I rats, all targeted nerves were resected which precluded the electrophysiological tests. Group II and IV rats had similar mean amplitude (mV) of muscle compound action potentials for all examined targeted muscles (triceps, biceps, forearm flexors, and forearm extensors), but Group III had much worse results. (Table 1)

Table 1. EMG, MNCV



Muscle Strength Test

Group I rats were precluded for muscle contraction strength tests. Group II and IV rats demonstrated similar muscle strength in triceps, biceps, forearm flexor and extensor muscle groups. The proximal muscles (triceps and biceps) strength in group III was poor and even worse in the distal muscle groups (forearm flexors and extensors). (Table 2)

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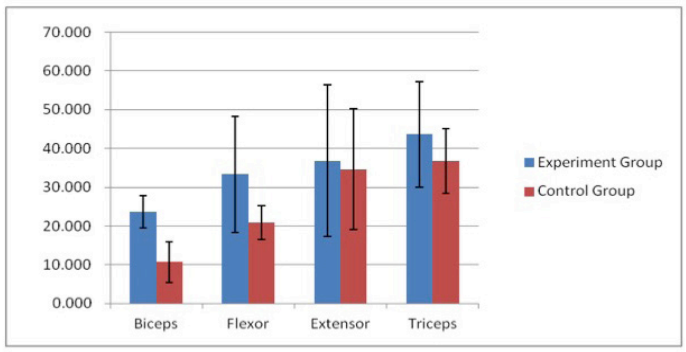
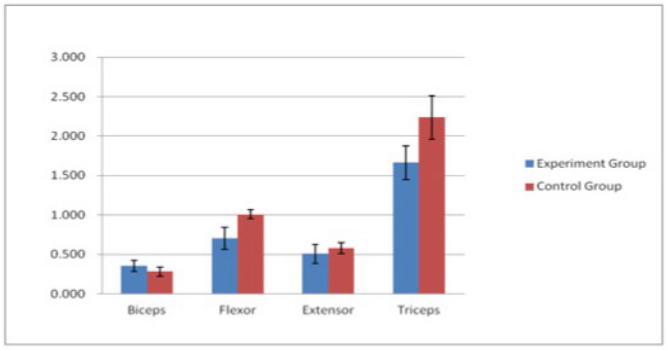
Table 2. Muscle Tetanus Contraction Force



Muscle Weight

Group I animals showed the most significant atrophy in all proximal and distal muscle groups. Group II and IV animals demonstrated in general comparable results in muscle weight, and similar degree of atrophy. Rats in groups III also showed atrophy especially in the distal muscle groups, but the degree of atrophy was not as severe as those in group I. (Table 3)

Table 3. Muscle Weight

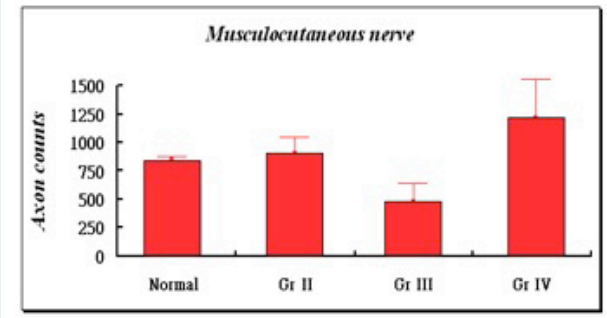


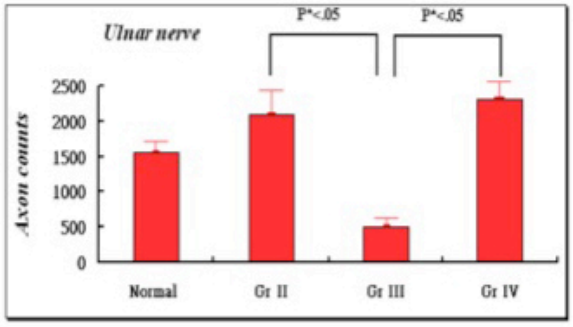
Histomorphometry

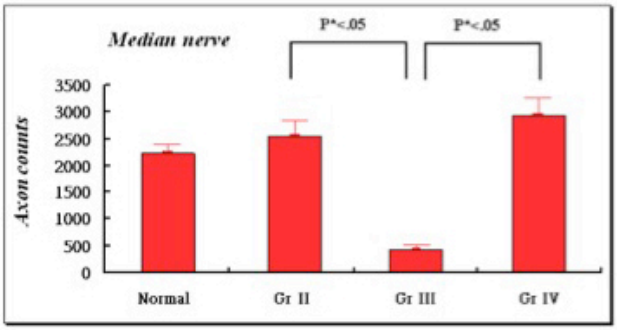
All experimental rats, re-explored at 16 weeks, showed scaring. Allograft nerves in recipients of Group III appeared grossly more shrunken and adherent to the surrounding tissues. Although there was evident of regeneration in nerve allograft of Group III, the regenerating nerve fibers were all small in diameter and poor in myelination, disruption and disorientation of axon fibers with inflammatory cell infiltration, greater degree of nerve degeneration, and markedly increased proportion of connective fibrotic tissue were noted in this group. In contrast, the nerve allograft treated with CsA (Group II) appeared more like the nerve autograft (Group IV). In these specimens of Group II and IV they demonstrated excellent nerve regeneration with a dense population of well myelinated fibers. The grafts were well vascularized without evidence of vascular thrombosis. The fibrotic scars were less apparent and the fascicles were well oriented. The morphology of nerve regeneration was quite correlated with the functional and electrophysiologic results.

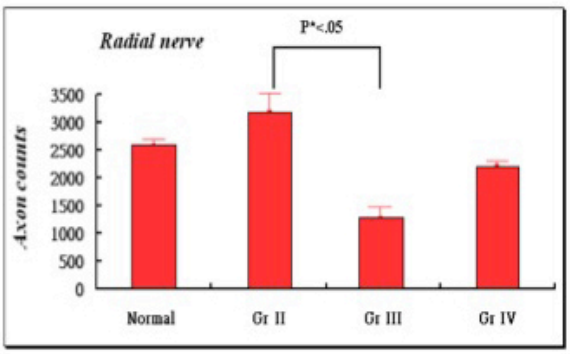
The mean axon diameter) was larger in immunosuppressed recipients (Group II) and autografts (Group IV) than the untreated allograft recipients (Group III) in the tested nerves: radial, musculocutaneous, median and ulnar nerves. Untreated recipients (Group III) were noted to have markedly decreased axon counts in radial, musculocutaneous, median and ulnar nerves, compared to the treated recipients (Group II) and autografts (Group IV) (Table 4).

Table 4. Average Axon Counts









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DISCUSSION

Non-Vascularized Nerve Allograft

Use of nerve allografts as a solution to the problem of insufficient autologous donor nerves has been studied since 1885.[7] However, the early results were not accepted. After the combination of microsurgical techniques in 1970s and the introduction of immunosuppressant in 1980s nerve allograft becomes a realistic reconstructive option. Zalewski[8] used non-vascularized nerve allotransplantation in rats and demonstrated that grafts were accepted if adequate immunosuppressant was given. Follow-up studies on rat sciatic nerves confirmed that allografts were also functionally similar to autologus nerve grafts when appropriate immunosuppressant is utilized.[9]

Vascularized Nerve Allograft

Muramatsu K et al[9] investigated the use of vascularized orthotopically allotransplant, a 40 mm saphenous nerve graft based on the saphenous artery and vein in Dark Agouti to Lewis in 1995. Vascularized and non-vascularized allografts in animals, if not receiving immunosuppressant, showed same signs of rejection within the first 3 days. The non-vascularized nerve allograft animals, if receiving CsA immunosuppressant 3mg/kg/day intramuscularly for six weeks and discontinued, would show histological signs of rejection 2 weeks after.[7,10] Similarly, once immunosuppressant was stopped the vascularized allografts in immunosuppression animals showed rejection too and even sooner than non-vascualrized nerve grafts. The authors concluded that vascularized nerve grafts are more antigenic than non-vascularized nerve grafts. One reason for the poor result of vascularized nerve grafts in the Group III of this study might be due to inadequate CsA dosage.

Clinical Application

Mackinnon[11] has pioneered the reconstruction of large peripheral nerve defects by using cadaveric allografts which were harvested and preserved for 7 days in University of Wisconsin Cold Storage Solution at 5°C before transplantation. The small-diameter allografts worked well as predicted and were preferable for reconstruction. The large-diameter allograft could be microneurolyzed to provide multiple cables of small diameter allografts. Patients were started on an immunosuppressive regimen consisting of either cyclosporin A or tacrolimus (FK506), azathioprine, and prednisone. In another study, Mackinnon[12] demonstrated that the nerve allograft serves as a temporary conduit. Axons regenerate through the conduit and the donor Schwann cells are replaced by host Schwann cells. The antigenicity exists only temporarily in nerve allograft. Immunosuppressant can be discontinued after regeneration across the allograft is evident.

Follow-up in hand allotransplantation trials has proved that nerve regeneration into the transplant allows some intrinsic muscle and sensory recovery within one year postoperatively.[5] The results are encouraging and prove that nerve regeneration in composite tissue allotransplantation is possible and functional recovery can be expected.

Brachial Plexus Nerve Allotransplantation

In Levy's human cadaveric study[13] four angiosomes of the human brachial plexus were identified, including subclavian, axillary, vertebral and dorsal scapular arteries. The human brachial plexus was almost entirely nourished by the subclavian system. As noted in previous angiosome studies, connections between angiosome territories lay within tissues. In Levy's study, the vascular connections between each angiosomes were within the nerve. This study illustrates the potential to harvest the vascularized brachial plexus as a free neural flap for allotransplantation in humans. Allogenic cadaveric brachial plexus is therefore considered a potential solution for specific brachial plexus injuries: in C5-T1 five spinal nerves either one rupture and 4 root avulsion, two ruptures and 3 root avulsion, 3 ruptures and 2 root avulsion, or 4 ruptures and one avulsion. The use of a vascularized brachial plexus allograft offers several advantages: (1) allows en bloc reconstruction of the plexus nerves, (2) provides enhanced rates of nerve regeneration, (3) permits the utilization of larger "trunk" grafts without the problem of central necrosis. The potential candidates for human brachial plexus allotransplantation include: (1) total plexus palsy with at least one rupture and others avulsion and extensive scars, (2) large benign neoplastic lesions involving the brachial plexus, such as plexiform neurofibroma, and (3) Irradiated brachial plexus neuritis.

Our study has confirmed that the Lewis Brown-Norway to Lewis transplantation had a major histocompatability barrier. If the animals not receive immunosuppressant, the transplant will have rejection by early loss of the skin island monitor and poor functional, electrophysiological and histologic results. Based on the immunosuppressant regimen the flap can be transferred from Lewis- Brown-Norway to Lewis rat and can survive for 16 weeks without rejection. Our study showed vascularized brachial plexus allotransplantation with CsA treatment (Group 2) has the similar results as the rats with vascularized brachial plexus autotransplantation (Group 4) if the immunosuppressant is given adequate, although vascularized nerve allografts are more antigenic than non-vascularized nerve allgrafts.

In Group I rats which underwent resection of the brachial plexus without reconstruction, recovery was minimal. In Group III rats receiving vascularized brachial plexus allotransplantation but without immunosupression., rejection was observed grossly and histologically. There were, however, some functional returns observed in the Group III rats. The functional return was more obvious in the proximal muscles than in the distal muscle groups. Similar results have been reported: complete destruction of nerve allografts will happen after

Interesting Case - *continued from pg 8*

rejection, but nerve regeneration can still take place in spite of a rejection response.[34,35] The possible reasons for the functional return might include: (1) only a half MHC barrier between Lewis- Brown-Norway and Lewis rats, (2) relatively weak antigenicity of the nerves.

CONCLUSION

In this study we have developed a new rodent model which allows assessment of the vascularized allogeneic brachial plexus. In addition, we proved the potential utility of a vascularized brachial plexus allograft for extensive challengeable brachial plexus injuries. In conclusion, vascularized brachial plexus allotransplantation in combination with treatment of immunosuppressive drugs is potential for clinical application.

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New Frontiers in Research Newsletter

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The Past, Present, and Future of Replacing Lost Limbs

Extremity amputations are commonplace, both in civilians and military personnel[1-3]. The loss of a limb affects individuals' physical and psychosocial wellbeing, and due to loss of productivity and health care costs there are societal implications as well [4]. There exists a need to continue to develop accessible and functional prostheses for amputees. Modern prosthetic limbs are becoming increasingly technologically advanced, though total fine motor control and sensory feedback remain futuristic goals.

PAST

Historically, technological advances in prostheses have been driven by times of combat. In ancient times and throughout the Middle Ages, prosthetic limbs were only available to the wealthy and were provided to knights as extensions of their armor, capable of holding a shield or ensuring balance on a horse [5]. The invention of gunpowder was a transformative event in the history of prosthetics, due to the resulting increase in traumatic limb amputations [5]. French surgeon Ambroise Paré introduced new amputation techniques and revolutionary extremity prostheses in the early 16th century [5]. Dr. Paré is considered by most to be the father of modern prosthetics. In the late 19th century the United States introduced the "Great Civil War Benefaction," a commitment to providing prostheses to all veterans who had sustained an extremity amputation during the Civil War [6]. After World War II (1945) the National Academy of Sciences established the Artificial Limb Program in response to an influx of veterans dissatisfied with the quality of prostheses at the time [7].

PRESENT

Owing to the development and refinement of microsurgical techniques, limb transplantation is now possible, and there have been over 100 upper extremity transplants to date [8]. Although both patient and graft survival are high (98% and 83%, respectively), the issues of lifelong immunosuppression and donor availability prevent limb transplantation from becoming commonplace [8]. In the meantime, the majority of amputees will be offered prostheses.

In 2006 the United States' Defense Advanced Research Projects Agency (DARPA) initiated the Revolutionizing Prosthetics Program (RPP) in attempt to improve extremity function and user satisfaction [7]. One of the most advanced prostheses available is the Life Under Kinetic Evolution (LUKE) Arm, developed during the first phase of the RPP. The LUKE arm is capable of the multifaceted, complex movements one expects from their native upper extremity, and may be applied to trans-radial amputations, trans-humeral amputations, or shoulder disarticulations [9,10]. Users of the LUKE arm highlight its limitations, including the necessity of foot controls for activities like driving or cycling. Nonetheless, the LUKE arm remains highly desirable overall [11]. With these arms now available, the emphasis of the RPP is direct mind control of these devices using brain-computer interfaces (BCI) or peripheral neuroprosthetics in a symbiosis of man and machine [12].

Peripheral neuroprosthetics involve direct interfacing of peripheral nerves with the prosthesis. Thus, the management of severed nerves at an amputation site may impact the patient's ability to one day receive an advanced prosthetic. A principal consideration when performing primary or revision amputation is to minimize the likelihood of neuroma formation, which may occur in approximately 30% of cases. Neuromas, localized collections of disorganized axons, collagen, myofibroblasts and inflammatory cells, are a leading cause of neuropathic pain [13] . There are countless published methods describing the prevention and treatment of a neuroma at an amputation site [14]. Examples include capping the nerve with biological and synthetic materials [15], fat transfer[16], burying the stump in muscle [17,18], suture ligation[18], and tunneling the terminal end into bone.[19, 20] While these methods may prevent pain, they may also prevent the application of future prosthetic technologies.

A great deal of research is being conducted to identify optimal methods for harnessing electrical signals at amputation sites and recruiting both the peripheral and central nervous systems to "drive" a modern prosthetic. Targeted Muscle Reinnervation (TMR is one such method whereby the nerve is provided a target muscle to innervate. The newly innervated muscle acts as an amplifier for the signal, which can be recorded by electrodes on the skin and translated into the intuitive actions [18]. The use of Regenerative Peripheral Nerve Interfaces (RPNI) is another model for facilitating neural communication with advanced prostheses. In RPNIs the electrode is placed internally, directly on the muscle being reinnervated. Higher signal amplitudes can be recorded by directly placing the electrode on the muscle, as the skin can hinder spatial resolution [21].

A caveat to using either TMR or RPNI is electrical cross-talk between adjacent musculature. To address these issues, and in thinking of neuroma pathophysiology, we have developed a novel model of a neural interface, the Oseointegrated Neural Interface (ONI). Using a technique for treating amputation site neuromas that was first described by Boldrey in 1943, the distal nerve end is redirected into

the medullary canal of long bones [20]. This technique provides stability, insulation, and a vascularized niche for the nerve, with the goal of eventually harnessing neural signals for bidirectional control of a prosthetic limb.

FUTURE

Tissue engineered limbs may one day solve the issues of donor availability and need for lifelong immunosuppression in the context of composite tissue allotransplantation. Limb regeneration is rare and extremely limited in mammals, but presents the holy grail of limb replacement. Several crucial independent studies have repeatedly demonstrated that the application of electrical stimulation can induce small but exciting amounts of regeneration in a rat amputation model [22-24]. Ongoing advances in tissue engineering, regenerative medicine, and biomedical engineering present an exciting frontier for limb replacement. Our ONI may provide valuable insight into neural interfaces and one day improve clinical outcomes for individuals seeking a bidirectional prosthesis.

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What's New in Microsurgery? New Options in Practice

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The Abdomen as a Donor Site for Vascularized Lymph Node Transfer

Surgical treatments such as lymphovenous bypass and vascularized lymph node transfer are becoming more popular for the treatment of lymphedema. Vascularized lymph node transfer (VLNT) is thought to work by absorbing excess lymph fluid and/or by lymphatogenesis[1]. Multiple donor sites have been described in the literature, all reporting successful improvement of lymphedema[1]. These sites include the axilla, submentum, supraclavicular, groin, and abdomen[1-13]. Within the abdominal donor site, multiple flaps have been described including the omental flap, jejunal mesenteric lymph node flap, and the appendicular lymph node flap.

While many donor site options are available, several of these options have notable disadvantages. Primarily, the groin, axilla, supraclavicular and submentum sites all incur the risk of donor site lymphedema. Viltanen et al reported minor changes in lymphatic flow of thirteen patients using lymphoscintography following lymphatic groin flap transfers to the axilla[14]. While that study did not show changes in limb circumference, reports by Pons et al and Vignes et al describe clinically evident donor site lymphedema in both the upper and lower extremities[15,16] following VLNT. Additionally, the submentum puts the marginal mandibular nerve at risk during dissection and creates a noticeable scar[1]. The supraclavicular site has variable anatomy, creates a noticeable scar, and can produce a chyle leak[1,2].

The abdomen, we believe, is the optimal donor site for vascularized lymph node transfer. As mentioned above, the omental flap, the jejunal mesenteric lymph node flap and the appendicular flap can all be harvested from the abdomen. The omental flap, using the right gastroepiploic artery and vein as the pedicle, has been reported for use in both upper and lower extremity lymphedema4-6. Harvest has been performed open through a midline laparotomy incision, laparoscopically and robotically[4-6]. At one year, lymphoscintography showed improvement in these patients[4].

The jejunal mesenteric lymph node flap is harvested through a mini-laparotomy incision[12]. A cluster of lymph nodes are identified and harvested with an adjacent vascular pedicle. This flap is small and therefore distal placement on an extremity with primary closure can usually be obtained. Improvement in lymphedema is seen in most patients.

Recently, a vascularized appendicular lymph node transfer case was reported[3]. This flap is based on the appendicular artery and vein and was transferred to the patient's right lower extremity. Post-operative circumference measurements and lymphoscintography demonstrated improvement in lymphedema. We are currently investigating the presence of lymph nodes in the mesoappendix. Our preliminary results show a relative paucity of lymph nodes in this structure, but the appendix is rich in lymphoid tissue. The mechanism of action for any flap based on the appendix and mesoappendix will need to be investigated.

There are many advantages of using the abdomen as the donor site for vascularized lymph node transfer. Of utmost importance is the decreased risk for donor site lymphedema. Additionally, it allows for simultaneous harvest of multiple vascularized lymph node flaps through the same incision. With more than one flap, a double level (ie axilla and wrist or groin and ankle) vascularized lymph node transfer is possible simultaneously. While some believe a distal placement on the extremity is best, others believe axillary/groin scar release and flap inset is paramount[13]. By utilizing the abdomen, two flaps can be harvested and placed both distally and proximally during the same surgery. We believe this provides our patients with maximal benefit. Furthermore, the scar is well concealed and the vascular anatomy is reliable. Specific to the appendicular lymph node transfer, the authors note a potential benefit by providing clearance of infection due to the strong immunologic properties of appendiceal lymphatic tissue[3]. An additional benefit of the abdomen as a donor site is that even after harvest of one vascularized lymph node flap, an additional flap from another site within the abdomen can be harvested in the future.

A potential downside to using the abdomen as a donor site is that entering the abdomen carries with it a risk of bowel obstruction or ileus. In our experience, only one patient has needed a temporary nasogastric tube post-operatively. This patient had previous intra-abdominal surgery that created extensive adhesions, which required lysis. This patient was able to have the nasogastric tube removed after three days and was advanced to a regular diet. No other abdominal donor site complications have been reported.

As more patients see benefit in lymphedema from vascularized lymph node transfer, we must seek to minimize donor site complications. Many donor sites are available for lymph node transfer; however, the abdomen may be the most ideal. The three described flaps from this area include omentum, jejunal mesentery, and appendicular. The abdominal donor site allows harvest of multiple flaps, a concealed scar, reliable vascular anatomy, and perhaps most important, a decreased risk for donor site lymphedema.

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Portrait of a Professor: Prof. Fu-Chan Wei, M.D.

It is a great honour and privilege to be the 2017 Fu-Chan Wei Lecturer for the World Society of Reconstructive Microsurgery. Professor Wei has been my student, my colleague, my mentor, my teacher, but most important of all, my friend.

A Legend in Microsurgery

He is a legend in microsurgery and has changed the way reconstructive surgery is carried out. (Figure 1.) His major surgical contributions revolve around perforator flaps, the vascularized fibula and toe to hand transfer. However, he has done much more than this, having trained hundreds of microsurgeons in his fellowship program that have gone on to establish microsurgical centers to the benefit of thousands of patients.

1. Dr. Zuker with Dr. Wei in his office in Taipei.

An Innovator

The Chang Gung Memorial Hospital is also a center for innovation. (Figure 2.) This has been championed by Dr. Wei, bringing untold benefits to our patients and creating opportunities for many more. Dr. Wei's mission has been to spread microsurgery worldwide, and he has done this in a most effective manner. He has created an amazing team of super specialists around him that are leaders in their fields. One can feel the collaboration of the team and the joy experienced by Dr. Wei in seeing his colleagues succeed and advance our field even further. (Figure 3.) This collaborative spirit has spawned enormous success, not just for Chang Gung Memorial Hospital and not just for microsurgery, but for the surgical world in general.

2. Dr. Wei with presentations to Dr. Zuker and Dr. Alison Snyder-Warwick.

A Visionary

This is a prime example of how collaboration and working together can improve the lives of so many of our patients and their families. In this light, I would like to dedicate this lecture to the "spirit of collaboration". (Figure 4.) Microsurgical expertise can be utilized in other surgical disciplines to improve outcomes, provide sustainability, accomplish what cannot be done alone, open new opportunities and allow for creativity. By collaborating with our surgical colleagues in fields such as transplantation surgery, oncologic surgery, orthopaedic surgery, cardiac surgery and even ophthalmology, we as microsurgeons can advance areas we never dreamed possible.

With this theme of collaboration, I hope to honour Dr. Wei in his role as a leader, as an innovator and as a great collaborator, having advanced the field of microsurgery and making it is what it is today. I feel so honoured to be asked to give this lecture and so fortunate to be his friend. (Figure 5, 6.)

3. Fu-Chan Wei on a return visit to Toronto with Dr. Zuker and future Chang Gung Fellow, Dr. Karen Wong.

6. A Taiwanese gastronomic adventure.

5. Dr. Wei and his lovely wife Nancy with Dr. and Mrs. Zuker on a culinary extravaganza in Taipei.

4. Fu-Chan Wei in center beaming at the success of The 2011 Chang Gung – Mayo Clinic Symposium in Reconstructive Surgery and surrounded by his talented team.

WSRM SERVICE INITITATIVE – CALL FOR VOLUNTEERS

WSRM has a new initiative to sponsor surgical missions to needy world areas to perform complex microsurgical reconstructions. The team would provide care to needy patients and also provide education in approach to management of complex disorders for the local surgeons and support staff. The support for these mission trips would need to come from donations from individuals and major health organizations and industry. In addition, the initiative would address:

A. Service to local hospitals, including lectures and surgeries

B. Service to teaching local surgeons, accepting candidates for short term or long-term service

C. Patient Care, patients traveling to the participating hospital (WSRM doctor's hospital) for treatment.

To further this initiative the Ad Hoc Service Committee has been created to look at opportunities for WSRM to engage in clinical/ educational service missions, investigate funding and cost issues to WSRM as well as investigate Medical /Legal issues of service work. If you are interested in serving on this committee and have service work experience please contact Krista Greco at kristagreco@isms.org as soon as possible.

Mark Your Calendar

2017 WSRM World Congress
June 14-17, 2017
Seoul, Korea
www.wsrm2017.com

2019 WSRM World Congress
Summer, 2019
Bologna, Italy

Global Meetings*

*The posting of these meetings does not define the WSRM as a sponsor or endorser.

3rd ALAM Meeting
November 29, 2017 – December 2, 2017
Cartagena, Colombia

2018 ASRM Annual Meeting
January 13 – 16, 2018
Fajardo, Puerto Rico
www.microsurg.org

14th EFSM Meeting
April 25-28, 2018
Belgrade, Serbia
www.efsm.eu

4th APFSRM Meeting
May 10-13, 2018
Antalya, Turkey
www.apfsrm.org

News from the Executive Council

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News from the Executive Council

2015 - 2017 WSRM Committee Roster

This is official notification to the membership of the members that have been appointed to serve in the standard committees of the WSRM. Please help us applaud those members that have volunteered their time to serve on a committee to better the organization.

Congress Organizing Committee

Myong Chul Park, MD, PhD, Organizing Chairman

Membership Committee

Isao Koshima, MD Chairman (Japan)
Yixin Zhang, MD (China)
Joon Pio Hong, MD (Korea)
Ming-Huei Cheng, MD (Taiwan)
Raja Sabapathy, MD (India)

Nominating Committee

L. Scott Levin, MD, FACS Chairman (USA)
Erkki Tukianen, MD (Finland)
Marko Bumbasirvec, MD (Serbia)
Roman Skoracki, MD (USA)
Jaume Masia, MD (Spain)

Constitution and Bylaws Committee

Milan Stevanovic, MD, Chairman (USA)
Lawrence Gottlieb, MD (USA)
Michel Saint-Cyr, MD (USA)
Samir Kumta, MD (India)
Damien Grinsell, MD (Australia)

Know someone who wants to become a member?

The application process is simple. Applications can be obtained at www.wsrm.net and submitted via email, mail or fax to the Central Office. Applications are accepted and reviewed on a continual basis so we encourage applicants to submit the information as soon as possible to start taking advantage of the membership benefits.

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Purpose
The object of the Society shall be to stimulate and advance knowledge of the science and art of Microsurgery and thereby improve and elevate the standards of practice in this field of surgical endeavor. The Society shall be the highest medium of recognition in the field of Microsurgery as evident by superior attainment and by contribution to its advancement. It shall provide an international forum for the exchange of ideas and the dissemination of innovative techniques.

The WSRM Newsletter is published two times yearly for members of WSRM, a non-profit organization. Subscriptions are included in the annual membership dues. All correspondence, address changes, and news for upcoming events should be addressed to:

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