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ORIGINAL ARTICLE

Feasibility of microsurgery in rural area as part of compulsory health service in Turkey: Replantation, free conventional, perforator, thin, and super thin flaps

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ABSTRACT

Objective: Region six in Turkey, an underdeveloped area with limited doctors, lacks experienced healthcare professionals, teamwork, assistants, and instruments, which limits the performance of complex procedures. It is generally discouraged to attempt complex microsurgery in these regions. This study aims to demonstrate the feasibility of microsurgery and provide guidance for ambitious young plastic reconstructive surgeons performing microsurgery in underdeveloped areas as part of a compulsory service program.

Material and Methods: A retrospective analysis was conducted on patients who underwent free flaps, replantation, and revascularization surgeries performed by the author, the sole plastic surgeon in the rural area, between August 2018 and August 2020. The analysis included operation notes, outpatient clinic notes, as well as pre-operative and post-operative pictures.

Results: A total of thirty-six microsurgical operations were performed on thirty-two patients. Two out of nineteen (10.5%) replantation attempts and one out of seventeen (5.8%) free flaps experienced failure. Among the flaps harvested, four were thin and four were super-thin. Furthermore, three out of five (60%) pediatric flaps encountered serious non-surgical complications, while most systemic complications were infection-related. All complications were effectively managed without the need for dispatch.

Conclusion: Microsurgery can be safely performed during the compulsory work period in the region six. Tips such as open-loop anastomoses, staff training, and easy means of flap monitoring can facilitate microsurgery. However, it may be prudent to consider avoiding such procedures in pediatric patients due to potential non-surgical complications and challenges with the dispatch system.

Keywords: Compulsory service, obligatory service, mandatory service, microsurgery, free flap, rural area, replantation, feasibility of microsurgery.

INTRODUCTION

Compulsory service programs have been implemented in seventy countries since the early twentieth century [1]. These programs have been given various names, including 'obligatory', 'mandatory', and 'requisite' programs. In Turkey, a compulsory health service program for doctors was reintroduced under Law No. 5371 in 2005, after its previous implementation from 1981 to 2003, owing to a shortage of doctors [2, 3]. The duration of this compulsory recruitment ranges from 300 to 600 days, depending on the region [2]. The program operates through a draw system where participating doctors are required to indicate their preferences for available positions, and a computerized random selection process is used to assign doctors to each position. The regions are numbered 1 to 6 for the development of cities and A to D for the availability of doctors. 6-D is the least developed and has the least number of doctors in Turkey [4]. The region 6 is generally described where complex procedures are not performed, due to a lack of the following: experienced doctors, available team work, medical assistants, instruments. Additionally, doctors may be hesitant to operate in this region due to potential complications and related malpractice lawsuits. The congestion and lack of experienced consultants in nearby tertiary level hospitals can result in the inefficient dispatch process, leading to patient frustrations caused by long waiting times and suboptimal treatments.

Replantation and free flap surgeries, which require microsurgery in the field of plastic and reconstructive surgery, pose considerable challenges. These procedures demand extensive experience, specific training, and a dedicated team for long and complex postoperative monitoring and rehabilitation. It is generally agreed upon that these types of operations should not be attempted in region 5 or 6.

The author, who received extensive microsurgery training during residency and subsequently completed a two-year microsurgery fellowship, was assigned as the sole plastic and reconstructive surgeon in a rural area classified as region 6-C for plastic and reconstructive surgery [4]. Despite the challenges posed by a scarcity of microsurgical materials and trained medical assistants, the author successfully performed numerous traumatic hand surgeries and complex microsurgical procedures. The objective of this study is to highlight the feasibility of such operations and pave the way for aspiring plastic reconstructive surgeons to perform microsurgery in underdeveloped areas within compulsory service programs. By sharing experiences, the study aims to address challenges related to the lack of materials, trained medical assistants and staff, as well as issues with flap and limb monitoring, and complication management.

MATERIAL AND METHOD

A retrospective analysis was conducted on patients who underwent free flaps, replantation, and revascularization surgeries between August 2018 and August 2020. The analysis involved reviewing operation notes, outpatient clinic records, as well as pre-operative and post-operative photographs. The author, who was the sole plastic surgeon in the rural area during that period, performed all surgeries. The study documented patient demographics, the reasons for surgery, surgical details, complications, and the survival of flaps and replanted body parts. Ethical approval was obtained from the relevant provincial ethics committee (approval no: 2020/1). All study subjects were informed and a written consent was obtained. Although the author performed a significant number of other complex procedures, such as tendon reconstructions, nerve repairs, brachial plexus explorations and repairs, ulnar and radial artery repairs, spaghetti hand injuries, and local perforator island flaps during the compulsory service, these cases were not included in the study to maintain focus on free flaps and replantation cases and avoid data heterogeneity.

RESULTS

During the two-year period, the author performed a total of thirty-six featured microsurgical procedures on thirty-two patients (three female, twenty-nine male). The mean age was thirty years old ranging from four to sixty-nine. It is important to note that other microsurgical repairs, such as nerve repairs and single bundle repairs, were excluded from this analysis. No legal disputes arose from patients

who underwent microsurgery, and the majority of complications observed were infection-related. All complications were successfully managed without requiring patient transfers. Details regarding the complications in pediatric cases are listed in Table 1.

Free Flaps

Fifteen patients underwent a total of seventeen free flap surgeries. Two patients received two free flaps each; one due to a large defect and another due to free flap failure. Of the patients, three were female and twelve were male, with a mean age of twenty-six years (ranging from four to forty-seven). Five patients were pediatric, with an average age of eleven years (ranging from four to seventeen). The mean follow-up period was six months (ranging from one month to three years). Except for one patient with a congenital mass, the etiology of the defects in all patients was trauma. Of the sixteen trauma cases, thirteen were acute (including five gunshot wounds, two mine injuries, a traffic accident, a fall from height, rubble injuries, and others), while three patients presented with chronic sequelae of trauma, including one burn contracture, one scaphoid non-union, and one Volkmann's ischemic contracture.

The distribution of free flaps performed by the author is as follows: six superficial circumflex iliac artery perforator (SCIP) flaps, five anterolateral thigh (ALT) flaps (including one thin flap, one two-island flap, and one chimeric flap), one functional gracilis flap, one osteocutaneous fibula flap, one peroneal artery perforator flap, one deep circumflex artery perforator (DCIA) flap, one iliac bone flap, and one femoral condyle chimeric flap. Among these flaps, eight were harvested as thin flaps (including one ALT flap, six SCIP flaps, and one DCIA flap), and four of them were harvested as super-thin flaps (including three SCIP flaps and one DCIA flap) [5]. End-to-end anastomoses were performed in eleven cases, while end-to-side anastomoses were performed in five cases. One anastomosis was performed in a 'T' type to restore distal circulation. Sixteen flaps (94.1%) had successful outcomes, with only one SCIP flap failing despite a revision attempt. Two flaps (11.7%) that survived required take-back surgeries. Among the pediatric flaps, three out of five (60%) developed severe non-surgical complications, as outlined in Table 1. Detailed information about the complications in the free flaps can be found in Table 2.

Table 1. Pediatric free flaps with high non-surgical complications

Pediatric Free Flaps	Age	Sex	Defect Location	Flap Size	Etiology	Flap Type	Recipient Artery	Flap Survival	Follow-Up	Functional Outcome	Complications
1	17	M	Right heel	16x8 cm	Landmine	Chimeric ALT*	Posterior tibial, EtE**	Success	6 months	Limited ambulation	Neutropenic Fever
2	7	F	Left dorsal foot	10x5 cm	Burn Contracture	Super-thin DCIA† perforator	Dorsalis pedis, EtS††	Success	1 month	Full ambulation	Acute HAV infection with intensive care monitorization
3	10	M	Left lateral elbow and arm	20x10 cm	Traffic Accident	Super-thin SCIP‡	Posterior circumflex radial artery, PtP¶	Success	6 months	Full ambulation	-
4	17	M	Right medial leg	22x8 cm	Gunshot Wound	ALT	Posterior tibial, EtS††	Success	6 months	Full ambulation	Neutropenic Fever
5	4	F	Left medial foot	10x4 cm	Run over by a car	Super-thin SCIP	Dorsalis pedis, EtE**	Success	18 months	Full ambulation	Mild Contracture treated with Z plasty

ALT*: Anterolateral thigh flap; SCIP‡: Superficial circumflex iliac artery perforator flap; DCIA †: Deep circumflex iliac artery perforator flap; EtE **: End to end anastomosis; EtS ††: End to Side anastomosis; PtP ¶: Perforator to perforator anastomosis

Table 2. Complications after free flap surgeries

	Complication	Possible cause	Management
Local complications *(n=5)*	Take-back	Hematoma due to vein kink.	No re-anastomosis performed
	Take-back	Kink over end-to-side anastomosis	Switched to end-to-end anastomosis
	Failure	No obvious reason	Another flap was performed
	Finger contracture	Inadequate physiotherapy	Z-plasty
	Mild lymphedema	Large lower extremity defect over saphenous vein and lymphatics	Physiotherapy
Systemic complication *(n=4)*	Neutropenic fever	Infection or drug related	Consulted to pediatrics with broad-spectrum antibiotics
	Neutropenic fever	Infection or drug related	Consulted to pediatrics with broad-spectrum antibiotics
	Acute Hepatitis A	Orofaceal	Intensive care monitorization
			No available center could be found for dispatch.
			Spontaneous recover
	Bacterial pneumonia	Long operation	Antibiotic treatment was started
(n=9/17)			

Replantation

The replantation cases exclusively involved male patients, with a mean age of thirty-two years (ranging from four to sixty-nine, mean thirty-five). Nineteen replantation procedures were performed on seventeen patients, including the replantation of three fingers in one patient. Out of the total replantations, four cases involved pediatric patients, with an average age of ten years (ranging from four to seventeen). The mean follow-up period was four months (ranging from one month to three years). In addition to finger amputations, attempts were made to replant one ear, one alar rim, and one toe. One patient had five finger amputations, of which four were attempted to be replanted. Two out of the nineteen replantation attempts failed, resulting in a survival rate of seventeen replants (89.4%). The unsuccessful replanted body parts were amputated either during or after surgery following revision attempts. Trauma was the sole cause of amputation in all replantation cases. Four cases presented with clean cut injuries (knife and bread slicer), while fifteen amputations (78.9%) were a result of crush or avulsed injuries, including incidents involving saws, dog bites, motorcycle chains, and agricultural machinery accidents. Among the replants, arterial repairs were performed in ten cases, both arterial and vein repairs were carried out in seven cases, arteriovenous anastomoses were performed in three cases, and two-artery repairs were performed in nine cases. Vein grafts were used in a total of five instances, with two utilized for vein defects and three for artery defects. Details regarding complications observed in the replantation cases are listed in Table 3.

DISCUSSION

The author achieved a success rate of 16 out of 17 (94.1%) for free flaps and 16 out of 18 (88.8%) for replantation or revascularization cases. This demonstrates that performing microsurgery as the sole plastic surgeon in an underdeveloped

Table 3. Complications after replantation

	Complication	Possible cause	Management
Local complications *(n=4)*	Osteomyelitis	Dirty wound	Half of replant was debrided
	Sudeck's atrophy	Trauma in an old patient	Physiotherapy
	Take-back	Skin compression	
	Failure	A-V shunt, very small piece and small vessels, avulsion by dog bite, lack of 11/0	Reconstructed with local flaps
Systemic complication *(n=1)*	CMV hepatitis	Incidental	Spontaneous recovery
(n=5/19)			

area is feasible, despite the lack of instruments and trained staff, with certain acceptable complications. However, the high rate of non-surgical complications in pediatric cases is concerning, despite the limited number of cases. The author aims to discuss indications, complications management, lack of instruments, patient care, and patient monitoring in detail to provide insight into the challenges and potential solutions in this specialized area.

Indications

As expected, the majority of cases were emergent cases, primarily involving extremity flap reconstructions. It should be noted that head and neck reconstruction or breast reconstruction surgeries could not be performed due to the absence of an oncology team for tumor resections and the lack of suitable intensive care facilities. Plastic and reconstructive surgeons working in region 5 or 6 should be well-versed in extremity and trauma reconstruction.

Management of Non-Surgical Complications

Three pediatric cases undergoing free flap surgeries experienced serious postoperative non-surgical complications. Two cases exhibited neutropenic fever, a pediatric emergency often caused by infection [6], which required the administration of broad-spectrum antibiotics and close monitoring for sepsis. Both cases were discharged after their neutrophil levels recovered. The third pediatric case developed acute Hepatitis A and required close monitoring in the pediatric intensive care unit for one week to monitor for potential fulminant progression. Attempts were made to transfer the patient to a tertiary level pediatric gastroenterology department, but no available spot or suitable center was found. The patient recovered spontaneously and was discharged safely. One adult replantation case was diagnosed with acute CMV hepatitis postoperatively, which was only a mild form, and the patient recovered spontaneously. Infectious disease-related complications in children, such as neutropenic fever and hepatitis, are not uncommon and may require management at a tertiary level. Although microsurgical reconstruction in pediatric cases, including complex super-thin flaps, was feasible for the author, it is suggested to avoid pediatric microsurgical reconstruction in region 6 due to delays and issues in the dispatch system.

Management of Microsurgical Complications

Microsurgery operations and emergency take-backs can be physically demanding and may impact routine elective outpatient clinic work. This can potentially lead to official complaints and a reduction in performance-based salary. The author proposes educating the staff on each case and scheduling elective flap surgeries on Thursdays or Fridays, considering the possibility of take-backs over the weekend. This recommendation is based on research by Wei et al. [7], which indicates that 95% of vascular problems occur within the first three days and that they are mostly salvageable (85%) during this time frame.

Management of Lack of Material and Instruments

To perform microsurgery, surgical sets, an operation microscope, and microsurgical sutures are necessary. Among these, the operation microscope holds the utmost importance, as it may be more challenging to find or replace compared to other equipment. Currently, most rural hospitals near the border have at least one operation microscope available for neurosurgeons, particularly in cases of cranial trauma or war surgery. The author had to utilize the only available microscope shared with neurosurgeons in the hospital for microsurgery procedures. However, the hospital did not possess suitable microsurgery instrument sets. Thus, the author resorted to using his personal microsurgical instrument set. To obtain conventional jeweler's forceps at a more affordable price, the author purchased them from a jewelry store. While it is possible to procure specific instruments and materials through a direct purchase system as outlined in Article 22 of Law No. 4734 [8], permission for such purchases lies in the hands of the administration and finance department. Microsurgical sutures, on the other hand, are more readily available and cost-effective. However, it's important to note that the micro sutures used by ophthalmologists, which have spatula tips, are not designed for use in vessels and nerves. For hand and flap surgeries, sutures with round tips and smaller-sized needles (preferably less than 5mm for 9/0) are preferred. The author successfully convinced the hospital administration to procure microsurgical sutures when supplies ran out, leading to the resumption of emergency

hand surgeries. Additionally, the author personally purchased some sutures for emergency purposes. It is noteworthy that all perforator flaps were raised using a free-style technique, as the only available Doppler device in the hospital was out of order. The osteocutaneous flaps were performed using a gigli saw or osteotome as an electrical saw was not available.

Assistance During Surgery

The presence of skilled assistance during surgery is another crucial factor in microsurgical procedures. While it is commonly believed that an experienced resident or nurse should assist the surgeon during microsurgery, the author's clinical fellowship experience involved raising flaps and performing anastomoses without any assistance, except for bone flaps that may require a large retractor. Although it may initially seem challenging, the use of automatic retractors, fish hooks, and open-loop anastomosis techniques [9] can facilitate these surgeries with minimal assistance. In fact, it is often preferable for the surgeon to have less help from the assistant, unless the assistant possesses extensive experience in microsurgery. This is because an inexperienced assistant may unintentionally move unnecessarily or use sharp retractors, potentially causing distractions or even injuring important perforators. For these reasons, the author suggests that the assistant scrub nurse adopt a passive approach and wait for clear directions instead of being overly active throughout the procedure.

Flap and Replant Monitoring

The need for flap and replant monitoring is another concern that may discourage microsurgeons from performing these operations in underdeveloped regions. In such areas, a shortage of experienced nurses and residents can result in the surgeon bearing the responsibility of monitoring flaps and replants alone. To address this issue, the author provided a ten-minute training talk to clinic nurses on flap and replant monitoring. This training focused on simple signs and terms that could be easily understood, such as oozing, hematoma, assessment of flap temperature, and color. The use of an infrared thermometer was found to be helpful and easy for the nurses to utilize [10]. In replantation cases, a saturation probe was also employed for improved monitoring [11]. These monitoring techniques are straightforward to use and alleviate the burden on the surgeon. However, it is important to note that these techniques can sometimes be misleading, and infrared thermometers may detect flap coldness too late, especially when extremity flaps are covered with a blanket. Consequently, physical examination remains the gold standard for most microsurgeons [12]. The author implemented a routine of monitoring the flaps immediately after surgery in the recovery room, as well as during the patient's transfer to the clinic room. This routine facilitated the salvage of one flap in the case of arterial thrombosis. After the immediate postoperative monitoring, clinical nurses monitored the flaps on an hourly basis. Whenever there was doubt, photographs and videos were shared with the author through WhatsApp. If there were suspicions regarding flap circulation, a nurse would initiate dermal bleeding by making a small cut with a blade. The author would then conduct further monitoring the following morning. Weekdays involved monitoring the flaps three times a day, while on weekends, they were monitored twice a day by the author and on an hourly basis by nurses for the first forty-eight hours. After forty-eight hours post-surgery, the frequency of monitoring was reduced to every three hours to alleviate the burden on the nurses.

Patient Care

Patient care in the context of microsurgery requires advanced experience, which is often lacking among nurses and other healthcare workers in underdeveloped areas. Therefore, it is crucial for the reconstructive surgeon to train healthcare workers in patient care, monitoring, and follow-up. This training should encompass basic principles specific to microsurgery patients, including maintaining a warm environment and a warm patient, elevating the extremity, avoiding any compression around the flap or replant, monitoring the patient's position, the importance of pain management to prevent vasospasm, and performing flap monitoring as discussed in a previous section. In the author's experience, training is made easier by the fact that staff in smaller and underdeveloped centers tend to be few in number, yet eager to learn new approaches.

Dispatch System

Due to a lack of instruments or experience, cases requiring microsurgery are often dispatched to larger centers. However, with a limited number of academic staff in plastic surgery at peripheral tertiary centers, many reconstructive surgery centers have been suspended, making it challenging to find a tertiary center that can admit patients needing microsurgery. The author avoided dispatching any patients requiring microsurgery, except on two occasions for short periods. In one instance, this was due to a shortage of micro sutures, and in the other, it was due to ongoing renovations in the operating rooms. Fortunately, despite the long waiting periods, the author was able to successfully dispatch the patients in these two cases through effective communication and negotiation. Given the high systemic complication rate in pediatric patients in this study, dispatching should be prioritized in pediatric patients requiring microsurgery, not because of possible complications but because of the problematic dispatching system if a systemic complication occurs in an underdeveloped area.

Handling Supermicrosurgery and Free Thin-Flaps

Handling supermicrosurgery, which involves dealing with vessels less than 0.8mm in diameter, presents significant challenges. It not only requires technical expertise but also necessitates specialized instruments with fine tips and extremely fine sutures, such as 11/0 with smaller needles (preferably less than 4mm). Supermicrosurgery is commonly employed in pediatric replantation, tip replantation, and thin free flaps. While the author successfully performed supermicrosurgery for these indications during his compulsory service, the lack of available 11/0 sutures, which were not accessible at the nearest tertiary level at the time, may have contributed to one of the failures. Although thin flap dissections and anastomosis of smaller vessels to larger vessels in an end-to-side manner can be accomplished with larger sutures, performing replantation on extremely small pieces becomes nearly impossible with them. Consequently, the author recommends refraining from supermicrosurgery unless suitable instruments and sutures are readily available.

Strengths and Limitations

This study boasts several strengths. Firstly, patients with different indications were operated on by the same surgeon, illustrating the feasibility of a wide range of microsurgery procedures. Secondly, there is a scarcity of studies addressing microsurgery in rural areas, making this study a valuable source of firsthand insight. The primary limitation of this study lies in the assumption based on the experience and motivation of a single surgeon, which can influence the feasibility and results. Furthermore, the mean follow-up time was relatively short. The rural setting, where doctors often resign after two years upon fulfilling their compulsory work, as well as the presence of refugees who may need to be deported or illegally escape to another country, pose challenges to maintaining long-term follow-up.

CONCLUSION

Performing microsurgery, including replantation and free flap surgeries, is deemed safe within the context of compulsory work in region 6, even with just one microsurgeon present at the center. Implementing technical tips such as open-loop anastomosis, along with staff training and the use of easy means for flap monitoring, contribute to the successful execution of microsurgery procedures. However, the author advises caution when considering microsurgery in pediatric patients within the region 6 compulsory work period due to potential non-surgical complications and challenges associated with the dispatch system. Additionally, it is recommended to delay supermicrosurgery, if elective, until suitable fine sutures are available.

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Author contribution

Study conception and design: AHS; data collection: AHS; analysis and interpretation of results: AHS; draft manuscript preparation: AHS. All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

The study was approved by the Clinical Research Ethics Committee of XXX (Protocol no. XXX).

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Conflict of interest

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