

Building Sustainable Reconstructive Microsurgery in Countries with Limited Resources: The Rwandan Experience

Ian Shyaka, MD*†
 Yves Nezerwa, MD*
 Francoise Mukagaju, MD‡
 Rushil R. Dang, BDS, DMD†
 Charles Furaha, MD*
 Faustin Ntiringanya, MD, PhD§¶

Background: Reconstructive microsurgery practice has been well adopted in developed countries, but this has not been the same in low- and middle-income countries (LMICs). Injuries related to road traffic accidents are highest in these countries, with 93% of the world's fatalities on the roads occurring in LMICs. The objective of this study was to highlight the need for sustainable microsurgery in LMICs and share strategies undertaken in Rwanda.

Methods: We review the contemporary literature about the needs and challenges facing reconstructive microsurgery in LMICs. We describe the strategies undertaken in Rwanda towards developing microsurgery. We also report the outcomes of the first ever microsurgery visiting professorship organized in the country and the steps taken towards achieving sustainable microsurgery practice in Rwanda.

Results: There is a huge unmet need for reconstructive microsurgery in LMICs. Most of the microsurgical operations in these countries are done in short term surgical mission setups. No data focusing on sustaining reconstructive microsurgery in LMICs has been described in the contemporary literature. There is a 2.5-fold increase in the number of trained plastic surgeons in Rwanda over the past 5 years, with increasing skills in microsurgery and opportunities for formal overseas fellowships.

Conclusion: With dedicated local champions, a comprehensive approach, and reliable partners, establishing sustainable microsurgery services is possible in countries with limited resources. In our experience, the fly-in-fly-out microsurgical missions aimed at mainly providing surgical care to patients seem to have a limited long-term impact and sustainability. We recommend integrating these missions into planned microsurgical initiatives of pre-existing local plastic surgery training programs. (*Plast Reconstr Surg Glob Open* 2023; 11:e5332; doi: 10.1097/GOX.0000000000005332; Published online 11 October 2023.)

INTRODUCTION

Reconstructive plastic surgery has over the years evolved, with a paradigm shift from the conventional reconstructive ladder to a reconstructive elevator approach.¹

*From the *Department of Plastic Surgery, Rwanda Military Hospital, Kigali, Rwanda; †Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Chang Gung University and Medical College, Taoyuan, Taiwan; ‡Department of Plastic Surgery, King Faisal Hospital, Kigali, Rwanda; §Department of Plastic Surgery, University Teaching Hospital of Kigali (CHUK), Kigali, Rwanda; and ¶Department of Surgery, University of Rwanda (UR), Kigali, Rwanda.*

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Microsurgery is a fundamental resource for this elevator approach to be applied. Indeed, microsurgery practice is an integral part of the reconstructive armamentarium in developed countries, but is less well adopted in low- and middle-income countries (LMICs).² In LMICs, there is a high incidence of road-traffic-related accidents, with 93% of the world's fatalities on the roads occurring in LMICs.³ Additionally, 42% of casualties from road traffic accidents involve traumatic limb injuries that require limb-salvage advanced reconstructive surgery.⁴ Furthermore, there is an increasing incidence of cancers that require advanced reconstruction, with two-thirds of oral cancers reported in LMICs.⁵ Along the same lines, burn injuries rank fourth as a cause of accidents in Rwanda. These burn injuries commonly lead to postburn sequelae of severe contractures often requiring complex reconstructive surgery.⁶

Despite the need demonstrated above, microsurgery is still regarded as unreachable, complex, expensive, and too limited to address the burden of diseases, as seen in this

Disclosure statements are at the end of this article, following the correspondence information.

part of the world. Limitations to microsurgery are multifactorial, including lack of awareness and limited exposure to microsurgery among plastic surgeons trained in LMICs, lack of skills, equipment, and consumable materials (such as small sutures).² The lack of access to microsurgery poses a significant challenge in managing complex defects such as lower limb open fractures with extensive soft tissue damage where local and/or pedicled flap options are limited.

Most of the microsurgical procedures done in LMICs have been done in mission settings by expert reconstructive microsurgeons from developed centers.⁷ This, however, is neither dependable nor sustainable. There is a reported higher free flap complication rate of up to 51% and low flap salvage rates of 45% in these mission setups.⁷⁻⁹ The fly-in-fly-out microsurgical missions are usually very short lived for adequate monitoring of early free flap complications. The complications are left to be dealt with by the local teams who have not been adequately trained to handle these delicate and critical events. There is also minimal transfer of skills to the local team due to the short-term basis of the missions. Also, missions are inconsistent and are affected by many factors such as the availability of

Takeaways

Question: Is there a need for sustainable reconstructive microsurgery in countries with limited resources, and is it feasible?

Findings: There is a huge unmet need for microsurgery in these countries, and it is feasible to bridge this gap with better sustainable measures.

Meaning: There is need for collaboration and prioritizing training of local staff for sustainability of microsurgery practice in countries with limited resources.

logistics, political dynamics, or pandemics, among others; hence, there could be longer than a year in between missions despite the increasing need. A survey done in 2023 to assess the fields that need further training among plastic surgery global fellows in sub-Saharan Africa with the Surgeons in Humanitarian Alliance for Reconstruction, Research and Education (SHARE) showed the biggest gap in flap reconstruction and reconstructive microsurgery (Fig. 1).

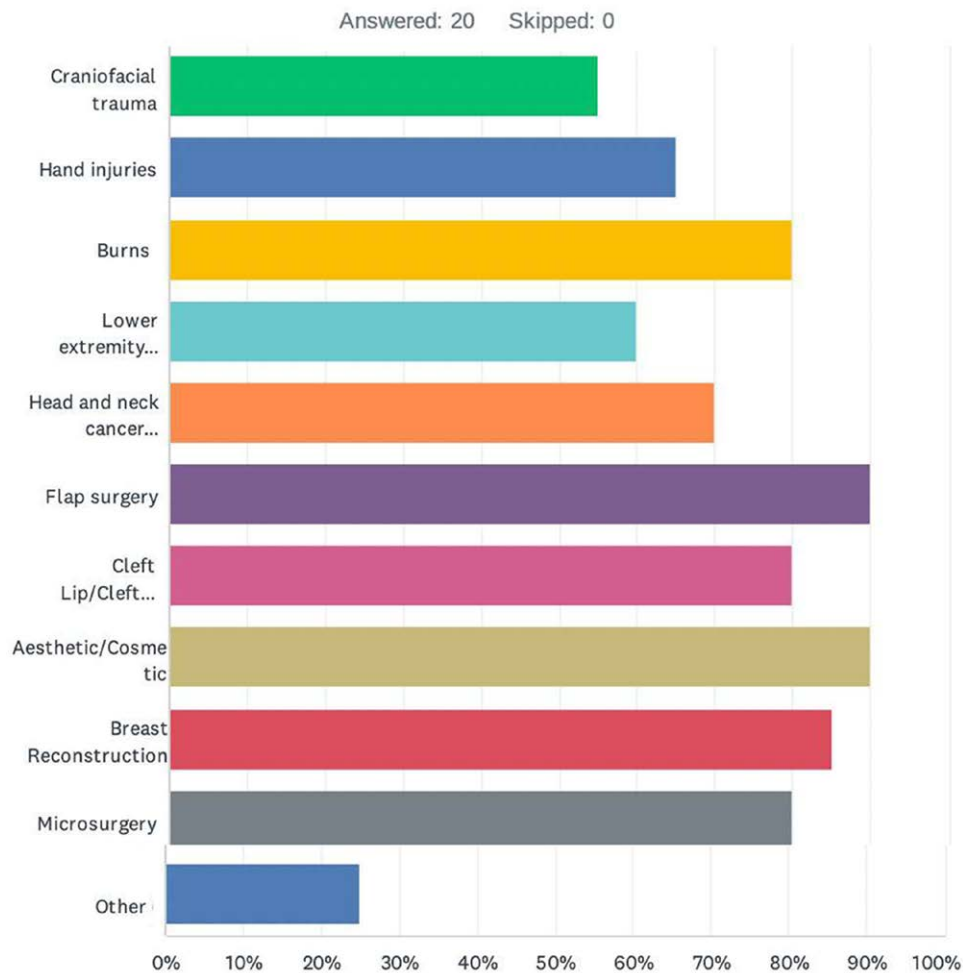


Fig. 1. Clinical topics of interest identified by the PSF/SHARE Plastic surgery global fellows, 2023. Flap surgery and microsurgery were among the top areas of interest in sub-Saharan Africa.

There is a huge unmet need for plastic surgery in Rwanda. Rwanda ranks 15th in the worldwide rates of road traffic accidents, with a reported high rate of lower limb injuries (41.9%) from road traffic injuries.^{10,11} Like most of the other LMICs, Rwanda has limited access to plastic surgery and almost no access to reconstructive microsurgery. Until 2023, the country had only two plastic surgeons serving a population of 13 million. However, a local plastic surgery training program has recently helped add three more plastic surgeons, making a total of five plastic surgeons as of today.

Using mainly local flaps, the reconstructive surgeons in Rwanda deal mostly with conditions such as burn injuries, orofacial clefts, lower limb reconstructive surgery, cancers, and other defects. Patients with traumatic soft tissue injuries that are not amenable to local or pedicled flaps are at high risk of amputation. If not amputated, patients will have prolonged hospitalization waiting for granulation tissue to cover exposed bones and tendons before skin graft. This significantly compromises limb functionality. It is important to note that the use of negative pressure wound therapy is still limited due to the high costs that are not easily affordable for most patients. Consequently, the long period of bone exposure predisposes patients to chronic osteomyelitis: another long-term health concern in these patients. Most of the patients involved in these types of injuries are breadwinners from a low social-economic status who might eventually have catastrophic health expenditure causing family impoverishment due to this prolonged hospitalization.¹² Considering the above, investing in microsurgery is not a luxury, but rather an urgent necessity in counties like Rwanda.

GOALS

Rwanda plastic surgery capacity building aimed to increase access to safe and affordable plastic surgery services for all Rwandans, including reconstructive microsurgery. The overall goals were to build and sustain a local microsurgery team supported by planned visiting professorships. Furthermore, we wanted to train and empower a multidisciplinary plastic surgery team, including nursing and anesthesia providers, while equipping hospitals with the necessary equipment and consumable materials.

STRATEGIES

We realized a great need for collaboration to obtain funding, external expert faculty, as well as the necessary

equipment and other support required toward achieving our set goals. Thus, we sought and established a collaboration with Operation Smile International, the Plastic Surgery Foundation (PSF)/SHARE, and the American College of Surgeons (ACS)

We then identified high-volume microsurgery centers that would accept our plastic surgery senior residents and specialists for clinical attachments at their units. Clinical attachments were arranged in various hospitals in South Africa, Aga Khan University Hospital-Karachi in Pakistan, and Sahlgrenska University Hospital and Uppsala University Hospital in Sweden. The rotations involved simulation courses, as well as microsurgical skills training on living animal models (Fig. 2).

Through this experience and exposure to renowned experts in the field of microsurgery at these high-volume centers, our trainees experienced the extent of solutions that microsurgery can add to Rwanda's reconstructive armamentarium. It was a great opportunity to inspire Rwandan plastic surgery trainees and link them with the microsurgery world. Because of this exposure, the first author became interested in pursuing a career in reconstructive microsurgery. With collective support, he applied for a formal microsurgery training at the renowned Chang Gung Memorial Hospital in Taiwan,¹³ where he was admitted and is currently pursuing his clinical fellowship training under Professor Fu Chan Wei¹⁴ at the institution (Fig. 3).

One microsurgeon would not be enough to carry the bulk of microsurgery needs in Rwanda. In collaboration with Operation Smile, the ACS Operation Giving Back (OGB), and the PSF SHARE program, visiting professorships were organized to build the microsurgery capacity of Rwandan plastic surgeons, plastic surgery residents, theater nurses and anesthesia providers. While transferring knowledge and skills to the local teams, these visiting professorships demystified microsurgery in the reconstructive surgery practice in the country. They have created momentum and made the system ready to sustain the practice. They have also helped to equip theaters with necessary microsurgery equipment and consumables.

THE RWANDA PLASTIC SURGERY TRAINING PROGRAM

Until 2018, there was no training program for plastic surgery in Rwanda. The only two available reconstructive



Fig. 2. Rwandan plastic surgery residents undergoing a microsurgery training course on living animal models at Sahlgrenska University Hospital, Sweden.



Fig. 3. Rwandan plastic surgeon pursuing reconstructive microsurgery fellowship training under Professor Fu Chan Wei, at Chang Gung Memorial Hospital in Taiwan.

and plastic surgeons in the country at the time had trained from overseas (South Africa and France), serving a population of 13 million. The demand for reconstructive surgery in the country is overwhelmingly high, with patients waiting time sometimes beyond 4 years, even for urgent surgery such as for debilitating postburn contractures, among others.

In 2019, two referral hospitals in the country (Rwanda Military Hospital and the University Teaching Hospital of Kigali) were accredited by the College of Surgeons of East, Central and Southern Africa to train plastic and reconstructive surgeons, through which the first cohort of three locally trained plastic surgeons enrolled and, in December 2022, qualified as plastic surgeons.

To increase the number of plastic surgeons in the country exponentially, a plastic surgery residency program has now been introduced into the National University of Rwanda. Through this initiative, 10 additional plastic surgeons are projected to be added by 2030.

RESTRUCTURING OF MICROSURGERY MISSIONS INTO VISITING PROFESSORSHIPS

The Rwanda plastic surgery team has restructured microsurgery and other plastic surgery missions into visiting professorships. We have now incorporated these missions into the formal plastic surgery curriculum, to meet the training needs of the plastic surgery residents and build the capacity of multidisciplinary local teams rather than focusing entirely on the patients' surgical care.

The purpose of microsurgery missions in Rwanda has now greatly shifted from providing mainly patient surgical care to the training of local staff (Fig. 4). In addition to training the Rwandan residents and plastic surgeons, these visiting professorships are structured to train local theater nurses, anesthesia providers, and postoperative care nurses.

CASE SERIES OF THE FIRST ORGANIZED MICROSURGERY VISITING PROFESSORSHIP IN RWANDA.

Case 1

The patient was a 32-year-old man with extensive left leg wound exposed tibia bone after sequestrectomy for chronic osteomyelitis post trauma (Fig. 5). The defect could not be reconstructed with local/pedicled flap options. Thus, he was being considered for a below-knee amputation. During the first microsurgery visiting professorship, reconstruction with a free latissimus dorsi muscle flap with skin graft was done. The procedure was uneventful, and the patient is now discharged and recovering well.

Case 2

The patient was a 37-year-old man at 22 days post admission for right open tibia fracture after a road traffic accident (Fig. 6). Reconstruction with a free vastus lateralis muscle flap with immediate skin graft was done. No complications were noted perioperatively. The patient developed mild pus discharge under the flap (probably



Fig. 4. Rwanda plastic surgery residents undergoing microsimulation training during a microsimulation visiting professorship with plastic surgeons from the PSF SHARE program.



Fig. 5. Before surgery (A), immediately after reconstruction with latissimus dorsi free flap with immediate skin graft (B), and at 4 weeks after surgery (C).

due to delayed reconstruction), which was managed with conventional dressing.

Case 3

The patient was a 38-year-old man at 33 days post admission for open left ankle fracture and dislocation (Fig. 7). The patient had been managed conservatively with regular dressing, awaiting adequate granulation for eventual skin grafting. Reconstruction with vastus lateralis muscle free flap and delayed skin graft was successfully done without any perioperative complications.

LESSONS LEARNED, THE WAY FORWARD, AND FUTURE PLANS

This first microsimulation visiting professorship was aimed at maximizing hands-on training of the local Rwandan reconstructive surgeons. The successful outcome despite the present limitations (related to both skills and equipment) made it evident that microsimulation is indeed feasible in Rwanda. Several weeks after this initial, very positive experience, a second visiting professorship team of SHARE/ACS microsurgeons arrived and conducted a microsimulation teaching course that included surgical simulations, microsimulation theory, and practice plus case-based discussions in addition to inoperative microsimulation teaching. Close collaboration and



Fig. 6. Before surgery (A), immediately after reconstruction with vastus lateralis muscle free flap with skin graft (B), and 4 weeks after reconstructive surgery (C).

communication between the Operation Smile and PSF SHARE/ACS OBG microsurgery teaching teams were key to creating a complementary learning experience for the residents. These groups are committed to continue this training collaboration with regular, coordinated visiting professorship multiple times throughout the year.

To establish a strong and sustainable microsurgery practice in Rwanda, we acknowledged a need to build a holistic team. The anesthesia providers and nurses play a vital role at all perioperative levels of microsurgery, and for task shifting during the critical postoperative monitoring phase. Our visiting professorship partners include nursing and anesthesia teams and, hence, transfer knowledge and skills to the whole team during these visiting professorships. We are also collaborating with other centers for elective placements of our Rwandan nurses and anesthesia providers to visit and acquire more experience from well-established microsurgery centers.

With support from the Rwandan Ministry of Health, and the above collaborations with our visiting professorship partners, we have already acquired microscopes, loupes, and other necessary equipment for microsurgical practice. We are also assured of a constant supply of consumable materials needed for the microsurgical procedures, because these are currently routinely procured locally.

The long-term goal is to have microsurgery incorporated into the regular plastic surgery practice and during the training of residents in Rwanda, with teaching provided mainly by the Rwandan faculty.

CONCLUSIONS AND RECOMMENDATIONS

With dedicated local champions, a comprehensive approach, and reliable partners, establishing sustainable microsurgery services is possible in countries with limited resources. In our experience, the fly-in-fly-out microsurgical missions aimed at mainly providing surgery to patients seem to have a limited long-term impact and sustainability. We suggest integrating these missions into the locally initiated microsurgical plans of the pre-existing plastic surgery training programs. However, we acknowledge the need for future research studies to analyze the long-term outcomes, for better and more reliable recommendations.

Ian Shyaka, MD

Rwanda Military Hospital
Kigali, Rwanda

E-mail: iangashugi@gmail.com

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The authors have no financial interest to declare in relation to the content of this article.

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Fig. 7. Before surgery (A); immediately after coverage with free vastus lateralis muscle flap (B) with delayed skin graft for better flap monitoring, because some parts of the muscle flap seemed darker, although it was all pink by day 1 postoperatively; and at 4 weeks after skin graft of the muscle flap (C).

infrastructure developments relating to microsurgery and plastic surgery at large.

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6. Visiting Professor: Jeremy D. Richmon, MD (Associate Professor, Massachusetts Eye and Ear, Harvard University).

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