Outcome Analysis of End-to-End and End-to-Side Anastomoses in 131 Patients Undergoing Microsurgical Free Flap Reconstruction of the Lower Extremity

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Abstract

Background   End-to-end and end-to-side anastomoses remain the most common techniques in microsurgical free flap reconstruction. Still, there is an ongoing effort to optimize established techniques and develop novel techniques. Numerous comparative studies have investigated flow dynamics and patency rates of microvascular anastomoses and their impact on flap survival. In contrast, few studies have investigated whether the type of anastomosis influences the outcome of microvascular free flap reconstruction of a lower extremity.

Patients and Methods   Retrospectively, we investigated the outcome of 131 consecutive free flaps for lower extremity reconstruction related to the anastomotic technique.

Results   No statistical significance between arterial or venous anastomoses were found regarding the anastomotic techniques ($p = 0.5470$). However, evaluated separately by vessel type, a trend toward statistical significance for anastomotic technique was observed in the arterial ($p = 0.0690$) and venous ($p = 0.1700$) vessels. No thromboses were found in arterial end-to-end anastomoses and venous end-to-side anastomoses. More venous ($n = 18$) than arterial thromboses ($n = 9$) occurred in primary anastomoses undergoing microsurgical free flap reconstruction ($p = 0.0098$). Flap survival rate was 97.37% in the end-to-end arterial group versus 86.36% in the end-to-side group. No thromboses were found in five arterial anastomoses using T-patch technique.

Conclusion   For lower extremities, there is a connate higher risk for venous thrombosis in anastomotic regions compared with arterial thrombosis. We observed divergent rates for thromboses between end-to-end and end-to-side anastomoses. However, if thrombotic events are explained by anastomotic technique and vessel type, the latter carries more importance.

Keywords
► free flap reconstruction
► end-to-end anastomosis
► end-to-side anastomosis

The evolution of microsurgery to date has enabled microsurgeons to perform anastomoses of 0.5-mm-caliber vessels,[1] so-called "super-microsurgery," and thus facilitating even the most sophisticated free flaps.

In 1997, Samaha et al examined the fate of more than 2,000 microvascular anastomoses in more than 900 tissue transplants,[2] comparing end-to-end versus end-to-side techniques. In contrast to Godina, who advocated the preferential

use of end-to-side arterial anastomoses in lower extremity reconstruction,[3] Samaha et al could not find any statistical difference between the two techniques. Rather, they proposed to choose the anastomosis technique secondary to factors influencing the choice of recipient vessels as vessel condition, accessibility, and preservation or augmentation of maximal distal flow to an extremity.[2,3] Tsai et al recommended end-to-side anastomosis when facing vessel-size discrepancy and for preserving the distal circulation of the limb.[4]

The aforementioned results were also confirmed by experimental and comparative studies in rats, showing no significant difference in free flap survival for either technique.[5–7]

In cases of difficult clinical situations such as pathologic vessel conditions due to trauma, infection or radiation, vessel wall discrepancy, or deeply located vessels, Verhelle and Heymans suggested T-grafts and a funnel-shaped vein graft.[8]

This retrospective study was performed to demonstrate our experience with end-to-end and end-to-side anastomoses in 131 patients undergoing microvascular lower extremity reconstruction over a period of 6 years.

Patients and Methods

In this study, we analyzed the outcome of end-to-end and end-to-side anastomoses in all free flaps undergoing reconstructive surgery of the lower extremity. The only exclusion criteria were the missing details about the anastomotic technique in the operation report ($n = 1$). Between 2007 and 2012, 97 male and 34 female patients were treated with 131 flaps in our institution by multiple surgeons. Retrospectively, we analyzed operative reports for anastomotic technique and revision-operative reports for occurrence of thrombotic events. We included only thrombotic events of primary anastomoses in autologous flap transplantation. Overall, we examined the thrombosis rate of 132 arterial and 145 venous primary anastomoses.

Patient age ranged from 7 to 88 years and was 49 years in average. The flaps used for defect closure are summarized in ►Fig. 1. The latissimus dorsi flap was the most commonly used flap for lower leg reconstruction (60.31%).

For evaluation of each individual's vascular status, we obtained peripheral pulses, the ankle brachial index, and arteriography. In case of arteriopathy (i.e., stenosis or interruption) the patients were referred to the radiologist and/or vascular surgeon for interventional improvement of intervention as balloon dilation or bypass surgery.

Selection of recipient vessels was performed in regards to the arteriography findings and defect location. In most cases free flap coverage was performed in supine or lateral decubitus position with end-to-end or end-to-side anastomosis of the anterior or posterior tibial artery. Venous anastomosis was performed on the deep or superficial system according to the intraoperative finding. In case of availability the superficial vein was preferred. All anastomoses were performed hand sutured.

In case of potential pressure on the flap pedicle due to positioning of the patient in the postoperative course, we performed an external fixation.
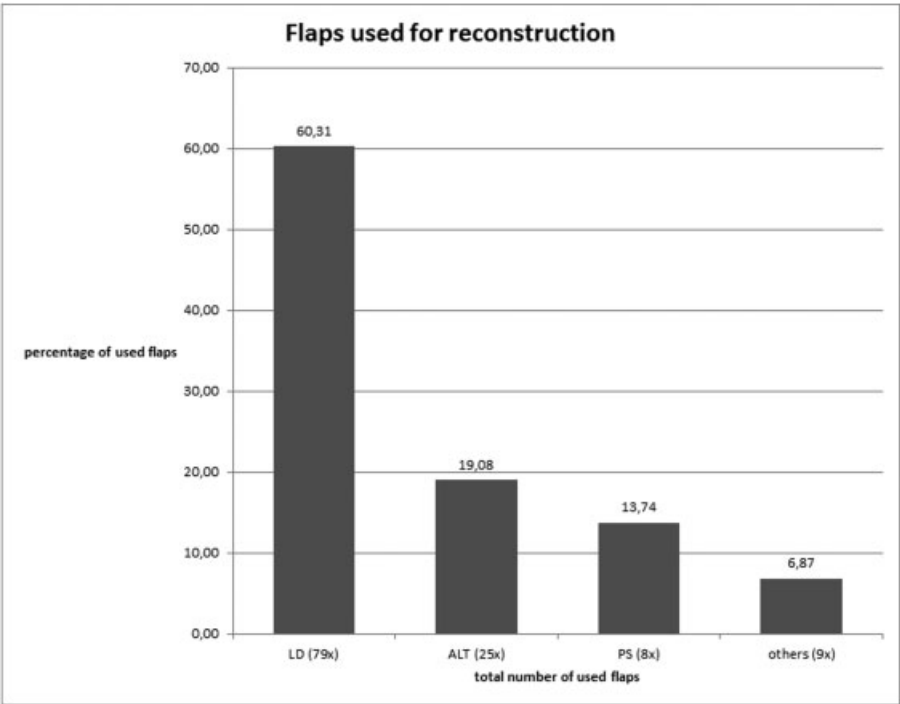
Fig. 1 For reconstruction, 131 flaps were used: Latissimus dorsi (LD) flap was used 79 times, anterolateral thigh (ALT) flap 25 times, parascapular (PS) flap 18 times, and 9 other flaps for covering defects on the lower extremity. On top of the bars, the corresponding percentage of used flaps is shown.

Table 1 Exact logistic regression model for occurrence of arterial thromboses

Variable	Thrombosis	No thrombosis	Model A1 (crude)		Model A2 (adjusted)	
	N/Total (%)	N/Total (%)	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value
Anastomosis						
End-to-side (Ref.)	9/87 (10.3%)	78/87 (89.7%)				
End-to-end	0/42 (0%)	42/42 (100%)	6.57 (1.29,∞)	0.0501	6.060 (1.16,∞)	0.0690
Etiology						
Trauma (Ref.)	8/99 (8.1%)	91/99 (91.9%)				
Infection	1/12 (8.3%)	11/12 (91.7%)	1.03 (0.02, 9.09)	1.0000	1.14 (0.02, 11.68)	1.0000
OM	0/3 (0%)	3/3 (100%)	3.08 (0.00, 21.60)	1.0000	7.18 (0.00, 136.32)	1.0000
Tumor	0/13 (0%)	13/13 (100%)	0.66 (0.00, 3.55)	0.7201	0.56 (0.00, 3.073)	0.6205
Other	0/3 (0%)	3/3 (100%)	3.08 (0.00, 21.60)	1.0000	5.00 (0.00, 95.00)	1.0000
Anticoagulation						
ASS + heparin therapeutic dose (Ref.)	0/16 (0%)	16/16 (100%)				
ASS + heparin low-dose prophylactic	5/68 (7.4%)	63/68 (92.6%)	1.65 (0.28,∞)	0.6753	1.62 (0.26, ∞)	0.6943
Heparin only	1/14 (7.1%)	13/14 (92.9%)	0.06 (0.28,∞)	0.9333	1.80 (0.095, ∞)	0.7143
ASS + heparin high-dose prophylactic	3/32 (9.4%)	29/32 (90.6%)	0.29 (0.28,∞)	0.5735	1.59 (0.22,∞)	0.7187

Abbreviations: ASS, acetylsalicylic acid; CI, confidence interval; OM, osteomyelitis; OR, odds ratio; Ref., reference group for the regression model.
Note: Occurrence of arterial thromboses is presented in columns 2 and 3 with absolute and relative frequencies. All models are from based on exact logistic regression. Model A1 uses thrombosis status (yes/no) as the dependent variable. Anastomosis, etiology, and anticoagulation are included separately as independent variables into the model. Model A2 includes the three independent variables into a single model.

Our anticoagulative protocol consisted of aspirin 100 mg/d and low-molecular-weight heparin (2,500–5,000 IU body weight adapted) according to the individual thrombotic risk. In case of complicated anastomosis (e.g., atherosclerosis, arterio-venous [AV] loop, major complications with the need for reexploration) or individual risk for thrombosis caused by secondary diagnoses, we performed systemic heparinization (15,000 IU/24 h resp. partial thromboplastin time [PTT] 50–60 seconds) during hospital stay.

With respect to their comorbidities and cardiopulmonary performance during the first 24 hours postoperatively, patients were monitored in our intensive care unit (ICU) accordingly. The visible flaps were monitored for clinical signs such as color, capillary refill, congestion, flap turgor, and flap temperature, respectively.

All flaps were monitored hourly during the first 24 hours, every 2 hours throughout the second day, and every 4 hours the following day.

Seroma, hematoma, wound dehiscence, and fat necrosis were considered to be minor complications. Flap compromise due to pressure, kinking, or thrombosis with the need for immediate reexploration was considered to be major complications.

Results

In this study, 41 of 131 patients underwent a revision operation (31.30%). Average time of revision was exactly 3 days after flap transplantation. Thrombotic events in the anastomotic region were found and treated in 24 of these patients (18.32% of all patients; arterial only [$n = 6$], venous only [$n = 15$], or both [$n = 3$]). In these cases average time to revision was 1.79 days. The remaining patients ($n = 17$) were treated operatively for other reasons, that is, active bleeding.

We found more venous ($n = 18$) than arterial thromboses ($n = 9$) in primary anastomoses undergoing microsurgical free flap reconstruction ($p < 0.01$). No thromboses were found in arterial end-to-end anastomoses and venous end-to-side anastomoses, respectively. Nine arterial thromboses were found in arterial end-to-side anastomoses and 18 venous thromboses were found in venous end-to-end anastomoses (►**Tables 1**, **2**). Although there was no statistical significance between the two anastomotic techniques, there was a high trend close to statistical significance for lower thrombotic risk when performing arterial anastomoses in end-to-end technique ($p = 0.0501$) and a low statistical trend to lower risk when performing venous anastomosis in end-to-side technique ($p = 0.1818$).

►**Tables 3** and **4** summarize the defect characteristics: type of injury, sites of defect, and recipient arterial vessels for supplying the flap. In 99 of 131 cases (75.57%), trauma injury was causal for lower extremity defects. The tibialis posterior artery was the most commonly used vessel for arterial flap access (61.37%).

►**Tables 5** to **7** show the distribution of arterial and venous anastomoses performed. There was one anterolateral thigh

Table 2 Exact logistic regression model for occurrence of venous thromboses

Variable	Thrombosis	No thrombosis	Model V1 (crude)		Model V2 (adjusted)	
	N/Total (%)	N/Total (%)	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value
Anastomosis						
End-to-side (Ref.)	0/15 (0%)	15/15 (100%)				
End-to-end	18/114 (15.8%)	96/114 (84.2%)	0.26 (0.00, 1.30)	0.1818	0.25 (0.00, 1.26)	0.1700
Etiology						
Trauma (Ref.)	15/99 (15.2%)	84/99 (84.8%)				
Infection	2/13 (15.4%)	11/13 (84.6%)	1.02 (0.10, 5.42)	1.0000	1.06 (0.10,5.91)	1.0000
OM	0/2 (0%)	2/2 (100%)	2.37 (0.00, 20.30)	1.0000	1.99 (0.00, 17.34)	1.0000
Tumor	1/13 (7.7%)	12/13 (92.3%)	0.47 (0.01, 3.64)	0.8259	0.50 (0.01, 4.10)	0.9014
Other	0/3 (0.0%)	3/3 (100%)	1.50 (0.00, 10.22)	1.0000	1.59 (0.0, 11.18)	1.0000
Anticoagulation						
ASS + heparin therapeutic dose (Ref.)	0/16 (0%)	16/16 (100%)				
ASS + heparin low-dose prophylactic	5/68 (7.4%)	63/68 (92.6%)	0.47 (0.11, 2.44)	0.4331	0.57 (0.12, 3.04)	0.6210
Heparin only	1/14 (7.1%)	13/14 (92.9%)	0.24 (0.00, 2.91)	0.4189	0.24 (0.00, 2.87)	0.4079
ASS + heparin high-dose prophylactic	3/32 (9.4%)	29/32 (90.6%)	0.42 (0.07, 2.66)	0.4565	0.43 (0.07, 2.82)	0.4929

Abbreviations: ASS, Aspirin; CI, confidence interval; OM, osteomyelitis; OR, odds ratio; Ref., reference group for the regression model.
Note: Occurrence of venous thromboses is presented in columns 2 and 3 with absolute and relative frequencies. All models are from based on exact logistic regression. Model A1 uses thrombosis status (yes/no) as the dependent variable. Anastomosis, etiology, and anticoagulation are included separately as independent variables into the model. Model A2 includes the three independent variables into a single model.

Table 3 Etiology and the according sights of main defect in 131 patients

Etiology	Foot	Ankle	Lower leg	Knee	Thigh	Total
Tumor	2	2	7	1	1	13
Trauma	21	4	65	4	5	99
Infection	6	1	7	2	0	16
Others	2	1	0	0	0	3
Total	31	8	79	7	6	131

Table 4 Sights of main defects and the recipient arterial vessels for flap reconstruction

Defect site	Dorsalis pedis	Tibialis anterior	Tibialis posterior	Popliteal	Femoral	Others	Total
Foot	3	13	16				32
Ankle			8				8
Lower leg		10	56	4	1	8	79
Knee				5	1	1	7
Thigh			1	1	3	1	6
Total	3	23	81	10	5	10	132

Note: There was one ALT flap with two anastomoses: dorsalis pedis and tibialis posterior artery (132 arterial anastomoses in 131 flaps and patients).

(ALT) flap with two arterial anastomoses: dorsalis pedis and tibialis posterior artery. In summary, there were 132 arterial anastomoses in 131 flaps and patients (►**Tables 4**, **5**). In 131 flaps there were 14 flaps with more than one venous anasto-mosis resulting in 145 venous anastomoses at all (►**Table 6**). End-to-end anastomotic technique was preferred in arterial anastomosis and end-to-side anastomotic technique was preferred in venous anastomosis (►**Table 7**).

Table 5 Recipient arteries in 132 arterial anastomoses split in end-to-end, end-to-side, and T-shaped anastomoses

Recipient arteries in arterial anastomosis					
	End-to-end	End-to-side	T-shape	Unknown	Summary
Dorsalis pedis artery	2	1			3
Posterior tibial artery	13	64	4		81
Anterior tibial artery	12	10		1	23
Popliteal artery	1	8	1		10
Femoral artery	1	4			5
Other	9	1			10
Summary	38	88	5	1	132

Note: One anastomosis technique was not documented (unknown). In 81 cases tibialis, the posterior artery was the most commonly used vessel for arterial flap access (61.83% of 131 flaps).

Table 6 Recipient veins in 145 venous anastomoses split in end-to-end and end-to-side

Recipient veins in venous anastomosis				
	End-to-End	End-to-Side	Unknown	Summary
Dorsalis pedis artery VC	2			2
Posterior tibial artery VC	58	10		68
Anterior tibial artery VC	16		1	17
Popliteal artery VC	4	5		9
Femoral artery VC	2	1		3
Vena saphena magna	36	1		37
Vena saphena parva	1			1
Others	8			8
Summary	127	17	1	145

Abbreviation: VC, vena communicants.
Note: One was unknown. In 68 cases vena communicants of tibialis posterior artery was used for venous flap access (51.91% of 131 flaps).

Table 7 Performed arterial and venous anastomoses at all

Anastomoses (total)					
	End-to-side	End-to-end	T-patch	Unknown	Total
Arterial	88	38[a]	5	1	132
Venous	17	127[b]	0	1	145
Total	105	165	5	2	277

[a]Two of the end-to-end arterial anastomoses were performed as loops. One arterial and one venous anastomosis technique was unknown.
[b]In 127 venous end-to-end-anastomoses, one Loop and one conduit were used.

Statistical Analysis

Primary outcome was the occurrence of thrombotic events in arterial and venous anastomoses during inpatient stay. The main question was whether end-to-end or end-to-side techniques are more effective with respect to thrombotic events. Exact logistic regression analyses with thrombotic event as the dependent and surgical technique (end-to-end vs. end-to-side), anticoagulation, and etiology as independent variable were performed separately for venous and arterial anasto-moses (models A1 and V1). Subsequently, surgical technique, etiology, and anticoagulation were entered into a multivariable model as the two latter ones are covariables of clinical relevance (models A2 and V2). Two patients were excluded because of two different anastomotic techniques in one vessel type. For statistical analysis, the number of patients, not the number of anastomoses, was counted. Because of the setup of the experiment (thrombotic events are recorded for the arterial und venous anastomoses per patient, and thus are not independent), a generalized estimating equation (GEE)

model was set up to investigate the effect of location and surgical technique on the occurrence of thrombosis. All odds ratios (ORs) are presented with their corresponding 95% confidence intervals (CIs). Because of extremely small group sizes and/or groups with no events, the results in the exact logistic regression may not always be reliable and should be viewed with caution.

No adjustments for multiplicity were made due to the exploratory approach of this retrospective trial. The analyses were performed with SAS 9.3 (SAS Institute Inc., Cary, North Carolina, United States).

Results

In this study, 41 of 131 patients underwent a revision operation (31.30%). Average time of revision was exactly 3 days after flap transplantation. Thrombotic events in the anastomotic region were found and treated in 24 of these patients (18.32% of all patients; arterial only [$n = 6$], venous only [$n = 15$], or both [$n = 3$]). In these cases average time to revision was 1.79 days. The remaining patients ($n = 17$) were treated operatively for other reasons, that is, active bleeding.

We found more venous ($n = 18$) than arterial thromboses ($n = 9$) in primary anastomoses undergoing microsurgical free flap reconstruction ($p < 0.01$). No thromboses were found in arterial end-to-end anastomoses and venous end-to-side anastomoses, respectively. Nine arterial thromboses were found in arterial end-to-side anastomoses and 18 venous thromboses were found in venous end-to-end anastomoses (►Tables 1, 2). Although there was no statistical significance between the two anastomotic techniques, there was a high trend close to statistical significance for lower thrombotic risk when performing arterial anastomoses in end-to-end technique ($p = 0.0501$) and a low statistical trend to lower risk when performing venous anastomosis in end-to-side technique ($p = 0.1818$).

We found no association between arterial and venous thrombotic events and different etiologies of wounds covered by free flaps ($p = 0.72–1.00$). Eight of nine arterial thromboses were found in trauma etiology and one thrombosis was found in infection etiology. None was found in osteomyelitis (OM) tumor, or other etiologies; 15 venous thromboses were found in trauma etiology, 2 in infection,

and 1 in tumor etiology. None was found in OM or other etiologies.

There also was no association between arterial or venous thrombotic events and different patterns of anticoagulation after transplantation of free flaps ($p = 0.42–0.93$). There was no thrombosis found in acetylsalicylic acid (ASS) plus therapeutic heparin dose group. Low event rates were observed in the remaining groups, which did not yield statistically significant results ($p = 0.68$, $p = 0.93$, and $p = 0.57$). We found venous thrombotic events in every anticoagulation group.

In the end-to-end arterial group, flap survival rate after treatment of complications was 97.37 versus 86.36% in the end-to-side arterial group. Flap survival undergoing T-patch anastomosis technique for arterial anastomoses was 100% ($n = 5$). Overall flap survival was 90.08%.

All results were separately analyzed for the occurrence of thrombotic events in arterial and venous anastomoses. Because both the arterial and the venous regions are connected to the flap, it cannot be assumed that the events are independent, and thus a GEE model was needed. Thus, a model was set up with thrombotic event (yes/no) as the dependent variable; whereas anastomotic technique (end-to-side/end-to-end) and location (venous/arterial) served as independent variables (►Table 8). Anastomotic technique yielded an OR of 1.19 (reference: end-to-end, 95% CI: 0.68–2.06, $p = 0.5470$) and for location an OR of 2.35 (reference: arterial, 95% CI: 1.23–4.49, $p = 0.0096$), as shown in ►Table 8.

We assumed that there is an interaction present between the two independent variables; however, we were not able to verify our assumption.

Discussion

Statistically, we found a trend toward a lower thrombotic risk for venous anastomoses using end-to-side technique although this is the more demanding technique for the microsurgeon. On the other hand, we found a high trend for lower thrombotic risk for arterial anastomoses using end-to-end technique. To decide which technique is used, we based our decision on the availability of recipient vessels and the existence of a one-, two-, or three-vessel–type vascularization of the lower leg. A special note of caution relates to the interpretation of our regression models; extremely

Table 8 GEE model for dependency of anastomotic technique and vessel type on thromboses

Variable	Thrombosis	No thrombosis	GEE model	
	N/Total (%)	N/Total (%)	OR (95% CI)	p Value
Anastomosis technique				
End-to-side (Ref.)	9/102 (8.8%)	93/102 (91.2%)		
End-to-end	18/156 (11.5%)	138/156 (88.5%)	1.18(0.683, 2.056)	0.5470
Vessel type				
Venous (Ref.)	18/129 (14%)	111/129 (86%)		
Arterial	9/129 (7%)	120/129 (93%)	2.353 (1.232, 4.494)	0.0096

Abbreviations: CI, confidence interval; GEE, generalized estimating equation; OR, odds ratio; Ref., reference group for the regression model.

unbalanced group sizes and groups with no events impose limitations to this approach.

Cho at al demonstrated no advantages for end-to-end or end-to-side technique of arterial anastomoses based on reconstructive outcomes for lower extremity free tissue transfer.[9] In addition, we found no significant difference in outcome of end-to-end or end-to-side arterial anastomoses. Our trend for lower thrombotic rates of end-to-end arterial anastomoses may be observed because this technique is simpler to perform.[2]

In this study, we found more venous than arterial thromboses in early flap monitoring. Thrombotic events are common in the general population with high incidence rates of 1.43 per 1,000 person-years, deep venous thrombosis of the lower leg being the most common location for thrombosis.[10] Several risk factors for thrombosis are known, that is, the incidence of deep venous thrombosis in specific patient groups such as in operative medicine reaches up to 80%.[11,12] Substitution of heparin is the main therapy in inpatient prophylaxis of thrombosis and new oral anticoagulants need to show efficacy.[13]

Nevertheless, thrombotic events are common and major complications in free flap reconstruction of the lower extremity and can lead to flap failure. Fujiki et al observed that venous thromboses are more frequent than arterial thromboses in free flaps to the lower extremities.[14] They also demonstrated better results for flow-through anastomoses in comparison to end-to-end and end-to-side anastomoses. Miyamoto et al showed advantages in blood flow for flow-through arterial anastomoses in a mouse model.[15] In addition, we observed no thrombotic events in five arterial T-patch anastomoses. However, the possibility for flap removal and access in T-patch technique is not always given.

Optimizing anastomotic techniques is an ongoing process. In microsurgery Chernichenko et al demonstrated the feasibility of end-to-side venous anastomoses using an anastomotic coupling device for microvascular free-tissue transfer in head and neck reconstruction with excellent outcomes.[16] In contrast, our clinic still adheres to prepare each anastomosis by hand without devices for proceeding individually, training microsurgery and saving costs. However, in our studies all 15 end-to-side venous anastomoses were performed by hand without thrombotic events observed. One possible explanation for this observed lower thrombotic rate is that these end-to-side venous anastomoses get access to the deeper vein system in all cases (►Table 6). These deeper veins may have a better backflow caused by muscle pump function and a common vascular sheath with their accompanying artery. Possible causes of thrombotic complications such as edema, flap compression, and rheologic disturbances might have more influence to the superficial vein system although strictly avoiding these factors is part of our perioperative management.

Using a venous coupler for end-to-end anastomoses could lead to a lower thrombosis rate for this group in our studies, but as a venous coupler device is not established in our clinic, this is therefore a question of debate.

Ahmadi et al showed that performing two venous anastomoses in one free flap can reduce the complication rate.[17] This observation may have potential also might be a possibility to reduce flap failure but is bounded to the existence of suitable donor veins. However, in our series we found three venous thromboses in 14 patients with two venous anastomoses in the same flap.

For optimal outcome in free flap reconstruction, various influencing factors exist. Individual patient factors, that is, compliance, comorbidities, and vascular status need to be considered. Several groups showed the influence of individual factors, for example vascular status via the ankle brachial index,[18] or diabetes.[19] A body mass index greater than 30 kg/m^2 does not seem to increase complication rates[20] but influences the thickness of different flap-types in a different manner[21] and has to be considered in preoperative flap choosing anyway. Wettstein et al observed a higher complication rate with increased age of patient.[22]

Optimization of the perioperative management with individually based anticoagulative protocols requires further progress. Real-time monitoring of the hemostasis via thromboelastometry[23] and intra-arterial thrombolysis in case of thrombotic events[24] could be additional tools in the future. However, there was no statistical correlation between the thrombosis rates of arterial or venous anastomoses and the extent of anticoagulation. This observation was not surprising because the anticoagulation was adapted individually to the thrombotic risk of each patient.

In our series revision operations were necessary in 31.30% of all flaps, but after treatment of complications, flap survival rate was 90.08%. These results demonstrate the importance of close flap-monitoring post surgery.

In regards to the aforementioned and various other influencing factors for the outcome of free flap reconstruction, therapy will always be individually based and new aspects and methods will continue to develop in the field of plastic surgery.

Conclusion

Convincing data suggest that the survival rate of free flaps to the lower extremity depends on factors such as the right choice of suitable recipient vessels, an excellent anastomotic technique by an experienced surgeon, and an optimized perioperative management. For lower extremities there is a connate higher risk for venous thrombosis in anastomotic regions compared with arterial thrombosis. We have observed that rates for thromboses between end-to-end and end-to-side anastomoses present a reverse relation, considered separately by vessel type. However, if thrombotic events are explained by anastomotic technique and vessel type, the latter factor deserves further recognition.

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