Internal Mammary Perforators: A Cadaver Study

Gedge D. Rosson, M.D.,[1,2] Luther H. Holton, M.D.,[3] Ronald P. Silverman, M.D.,[3] Navin K. Singh, M.D.,[1] and Maurice Y. Nahabedian, M.D.[1]

ABSTRACT

Microsurgeons currently employ the internal mammary artery and vein as recipient vessels for microvascular reconstruction of the breast with increasing frequency. Recent reports have demonstrated that the perforating branches of the internal mammary artery and vein can also be used as recipient vessels. The purpose of the following cadaver study was to determine the location and diameter of these internal mammary perforators and whether they are suitable as recipient vessels. Ten fresh cadavers were obtained for this project. Using a micrometer under loupe magnification, bilateral measurements were taken of the perforators from the first five interspaces. The largest arterial perforator averaged 1.74 mm in diameter and the largest venous perforator averaged 1.78 mm in diameter. The largest perforators were most commonly found in the second interspace. Based on the results of this study, the internal mammary perforators appear to have suitable diameter for microvascular anastomosis and should be considered.

KEYWORDS: Internal mammary perforators, breast reconstruction, recipient vessels

The internal mammary artery and vein are now routinely used as recipient vessels for microvascular reconstruction of the breast.[1–13] These vessels have been demonstrated to be high flow, reliable, and of suitable caliber. Use of the internal mammary perforators as alternate recipient vessels for free flap breast reconstruction has been recently reported by several groups.[14–19] Hamdi et al.[18] have reported on the largest series to date that included the internal mammary perforators as recipient vessels in 30 of 335 flaps (9 percent) over a 2.5 year period. Palmer and Taylor[20,21] have described the angiosomes relevant to the internal mammary perforators, but did not describe physical characteristics such as diameter, flow, and length. They did, however, recapitulate the concept of a "principal perforator" that was usually located in the second rib space.[20] In a recent anatomic and clinical study, the internal and external diameters of internal mammary perforators that were fixed in formalin were measured.[19] The average internal diameter of the perforators was 0.6 mm and the average external diameter was 0.85 mm. Unfortunately, the average diameter at each interspace and the average diameter of the largest perforator were not reported.

The purpose of this study was to measure the external diameter of the perforating branches of the internal mammary artery and vein located within the first through fifth interspaces in a cadaver model. The location of the largest perforator was also considered important. This information would be useful to microsurgeons who are considering use of the internal mammary perforators.

MATERIALS AND METHODS

Ten fresh cadavers (8 female, two male) were dissected in this study. The cadavers were fresh, rather than

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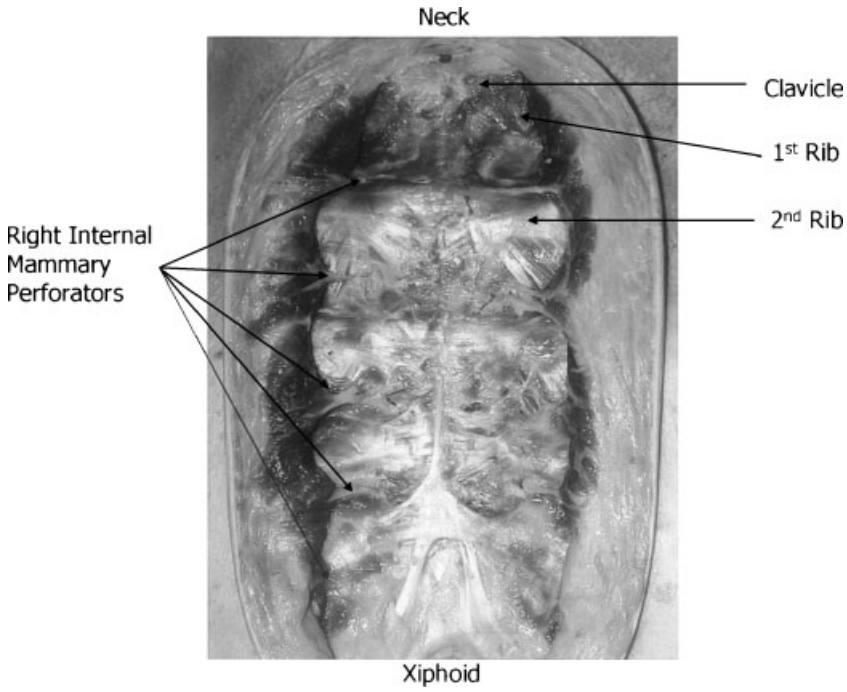

Figure 1 Example of midline sternal dissection.

formalin-fixed, in order to avoid any fixation artifact. Mean cadaver age was 80.4 years, ranging from 47 to 92 years. The exposure of the internal mammary perforators was through an anterior midline presternal incision. (Fig. 1) Using a micrometer under loupe magnification, the first five internal mammary arterial and venous perforators were measured bilaterally (Fig. 2). When two venous perforators were found at an interspace, only the larger vessel was measured. To decrease variability with the measurements, all were performed by the same investigator.

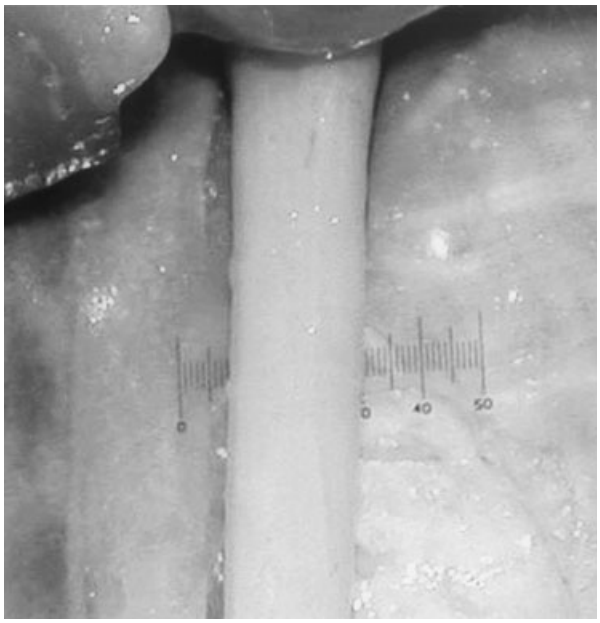

Figure 2 Example of arterial perforator measurement.

RESULTS

The mean external diameter of the arterial perforators was 1.14 mm (SD $\pm$ 0.50, range: 0.3–2.7) (Table 1). The mean external diameter of the venous perforators was also 1.14 mm (SD $\pm$ 0.62, range: 0.25–3.5) (Table 2). When only the largest perforators from each side were evaluated, the artery averaged 1.74 mm, with a range of 1.1 to 2.7 mm, and the vein averaged 1.78 mm, with a range of 0.75 to 3.5 mm. The largest arterial and venous perforators were most frequently found in the second rib interspace (Figs. 3, 4). Every cadaver had perforators which measured at least 1 mm in diameter.

DISCUSSION

Microsurgeons may find it interesting to consider the use of internal mammary perforators as alternate recipient vessels for microvascular anastomosis. Use of the internal mammary perforators has not been seriously contemplated previously, primarily because they are easily damaged during a mastectomy, are usually smaller in caliber, are thought to be at higher risk for anastomotic failure, and do not always present in a given surgical

Table 1 Average Diameter of the Arterial Perforators

Intercostal	Average Diameter	Standard Deviation
1st	0.96 (0.3–1.9)	0.41
2nd	1.4 (0.5–2.5)	0.59
3rd	1.3 (0.5–2.7)	0.55
4th	1.0 (0.3–1.7)	0.33
5th	0.96 (0.5–2.0)	0.34

Table 2 Average Diameter of the Venous Perforators

Intercostal	Average Diameter	Standard Deviation
1st	1.1 (0.25–2.7)	0.62
2nd	1.5 (0.5–3.5)	0.83
3rd	1.2 (0.5–3.0)	0.59
4th	1.1 (0.3–2.0)	0.46
5th	0.96 (0.5–1.8)	0.32

field. Thus, most surgeons prefer and continue to use the internal mammary artery and vein. However, there are several important beneficial aspects of using the perforating branches, rather than the internal mammary vessels, for this procedure, the primary one being the avoidance of resection of the costal cartilage.

The first prospective and multicenter study evaluating use of the internal mammary artery was performed by Banic et al. in 1995.[2] Of 123 arterial anastomosis, 17 were to the internal mammary artery and none were to the internal mammary vein. All venous anastomoses were to the external jugular vein. Dupin et al.[6] reported the largest series of free flap breast reconstructions using the internal mammary vessels, and a 99 percent overall flap survival in 110 TRAM (transverse rectus abdominus myocutaneous) free flaps. The authors noted conversion to the subscapular vessels in one patient, and the need for a vein graft to the thoracodorsal vein in another. Blondeel[12] reported a series of 100 DIEP (deep inferior epigastric artery perforator) flaps in which the recipient vessels were the internal mammary artery and vein in 90 percent of women. Moran et al.[13] reported the first prospective study which evaluated the outcomes following thoracodorsal and internal mammary vessel recipient sites for free flap breast reconstruction. There were no significant differences in complication rates, recovery time, aesthetic grade, and patient satisfaction.

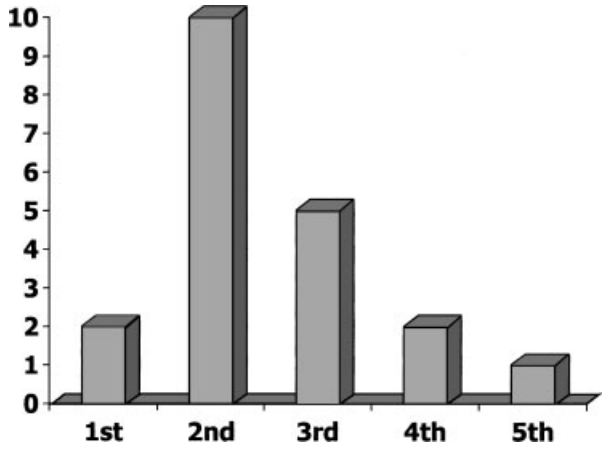

Figure 3 Location of largest internal mammary arterial perforator.

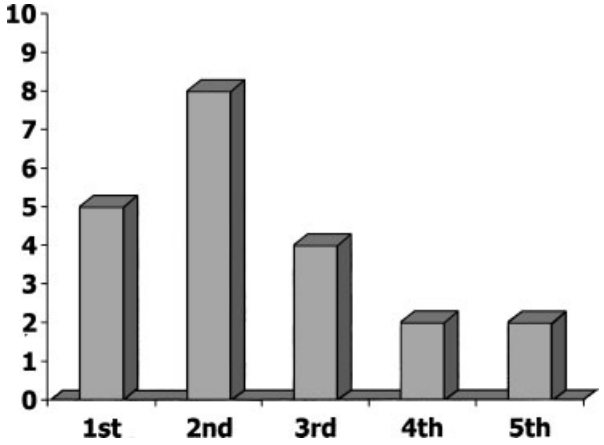

Figure 4 Location of largest internal mammary venous perforator.

There are few studies that have evaluated use of the perforating branches of the internal mammary artery and vein as recipient vessels.[16–19] In two separate studies by Haywood et al.[17] and Munhoz and colleagues,[19] the internal mammary perforators were used as recipient vessels in 21 of 54 (39 percent) consecutive flaps over an unknown time period, and in 13 of 40 (33 percent) of consecutive flaps over a 2-year time period, respectively. Measurements of the selected perforator were performed in two studies. Park et al.[16] in a series of five patients using the perforators as recipient vessels (four free TRAM flaps and one pedicle TRAM with perforator "supercharge"), reported an average arterial size of 1.56 mm and an average venous size of 1.4 mm. Hamdi and colleagues[18] reported an average arterial diameter of 1 mm and venous diameter of 1.7 mm.

Our study has demonstrated that the largest perforators were most frequently located in the second rib space, reconfirming the idea of a "principal perforator". The mean external diameter of the largest perforating artery was 1.83 mm and the largest perforating vein was 1.87 mm. Although these diameters are less than those of the internal mammary artery and internal mammary vein, a successful anastomosis is possible with vessels of this caliber. The question then becomes, "Should these internal mammary perforators be seriously considered?"

Advantages of the internal mammary perforators over both the internal mammary and thoracodorsal vessels include: decreased exposure and preparation time for the recipient vessels, no resection of the costal cartilage or rib, preservation of the internal mammary artery for use in future coronary revascularization, avoidance of axillary dissection, and ease of positioning the microscope. Unfortunately, a suitable internal mammary perforator is not always evident following a mastectomy; however, on occasion, a large perforator is visible along the medial border of the mastectomy defect. It is in these situations that use of the perforator can be considered.

Although pneumothorax is a possibility with partial resection of the costal cartilage or rib, only one small pneumothorax has been reported in the breast reconstruction literature that resolved spontaneously with conservative management.[6] Contour deformity following resection of the anterior costal cartilage has been cited as a potential complication[12]; however, this has not been observed in our series of patients (unpublished data). Post-sternotomy intercostal neuralgia following use of the internal mammary artery for coronary artery bypass[22,23] is a potential complication of partial rib resection and is clearly avoided by the use of the internal mammary perforators as recipient vessels.

Based on the findings of this study, the researchers have created a protocol for ascertaining suitability of the internal mammary perforator. This includes preoperative mapping of the perforators along the sternal border using a hand-held Doppler, intraoperative exploration for a suitable perforator, and preparation for resection of the costal cartilage to expose the internal mammary artery and vein, if needed. Although not imperative, preoperative communication between the ablative and reconstructive surgeons to preserve these perforators can be useful. Future research relevant to these perforators will include measurement of the internal diameter and calculation of blood flow in live patients, using color Doppler imaging and laser Doppler flowmetry.

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