Devascularizing Complications of Free Fibula Harvest: Peronea Arteria Magna

Gedge D. Rosson, M.D.[1,2] and Navin K. Singh, M.D.[1]

ABSTRACT

The authors present a case report of devascularizing complications following free fibula harvest. A retrospective review of 93 consecutively imaged limbs demonstrated a peronea arteria magna (PAM) prevalence of 5.3 percent in an urban population, which was used to perform a cost-effectiveness analysis for preoperative vascular imaging of the donor limb using magnetic resonance angiography (MRA) and traditional angiography (TA).

Donor-site complications of fibula harvest range from 15 to 30 percent, but are rarely limb-threatening. Limb loss is a dreaded complication of congenital PAM, which can be present with a normal vascular exam.

Some microsurgery groups advocate using no preoperative imaging of the donor limb; they rely on intraoperative assessment of the vascular anatomy. An aborted harvest due to aberrant anatomy leads to both direct and indirect added costs. The authors believe that MRA imaging of the donor limb, being minimally invasive, is cost-effective and indicated for free fibula transfers. For equivocal results, conversion to more invasive and costly TA may be necessary.

KEYWORDS: Peronea arteria magna, cost effectiveness, magnetic resonance angiography, traditional angiography, free fibula

The first report of a free fibular microvascular transfer, placed beneath a prior groin flap to repair a tibial defect, was by Taylor et al. in 1975.[1] The free fibula flap was first reported for mandibular reconstruction by Hidalgo in 1989.[2] Currently, the free fibula transfer is a commonplace technique for long bone and mandibular reconstruction. The utility of preoperative angiography continues to be debated. Owing to our experience with a severe complication in one of our patients, we conducted a Medline review of the available English language literature regarding free fibula flap assessment and morbidity, retrospectively analyzed our own lower extremity trauma and free fibula patients for evidence of congenital peronea arteria magna (PAM), and performed a cost effectiveness and sensitivity analysis for both traditional angiography (TA) and magnetic resonance angiography (MRA).

CASE REPORT

Our patient was a 40-year-old man with a shotgun blast to his forearm. He suffered a significant soft-tissue and bony defect of the forearm. A 10-cm segmental bony defect of the radius was reconstructed with a free fibula osteofasciocutaneous flap (Figs. 1–4). No preoperative donor-leg angiography was performed. We conducted a careful clinical examination, and normal dorsalis pedis and posterior tibial pulses were palpated preoperatively.

Journal of Reconstructive Microsurgery, Volume 21, Number 8, 2005; accepted for publication June 22, 2005. Address for correspondence and reprint requests: Gedge D. Rosson, M.D., Plastic, Reconstructive, and Maxillofacial Surgery, Johns Hopkins Outpatient Center, McElderry 8152A, 601 North Caroline Street, Baltimore, MD 21287. [1]Division of Plastic, Reconstructive, and Maxillofacial Surgery, Johns Hopkins University School of Medicine and [2]The Dellon Institute for Peripheral Nerve Surgery, Baltimore, Maryland. Copyright © 2005 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662. 0743-684X,p;2005,21,08,533,538,ftx,en;jrm01142x.

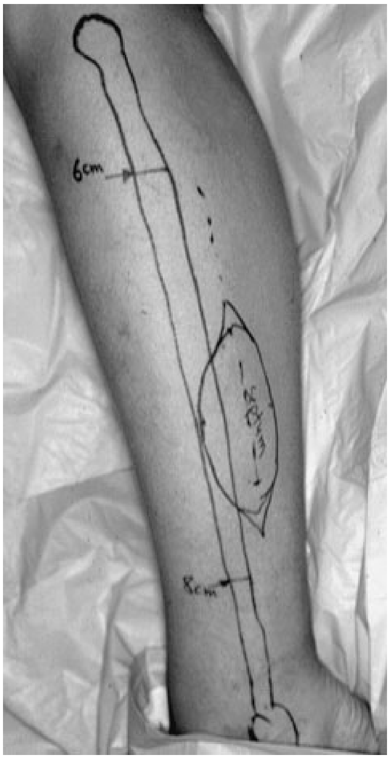

Figure 1 Free fibula osteoseptocutaneous flap: preoperative markings.

Intraoperatively, dorsalis pedis and posterior tibial signals were Dopplerable. Postoperatively, the foot appeared mottled in the recovery room, and no arterial signals were detectable. The patient was then taken to the interventional radiology suite, where an emergent angiogram revealed absence of the posterior tibial artery, hypoplasia or spasm of the anterior tibial artery, and a surgically absent peroneal artery. He was then taken back to the operating room for attempts at limb salvage. Intra-arterial infusion of papaverine and surgical arterial adventitial release were attempted, but the foot remained compromised. Ultimately, vascular bypass with reversed saphenous vein was required to regain limb perfusion.

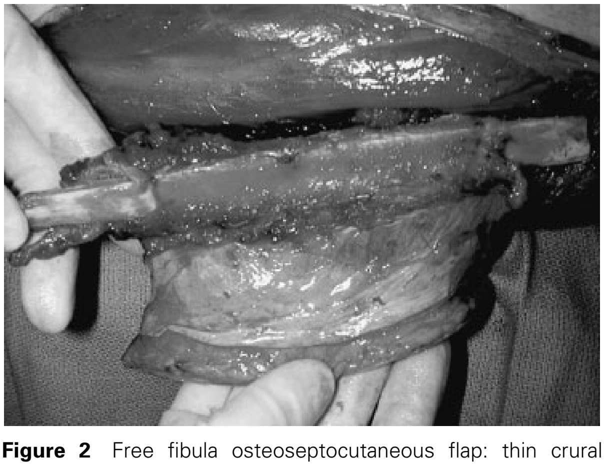

Figure 2 Free fibula osteoseptocutaneous flap: thin crural septum containing perforators to skin island.

Figure 3 Completed microsurgical anastomoses.

DISCUSSION

Several microsurgery groups advocate the use of preoperative imaging of the donor leg using traditional angiography,[3–9] traditional angiography or pencil Doppler,[10] magnetic resonance angiography,[11,12] CAT scan,[13] or color-flow Doppler.[14] Several recent radiology articles[15–17] have confirmed the accuracy of gadolinium-enhanced 3D MR angiography for evaluation of the

Figure 4 Radius reconstruction.

Table 1 Reported Prevalence of Peronea Arteria Magna

Kim et al.[27]	0.2%	n = 495
Lutz et al.[18]	0.9%	n = 120
Disa and Cordeiro[19]	1.3%	n = 79
Our population	5.3%	n = 93
Blackwell[7]	5.3%	n = 19
Young et al.[8]	8.3%	n = 24
Weighted average	1.4%	n = 830

Table 2 Sensitivity Analysis

Traditional Angiogram	
0.2% prevalence	$1,030 excess cost per patient
8.3% prevalence	Save $10,300 per patient
MR Angiogram	
0.2% prevalence	$144 excess cost per patient
8.3% prevalence	Save $11,200 per patient

lower extremity vasculature down to the ankle. Excellent visualization of the crural anatomy and diagnosis of significant stenosis or occlusion can be performed with this minimally invasive imaging modality.

Some microsurgery groups have advocated in the literature the use of no preoperative imaging of the donor limb.[18,19] They rely on preoperative clinical examination and intraoperative assessment of the vascular anatomy, stating that the harvest can be easily aborted if congenital PAM or an absent peroneal artery is discovered intraoperatively. Unfortunately, an aborted harvest due to aberrant anatomy leads to both direct and indirect added costs.

We retrospectively analyzed all the lower extremity angiograms performed on patients treated for lower extremity salvage or free fibula harvest from July 1999 through February 2002. Ninety-three consecutively imaged limbs demonstrated a peronea arteria magna prevalence of 5.3 percent in our urban population. The reported prevalence of PAM in the literature ranges from 0.2 to 8.3 percent (Table 1).

For the cost analysis, we contacted the billing offices of the hospital, physician's group, and radiology department at our institution. We estimated the cost of a routine free flap to be $30,000. The total hospital cost for our case presentation patient was $170,000. In our patient with unrecognized PAM, the excess direct medical cost of the complication was $140,000. In our institution, the cost of routine arterial imaging is as follows: abdominal aorta angiogram with lower extremity runoff = $1310; MR angiogram of a lower extremity = $424. We show the sensitivity analysis in Table 2. Figure 5 shows the calculated excess cost or savings for each reported prevalence. Positive bars represent excess cost per patient, while negative bars represent potential savings per patient for each form of imaging. This represents the direct medical costs and is an underestimate of the actual costs. The actual costs would also include time lost from work, disability, pain, and medico-legal action.

The overall donor site morbidity of fibular harvest is reported to be 15 to 30 percent,[20–23] with subjective instability in 42 percent,[24] and objective sensory deficits in 76 percent.[25] Luckily, morbidity is rarely limb-threatening. Limb loss is a dreaded complication of free fibular harvest in a patient with congenital peroneal arteria magna. Of critical importance, PAM can be present with a normal clinical vascular exam. Additionally, an aplastic or hypoplastic peroneal artery can be encountered with a normal vascular exam, leading to an intraoperatively aborted harvest.

An excellent classification scheme has been developed by Lippert and Pabst[26] and reported in the surgical literature by Kim et al[27] (Table 3, Fig. 6). In a

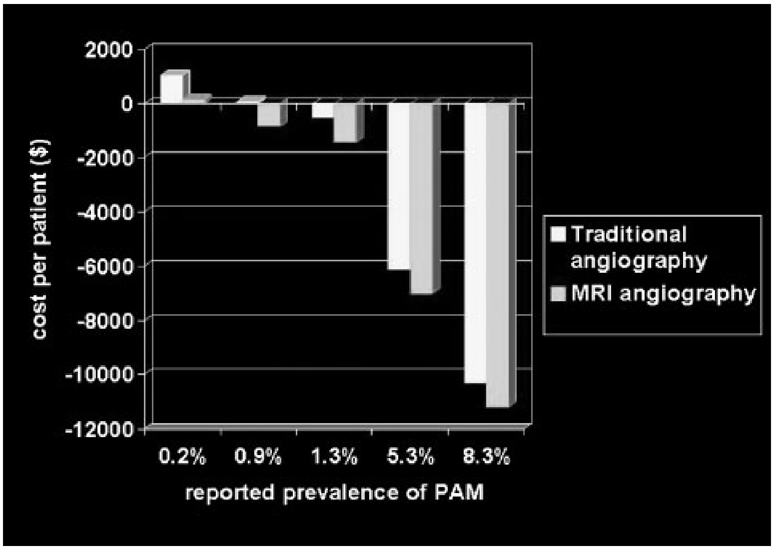

Figure 5 Calculated excess cost or savings per patient to avoid this complication, using traditional angiography vs. MRI angiography.

Table 3 Classification of the Arterial Branching Patterns in the Leg[26,27]

Class	Vascular Pattern
I-A	Usual pattern: AT branches below the knee, followed by bifurcation of TPT into PT and Per (92.2%)
I-B	Trifurcation: AT, PT, and Per arise below the knee within 0.5 cm of each other (2.0%)
I-C	Anterior tibioperoneal trunk: PT is first branch, then TPT bifurcates into PR and AT (1.2%)
II-A1	AT arises at or above the knee joint, with normal course in its proximal segment (3.0%)
II-A2	AT arises at or above the knee joint, with medial curve in its proximal segment (0.7%)
II-B	PT arises at or above the knee joint, common trunk of AT and Per (0.8%)
II-C	Per arises at or above the knee joint, common trunk of AT and PT (0.16%)
III-A	Hypoplastic or aplastic PT, distally replaced by Per (3.8%)
III-B	Hypoplastic or aplastic AT, DP replaced by Per (1.6%)
III-C	Hypoplastic or aplastic AT and PT, DP and PT replaced by Per ''PAM anomaly'' (0.2%)
III-D	Hypoplastic or aplastic Per (0.1%)

AT = anterior tibial artery; DP = dorsalis pedis artery; PT = posterior tibial artery; Per = peroneal artery; TPT = tibioperoneal trunk.

class III-C leg, the dorsalis pedis artery (DP) and posteriortibial artery (PT) pulses are palpable because they come from collateral branches of the dominant peroneal artery. In a class IV leg, the DP and PT pulses are palpable, yet there is no peroneal artery whatsoever.

The specific calculated excess cost for our patient at various putative PAM prevalences can be generalized for any estimated excess cost at any prevalence for a radiologic study. If we define N = uncomplicated cost of normal case and D = cost of disease peroneal/PAM case, then E = excess cost of complication = D−N. I = cost of imaging (general case), with M = cost of MRA and A = cost of traditional angiogram. P = prevalence, B = budgeted average cost (no test), and B′ = budgeted average cost with test I.

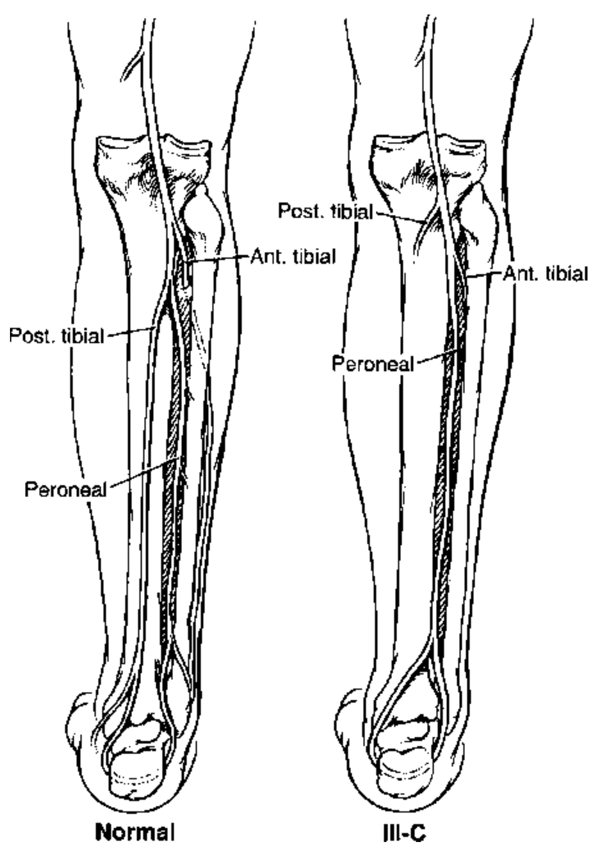

Figure 6 Illustrations of the normal three vessel leg and the abnormal peronea arteria magna (III-C).

If you do no test, then

$$\begin{aligned} B &= N(1-P) + PD \\ &= N - NP + P(E+N) \\ &= N + PE \end{aligned}$$

If you do a test, then

$$\begin{aligned} B' &= (N+I)(1-P) + P(N+2I) \\ &= N - NP + I - PI + NP + 2PI \\ &= N + I + PI \\ &= N + I(1+P) \end{aligned}$$

It is cost effective to do the test when $B' \leq B$

$$\begin{aligned} N + I(1+P) &\leq N + PE \\ I(1+P) &\leq PE \end{aligned}$$

Solving for P gives $1/P \leq E/I - 1$.

This general equation provides a graph of cost effectiveness for any given imaging cost over a range of P and E values. Therefore, each institution can decide what they think the PAM prevalence to be, and what the potential excess cost might be for them due to operating on a diseased peroneal without preoperative imaging. This can be seen in Figures 7 and 8. If the value for P and E fall on a point below the curve, then the imaging is cost-effective.

CONCLUSIONS

Unnecessary surgery should be avoided whenever possible. To that end, some form of preoperative imaging for

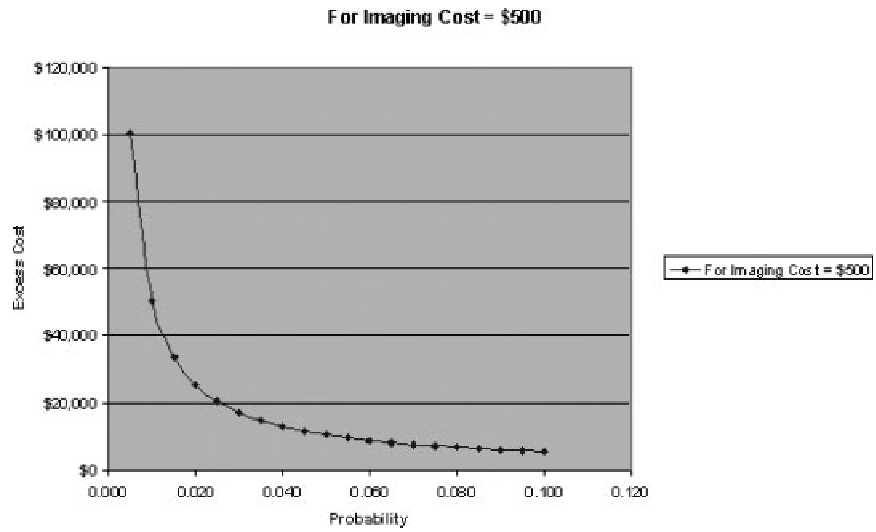

Figure 7 Economic break-even curve for excess cost of aborted harvest versus prevalence of PAM when cost of imaging = $500.

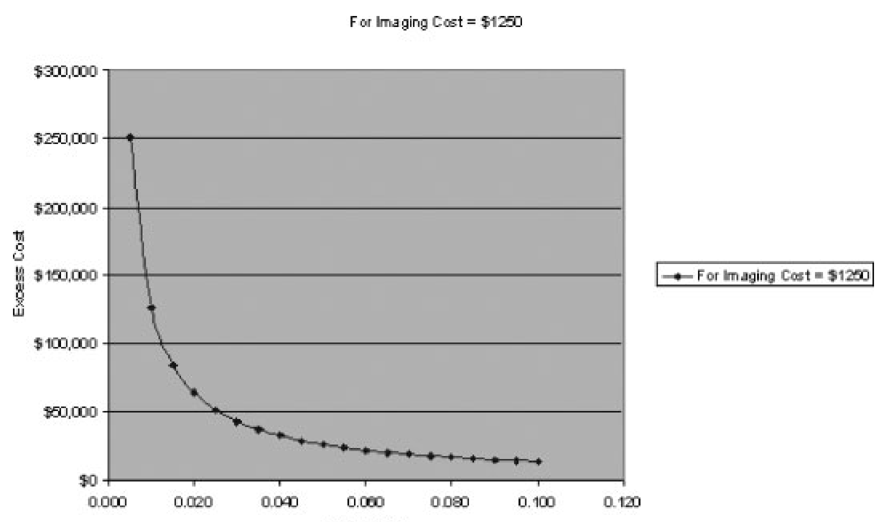

Figure 8 Economic break-even curve for excess cost of aborted harvest versus prevalence of PAM when cost of imaging = $1250.

potential free fibula transfer patients should be used. Our group feels that magnetic resonance angiography imaging of the donor limb, being minimally invasive, is cost effective and indicated for all free fibula transfers. For equivocal results, conversion to more invasive and costly traditional angiography may be necessary.

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