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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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OUTCOMES OF A LONG-TERMS MICROVASCULAR TRAINING FOR RESIDENTS IN ORTHOPEDIC

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Abstract.

Background: The acquisition of specific technical skills in the field of microsurgery like the use of operating microscope and microsurgical instruments, arterial and venous anastomosis, vascular grafts, nerve sutures and tenorrhaphies, is very important during the training in Orthopedics and in Hand Surgery in order to deal with management of complex and amputative traumas of the upper limb. The learning curve in microsurgical techniques is significantly shortened for surgeons who benefit from pre-clinical courses on an animal model. The aim of this study was to standardize a long-term microsurgical activity during the training in Orthopedics and Hand Surgery and to document the benefits that the residents of the School of Specialization got by chance of practicing weekly this discipline on in-vivo model.

Methods: In 2016, a protocol for teaching in vivo microsurgery on Wistar rats for orthopedics and hand surgery residents was approved. In the first 3 years of graduation course, the students performed the training aimed at acquiring manual dexterity and confidence with the microsurgical instrumentations on nonliving models. Subsequent exercises were performed ex vivo on chicken leg models under the microscope or loupes. Finally, the in-vivo rat exercises were intended for residents in the last 2 years who required access to the supplementary diploma in hand surgery.

Outcome evaluations consisted of the Global Rating Scale score and time to completion. Two-tailed Student t test was performed to compare initial and final outcome evaluations ($p < 0.05$).

Results: Only 8 residents completed the microvascular training of almost thirty microsurgical teaching sessions administered on a weekly basis. The total mean GRS score (and standard deviation) improved from 15 ± 2 points for the initial score to 21 ± 6 points for the final score ($p < 0.005$). Time to completion of the anastomosis also significantly improved ($p < 0.005$), from a mean score of 31:18 ± 9:21 minutes for the initial time to 21:15 ± 6:10 minutes for the final time.

Conclusions: A microvascular training curriculum utilizing a live rat model, preceded by a training on non-living models, provides a superior surgical simulation experience and is effective at improving resident microvascular surgical skills.

Key words. Microsurgery, training, resident, rats, microvascular sutures, hand surgery.

Introduction.

Microsurgery is a specialized surgical skill utilized by a limited number of orthopedic surgeons who perform free tissue transfers, nerve grafting and repair, and replantation of amputated digits or extremities but commonly orthopedic residency training programs do not offer consistent or structured exposure to this skill [1,2]. The acquisition of specific technical skills in the field of microsurgery like as the use of operating microscope and microsurgical instruments, arterial and venous anastomosis, vascular grafts, nerve sutures and tenorrhaphies, is very important during the training in Orthopedics and in Hand Surgery in order to deal with management of complex and amputative traumas of the upper limb [3]. Microsurgery is a time-consuming surgical technique and these interventions, despite their complexity, need to be completed in the shortest possible time, given the complications due to prolonged ischemia time. In order to acquire the technical skills necessary for a good execution of microsurgical procedures in good time, microsurgical practice during the training period is the most important exercise [4]. As shown by numerous studies in the literature the learning curve in microsurgical techniques is significantly shortened for surgeons who benefit from pre-clinical courses on an animal model [5]. All courses at the international level recognize the adult rat as the best model to perform the exercises, being able to perform numerous different types of exercises, taking into account that the diameter and structure of the femoral arteries and veins of the animal (the most frequently used in exercises) are in all similar to the human metacarpal and digital arteries. The animal model also offers the possibility of performing tissue dissection firsthand to reach the vasculo-nervous bundle and allows to evaluate the tightness of the anastomosis and the patency of the vessel. The School of Specialization in Orthopedics and Traumatology of the Catholic University of the Sacred Heart is one of the few in Italy to have inside a department of Hand Surgery, where residents can try their hand at microsurgical techniques daily.

The aim of this study was to standardize a long-term microsurgical activity during the training in Orthopedics and Hand Surgery and to document the benefits that the residents of the School of Specialization got by chance of practicing weekly this discipline on in-vivo model.

Materials and Methods.

In 2016, a protocol for teaching in vivo microsurgery on Wistar rats for orthopedics and hand surgery residents was approved by the local ethics committee (Protocol number: 1F295.21-05/07/2016) and from the Italian Ministry of Health (Protocol number: 1036/2016-PR). Surgical training was performed according to the guiding principles for research involving animals and the European legislation. The graduation course in orthopedics lasted 5 years and had a supplementary

diploma in hand surgery in the last 2 years. In the first 3 years of graduation course, the students performed the training following the Recommendations of the European Society for Surgical Research (ESSR) and the International Society for Experimental Microsurgery (ISEM) [6]. The first exercises were aimed at acquiring manual dexterity and confidence with the microsurgical instrumentations and were performed without optical magnification on gauze, then on a piece of latex glove and then on silicone tubules for a minimum of 10 hours in total. Subsequent exercises were performed ex vivo on chicken leg models under the microscope or loupes possibly with the assessment of an experienced microsurgeon tutor. To minimize the use of live animals in keeping with the 3Rs principle, according to international microsurgery simulation society (IMSS) were performed 55 anastomoses on non-living (ex-vivo) models [7]. The in-vivo rat exercises were intended for residents in the last 2 years who required access to the supplementary diploma.

The teaching protocol was set from 2016 to 2021, but because of Covid Pandemic, data collection stopped in March 2020.

Thirteen residents were enrolled in the protocol.

The number of animals authorized was 600 in five years.

The exercises authorized were:

Thigh

- Termino-terminal anastomosis of the femoral vein and artery
- Termino-terminal anastomosis of the femoral artery with epigastric vein graft or femoral vein graft
- Inguinal flap transferred to the opposite groin

Neck

- Termino-terminal anastomosis of the carotid artery and external jugular vein

Abdomen

- Termino-terminal suture of the subrenal aorta
- Sciatic and its branches, sutures, and grafts with sural

In order to minimize the number of animals used for this training course, surgical interventions were performed on the same animal under general anesthesia on all accessible anatomical districts, following the exercises proposed below, already examined by the Italian Society of Microsurgery.

In order to minimize the suffering imposed on the animal, the protocol provided acute general anesthesia for interventions.

To document the benefits that the residents of the School of Specialization got by chance of practicing in this discipline on in-vivo model was considered a microsurgical activity consisted of almost thirty, one-on-one teaching sessions administered on a weekly basis for each resident.

In order that the experiment is easily reproducible the evaluation was performed only on a live rat femoral artery model because it is the most simple and largest used model and offers the closest approximation to the size and feel of a human digital artery.

Each participant attempted an end-to-end arterial anastomosis on the femoral artery of a live anesthetized rat with use of 10-0 nylon suture under the microscope.

At the completion of each session, the rat was killed in accordance with Institutional Animal Care and Use Committee requirements.

Outcome evaluations were performed during the first anastomosis and during the thirty-anastomosis using the Global Rating Scale (GRS) score and evaluating time to complete the anastomosis.

Timing of the anastomosis was considered as time between the beginning of the first stitch and the completion of the last stitch in absence of bleeding.

The GRS is a score for evaluation of respect for the surrounding tissue, time and motion, efficiency with and use of microsurgical instruments, performance of the anastomosis, and vessel patency optimized in poor, moderate, or excellent results Table 1 [8].

Statistical analysis.

To compare initial and final outcome evaluations, Statistical Analysis Two-tailed Student t were performed with the level of significance set at $p < 0.05$.

Results.

All the thirteen enrolled residents completed the ex-vivo training, but because of the Covid Pandemic, that drastically conditioned the laboratories usability from March 2020, only eight residents completed the microvascular training of almost thirty microsurgical teaching sessions administered on a weekly basis.

The total mean GRS score (and standard deviation) improved from 15 ± 2 points for the initial score to 21 ± 6 points for the final score ($p < 0.005$) as reported in Figure 1.

The total GRS score also indicated that all eight residents performed the anastomosis with moderate quality at the initial attempt and all eight residents performed the anastomosis with excellent quality at the final attempt.

The improvements for each of the five components evaluated by the GRS are reported in Figure 2. Significant improvements ranging from 37% to 61% were made in each of the five GRS components ($p < 0.02$).

The outcome evaluations also demonstrated that the time to perform an end-to-end arterial anastomosis improved by an average of 15:11 minutes, from a mean score of $31:18 \pm 9:21$ minutes for the initial time to $21:15 \pm 6:10$ minutes for the final time, following completion of the microvascular training ($p < 0.005$).

Discussion.

Microsurgical techniques are commonly used in different surgical specialties. Training in microsurgical skills is generally limited by the high cost of microsurgery training microscopes and equipment and by limited access to in-vivo models. The high costs are the limits also in teaching such techniques during graduate school. Microvascular training during graduate school improves microvascular surgical skills of residents after an 8-week course and may also improve macrosurgical techniques [1,5]. Numerous microsurgical training courses are available worldwide, but there is no general agreement concerning the standardization of microsurgical training. The European Society for Surgical Research (ESSR) and the International Society for Experimental Microsurgery (ISEM) recommended, for learning the basics of microsurgery, that 1- or 2-day courses cannot be effective because these short courses are too long for an

Table 1. *Global Rating Scale for Microvascular Anastomosis.*

	1	2	3	4	5
Respect for tissue	Frequently used unnecessary force on tissue, caused damage, inappropriate use of instruments		Careful handling of tissue, but occasionally caused inadvertent damage		Consistently handled tissue appropriately with minimal damage
Time and motion	Many unnecessary moves		Efficient time/motion, but some unnecessary moves		Economy of movement and maximum efficiency
Handling of instruments	Repeatedly makes tentative or awkward moves with instruments.		Competent use of instruments although occasionally appeared stiff or awkward		Fluid moves with instruments with no awkwardness.
Performance of anastomosis	Poorly placed sutures and poor use of irrigation and vasodilator		Fair placement of suture and use of irrigation and vasodilator		Well-placed sutures and appropriate use of irrigation and vasodilator
Patency	Poor, thrombosed		Moderate, reduced flow		Excellent, unimpeded flow

Atkins JL, Kalu PU, Lannon DA, Green CJ, Butler PE. Training in microsurgical skills: does course-based learning deliver? Microsurgery. 2005;25:481-485.

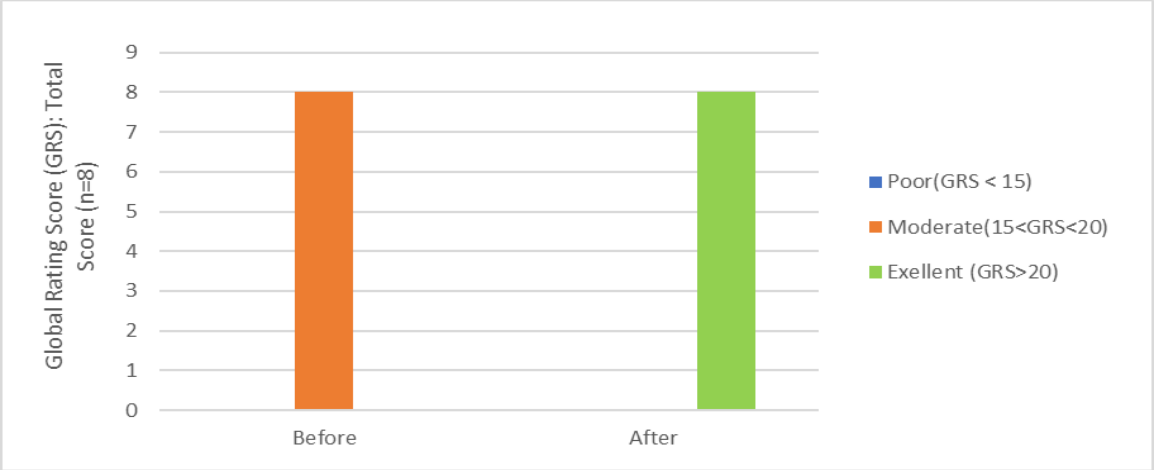

Figure 1. *Mean Global Rating Scale (GRS) scores before and after the protocol.*

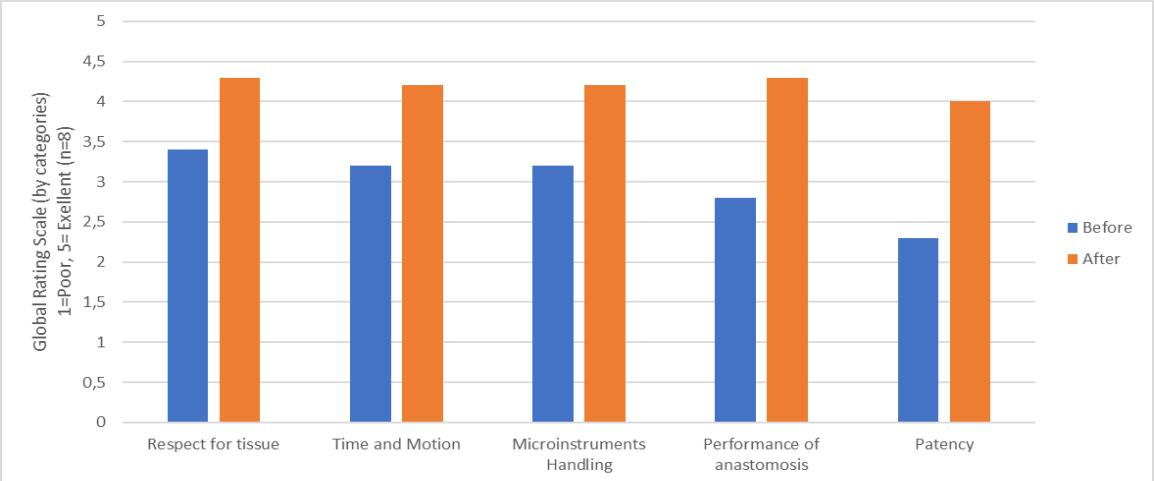

Figure 2. *Comparison of the specific Global Rating Scale (GRS) scores before and after completion of the protocol.*

introduction but not satisfactory for an effective skill acquisition whilst courses offering 40 h or more might be suitable for basic training [6]. Modalities account for the best microsurgical training are debated and many studies are investigating the role of living and nonliving models. The combination of living and nonliving training microsurgical models leads to superior results; however, the gold standard remains the living model. During graduate school, in-vivo practice on rats is rarely performed whilst ex-vivo practice on chicken leg model with microscope or loupe is the most common exercise performed. In an orthopedic residency program, commonly, was promoted a self-directed, microsurgical training curriculum using nonliving models. Ko JW et al. demonstrated that the learning curve in microsurgical techniques is significantly shortened for surgeons

who benefit from pre-clinical courses on an animal model [5]. In this study all residents that ended the program improved in all categories of the GRS scores and their time to completion of a microvascular anastomosis decreased. Given the limitations of this study including the relatively small sample size, the fact that this study was performed at a single institution and that the GRS is a subjective and qualitative score our results demonstrate that a long-term weekly based microvascular training among the residents could improve an orthopedic residency training program.

Conclusions.

A microvascular training curriculum utilizing a live rat model provides a superior surgical simulation experience but a larger multicentric study may be performed to confirm these findings. This training on a live rat model has to be preceded by a training on non-living models according to recommendations of European Society for Surgical Research (ESSR) and the International Society for Experimental Microsurgery (ISEM) and International microsurgery simulation society (IMSS).

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