

# THE MATURATION OF THE ROLE OF MICROSURGICAL FLAP PROCEDURES IN A MEDICAL CENTER

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## REZUMAT

Pe o perioadă de 6 ani (1992-1998), au fost studiate toate intervențiile de transfer liber microchirurgical, pentru a evalua cum au fost aplicate aceste procedee într-un centru medical și cum au evoluat aceste proceduri de-a lungul timpului. În ultimii 4 ani, au fost efectuate 166 de transferuri libere cu o rată de succes de 93%, comparată cu 113 transferuri libere cu o rată de succes de 95% efectuate în primii 2 ani. Rata de eșec a fost mai mare în cazurile de reconstrucție a capului și gâtului (10%). Zonele receptoare au fost distribuite în toate regiunile anatomice ale corpului. De-a lungul celor două perioade de timp, au fost folosite cu frecvență crescută lambourile cutanate (19% vs. 6%) și lambourile osoase (20% vs. 8%) reflectând o schimbare constantă în modul de prezentare a cazurilor. Sursele de referire a pacienților au fost constituite în marea majoritate din centre în afara spitalului (36%) precum și 3 centre medicale de ortopedie (25%), chirurgie generală (13%) și ORL (13%). Cazurile rezolvate precoce în colaborare cu alte echipe chirurgicale au crescut în frecvență de la 49% la 56%, constituind în marea majoritate reconstrucții mandibulare sau ale capului femural cu necroză aseptică. Procesul de maturizare al acestui serviciu arată păstrarea unei diversități respectabile de lambouri utilizate pentru reconstrucție, a unor surse constante de pacienți, ceea ce a dus la creșterea numărului de pacienți și a cazurilor de reconstrucție imediată. Astfel, a fost posibilă identificarea unor puncte problematice, cum ar fi ratele de eșec ale reconstrucțiilor la nivelul capului și gâtului. Acest serviciu poate servi ca și model pentru aplicarea la scară largă a transferurilor libere microchirurgicale într-un centru medical cât și pentru a facilita analiza organizării și dezvoltării departamentelor de microchirurgie reconstructivă.

**Cuvinte cheie:** microchirurgie, lambouri microchirurgicale, centre de microchirurgie

## ABSTRACT

For a period of 6 years (1992-1998), we studied our microsurgical flap procedures to evaluate how these procedures were generally applied in a medical center, and how those applications evolved over time. Over the last 4 years, we performed 166 flap cases with a success rate of 93%, compared to 113 flaps with a 95% success rate during the first 2 years. Failure rates were higher in head and neck cases (10%). Recipient sites remained distributed throughout all body regions. Over the 2 time periods, there was an increased use of skin flaps (19% vs. 6%) and bone flaps (20% vs. 8%), reflecting changing case patterns. Referral sources included substantial numbers from outside the medical center (36%) and 3 principal medical center specialties, orthopedics (25%); general surgery (13%); and ENT (13%). Cases done as immediate reconstructions with other surgical specialty teams increased from 49% to 56%, and these cases included increased numbers of mandible reconstruction and fibula flaps for avascular necrosis of the hip. The maturation of this practice, therefore, showed increased diversity of flaps, maintenance of referral patterns, and increasing numbers of cases and immediate reconstruction cases. Identification of problem areas such as head and neck failure rates was possible. This practice can serve as a model of the broad application of microsurgical flap procedures in a medical center and lead to analyses that can support the organization and development of reconstructive microsurgery units.

**Key Words:** microsurgery, microsurgical flaps, microsurgery centers

## INTRODUCTION

Reports of microsurgical flap cases often concentrate on individual flaps, individual recipient regions and problems, or application to specific disorders.<sup>1-4</sup>

In 1992, the authors established an associated practice at Stanford University with the intent of offering comprehensive microsurgical services. As we developed our flap cases, we realized that the medical center's demand for such cases was a diffuse one, including a wide range of referral sources and problems. The immediate evaluation of the impact of these cases, therefore, would not include great numbers of specific flaps and narrowly defined applications. We did realize that study of our flap cases could yield data descriptive of microsurgical flap applications to a broad range of cases and illustrate how these operations served the needs of a medical center and its referral base.

We have previously published brief accounts of our first 2 years' cases.<sup>5,6</sup> The subsequent 4 years' cases

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and subsequent conclusions were reported but not yet published consequent to the dissolution of our Stanford practice in 1998-1999. The overall experience continues to guide some of our practice developments, and we therefore proceed with this report to illustrate some analyses and findings that can be derived from microsurgical flap cases performed within the framework of a general reconstructive practice.

## MATERIAL AND METHOD

As noted, the general outlines of these analyses were applied earlier to cases done from 1992-1994.<sup>5,6</sup> Cases performed for 1994-1998 were reviewed using office records, patient records, and surgeons' logs.

The microsurgical flap cases performed between 1999 and 1998 were all done at the Stanford University Medical Center or the Palo Alto Veterans Administration Hospital. One or both of the authors performed the microsurgical elements of the cases. Data from 1992-1994 were collected from earlier reports.<sup>5,6</sup>

## RESULTS

Table 1 outlines the overall number of flap cases with associated failure and complication rates. Failures were constant over the periods studied (5-7%), and complications were not significantly different (25% vs. 34%).

**Table 1.** Cases, Failures, and Complications

	1992-1994	1994-1998	Total
Cases	108	157	267
Flaps	113	166	279
Failures	6 (5%)	12 (7%)	18 (6%)
Major Complications	28 (25%)	53 (34%)	81 (30%)

The distribution of flap types changed, with an increased utilization of skin flaps and bone flaps in the 1994-1998 period. (Table 2)

**Table 2.** Flap Types

	1992-1994	1994-1998
Muscle	84 (74%)	96 (58%)
Skin/Fascia	7 (6%)	32 (19%)
Bone	9 (8%)	33 (20%)
Other	13 (12%)	5 (3%)
Total	113	166

Recipient site distribution showed small increases in trunk and pelvis cases as well as lower extremity cases; and small decreases in head and neck cases and upper extremity cases. (Table 3)

**Table 3.** Recipient Sites

	1992-1994	1994-1998
Head/Neck	47 (42%)	58 (35%)
Trunk/Pelvis	33 (29%)	56 (34%)
Upper Extremity	14 (12%)	13 (8%)
Lower Extremity	19 (17%)	39 (23%)
Total	113	166

Referral sources remained constant, with a mixture of medical center and community cases. (Table 4) Itemization of medical center referral source for 1994-1998 showed that orthopedics, ENT, and general surgery generated most of the referral cases. (Table 5)

**Table 4.** Referral Sources

	1992-1994	1994-1998
Medical Center	64 (59%)	101 (64%)
Community	44 (41%)	56 (36%)
Total	108	157

**Table 5.** Medical Center Referral Sources (1994-1998)

Specialty	Referral Cases
Orthopedics	44
ENT	21
General Surgery	20
Neurosurgery	6
Vascular Surgery	4
Medicine	3
Dermatology	1
Podiatry	1
Urology	1

In 1994-1998, 56% of the flap procedures were done as immediate reconstruction in concert with one or more additional surgical teams. This percentage is comparable to the 49% of team procedures noted in the earlier period. (Table 6) As with referral cases, orthopedics, ENT, and general surgery participated in most of the team cases.

**Table 6:** Team Procedures

Co-surgery Teams	1992-1994	1994-1998
General Surgery	13	19
Orthopedic Surgery	9	34
ENT	10	20
Neurosurgery	20	7
Neurosurgery/ENT	2	0
Thoracic Surgery	1	1
Orthopedic/General Surgery	1	0
ENT/General Surgery	1	5

Analyses of failures and complications were limited by small numbers of subgroups. Head and neck cases in 1994-1998, (Table 7) however, had a higher failure rate (10%) that the other sites combined (5.5%). This higher failure rate for head and neck cases was not statistically significant.

**Table 7:** Failure Rates by Site (1994-1998)

Recipient Site	Total Flaps	Failures
Head and Neck	58	6 (10%)
All Others	108	6 (5.5%)

## DISCUSSIONS

Our microsurgery flap practice underwent a number of changes during its maturation. While failure and complication rates remained constant, flap utilization diversified with increased use of skin and bone flaps. These changes reflected increased use of the radial forearm flap (principally in head and neck cases) and increased use of the fibula flap (principally in mandibular reconstruction and cases of avascular necrosis of the femoral head). The general distribution of recipient sites did not change, but absorbed the decrease in omental flaps used during the first part of the series<sup>5,6</sup> and contained general increases in head and neck cancer reconstruction.

The great variety of referral sources substantiated the assumption of wide applicability of these cases to difficult problems arising from many specialty patient groups. The referral sources from the medical center also contributed to the formation of combined surgical teams to perform simultaneous treatment and reconstructive procedures. From head to toe, these procedures successfully achieved immediate

reconstruction in cases involving the skull and skull base, midface and mandible, breast, hip, and lower extremity. The microsurgery team was successful in maintaining productive working relationships with these various specialties throughout this study period.

Although not statistically significant, the increased failure rate in our head and neck cases captured our attention, perhaps because reconstructive failures in this area may be the most painful of all. Our failure was comparable to some other reports,<sup>3</sup> and we noted the lower failure rates consistently reported from the M. D. Anderson group.<sup>2</sup> This group emphasized use of the external carotid artery and internal jugular vein as recipient vessels, while for most of the study period, we restricted our selection of recipient site vessels to branches of major neck vessels and the superficial temporal vessels. Our failures and the M. D. Anderson reports have increasingly led us to use the external carotid artery and internal jugular vein as recipient vessels with the impression of decreased failures as yet unsubstantiated by analysis.

This experience showed us that the general application of microsurgical flap procedures in a medical center met a wide variety of clinical needs, could adapt to changing patterns of problems, could sustain referral lines and productive team surgery relationships, and provide sufficient data to focus on some specific issues (such as recipient vessels in head and neck flap cases).

Our ongoing analyses came to reveal to us, however, that review of microsurgery flap cases alone did not provide a comprehensive picture of the overall performance and impact of a reconstructive microsurgery practice. One category of cases, namely surgical infections, brought this impression into focus. We initially made known to our referral sources that we were interested in lower extremity cases of osteomyelitis, especially ones that might require microsurgical flaps for postablative reconstruction.<sup>7</sup> Subsequently, we received a large number of referrals for surgical management of infection regardless of the need for microsurgical reconstruction.<sup>8</sup> (Table 8)

**Table 8:** Surgical Infection Referrals and Procedures (1992-1995)

Total Infections	147
Operative Procedures	
Ablative	131
Reconstructive (including 28 microsurgical flaps)	126

This experience led us to develop a category of patients labeled “complex reconstruction” and signifying with that designation cases referred originally for microsurgery but treated with nonmicrosurgical procedures; and/or patients requiring nonmicrosurgical reconstruction and participation of one or more additional specialties (ranging from operative teams to medical specialties such as infectious disease) to provide definitive care.

As we further reflected on our practice, we realized that even the “complex reconstruction” patients did not complete the full picture of microsurgical practice. Elective flap procedures and nerve reconstruction lead to secondary revisions and procedures ranging from nipple/areolar reconstruction to tendon transfers. Patients referred for emergency microsurgery may undergo replantation or revascularization of devascularized body parts, but may also undergo amputation or other procedures for trauma repair. Substantial numbers of these emergency patients go on to secondary procedures.<sup>9</sup>

We went on to develop a broad classification scheme to attempt to capture all cases utilizing or related to microsurgery, and these categories are outlined in Table 9.<sup>10</sup> The classification scheme includes categories for routine nonmicrosurgical cases and inpatient referral cases, both of which can be analyzed for intrinsic problems and for comparison with microsurgical cases.

**Table 9:** A Classification System for Cases in a Reconstructive Microsurgery Practice

Case Category	Description
I	Microsurgical Flaps
II	Nerve Reconstruction
IIIA	Emergency Microsurgery (including replantation and nerve revascularization)
IIIB	Cases Referred for Emergency Microsurgery (but undergoing conventional procedures)
IV	Secondary Procedures Following Microsurgery
V	Complex Reconstruction
Total Microsurgery Cases:	Categories I-V
VI	Routine Cases
VII	Inpatient Referral Cases
Total Nonmicrosurgical Cases:	Categories VI-VII

We first applied this classification scheme to an analysis of case-related hospital income over a 2-year

period (Table 10).<sup>10</sup> In this study, we felt that we had captured the full picture of a reconstructive surgery practice while demonstrating that the microsurgical cases made substantial profits for the hospital.

**Table 10:** Hospital Revenues for Microsurgical and Nonmicrosurgical Cases (1994-1996)

Case Category	Year	Total Cases	Revenue	Net Profit
Microsurgery	1994-1995	188	\$4,382,192	\$1,001,839
	1995-1996	230	\$4,775,249	\$ 902,450
Nonmicrosurgery	1994-1995	262	\$1,709,727	(\$147,135)
	1995-1996	202	\$1,324,035	(\$106,732)

( ): negative net profit, i.e., loss

Since 1999, one of the authors (W. L.) has been on the faculty of the University of Mississippi Medical Center. In 2001, that institution opened a Center for Microsurgery and Complex Reconstruction based largely on projections from the analyses outlined above. We soon hope to have clinical and economic data from that Center, and we hope that such ongoing studies will provide practice analysis models able to support the establishment, ongoing support, and further development of reconstructive microsurgery units.

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