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Predictors of internal mammary vessel diameter: A computed tomographic angiography-assisted anatomic analysis

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Summary The internal mammary vessels are the most common recipient vessels in free flap breast reconstruction. The literature on internal mammary vascular anatomy is limited by small sample sizes, cadaveric studies, or intraoperative changes. The purpose of this study is to analyze internal mammary anatomy using computed tomographic angiography.

A retrospective review of 110 consecutive computed tomographic angiography studies of female patients was performed. Measurements of vessel caliber, distance of internal mammary vessels to sternum, location of internal mammary vein bifurcation, intercostal space height, and chest width were analyzed. Patient demographics and comorbidities were reviewed.

The right internal mammary artery and vein were larger than the left in all intercostal spaces ($p = 0.02$ and $p < 0.001$, respectively). A significant correlation was found between both skeletal chest width and body mass index with internal mammary vessel caliber at the third intercostal space ($p \leq 0.02$). The internal mammary vein bifurcated at the third intercostal space bilaterally, 4.3 and 1.2 mm caudal to the third rib on the right and left sides, respectively. The third intercostal space was <1.5 cm in 25% of patients.

Understanding the anatomy, bifurcation, and caliber of internal mammary vessels can aid preoperative planning of autologous, free flap breast reconstruction. On average, the internal mammary vein bifurcates at the third intercostal space; patients with larger chest widths

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and body mass index had larger caliber internal mammary vessels, and 25% of patients had third intercostal space <1.5 cm and, thus, may not be suitable candidates for rib-sparing techniques.

Introduction

A critical decision in autologous microsurgical breast reconstruction is recipient vessel selection. The internal mammary (IM) vessels are the most commonly used recipient vessels in autologous, free flap breast reconstruction. Advantages of the IM vessels are their large caliber, available length, size match with deep inferior epigastric vessels, and central location for both microanastomosis and flap positioning.[1–5] In addition, the IM vessels are in the surgical field of the breast and chest wall defect; therefore, dissection in the axilla can be avoided as well as the potential morbidity of axillary injury, lymphedema, and thoracodorsal nerve injury.[1–3] In addition, use of the IM vessels preserves the thoracodorsal vessels and saves the latissimus dorsi flap as a "lifeboat" for salvage reconstruction after free flap failures.[2,3,6]

Despite the importance of recipient vessel selection and dissection, the majority of clinical investigations addressing preoperative surgical planning and imaging have focused on donor sites. Previous studies investigating the anatomy of the internal mammary vessels have been limited by small sample sizes, cadaveric studies which do not correlate to normal physiology and vascular tone, and intraoperative observations of manipulated and surgically altered vessel anatomy that can cause vasospasm.[2,7–10] Many studies do not describe vascular relationships to surrounding anatomical structures, intraluminal vessel diameter, or vascular changes due to patient comorbidities. The aim of our study was to characterize the anatomy and intraluminal size of the internal mammary vessels by using noninvasive computed tomographic angiography (CTA) imaging. This study has the potential to be a guide when preoperative imaging is not performed. A secondary goal was to analyze patient factors and comorbidities that influence the anatomy of the internal mammary vessels.

Methods

A retrospective, IRB-approved analysis of consecutive chest CTA studies in 110 female patients was performed. Indications for CTA imaging included breast masses, cardiac pathology, or pulmonary processes. Exclusion criteria included inadequate imaging of IM vessels, positional difficulties, motion artifacts, inability of patient to raise arms overhead, congenital chest wall deformities, age less than 18 years, and history of chest wall surgery or trauma. The study design was aimed to measure a representative sample of the average female patient population by reviewing CTA images that were not necessarily from breast reconstruction patients and would determine an approximation of the average skeletal and vascular anatomy, branching, and diameters of the internal mammary vasculature.

Anatomic measurements of interest included chest width (CW), intercostal space (ICS) distance, distance between lateral sternal border and IM vessels at the third ICS, IM vessel caliber, and bifurcation level of the internal mammary vein (IMV). CW was measured as the maximal skeletal chest wall width in axial view, at the inferior border of the third rib. Rib heights and intercostal spaces were measured at the level of the internal mammary artery (Figure 1). Intraluminal diameters were measured at the inferior border of each rib (Figure 2). Each variable was measured three times and averaged by two independent reviewers. Measurements with a range ≥0.5 mm were repeated. All measurements were recorded to the nearest 0.1 mm. Chart reviews were performed to identify any effect of patient factors and comorbidities on vascular anatomy.

All scans were performed in a 64-detector scanner (Aquilion 64, Toshiba Medial Systems, Otawara, Japan) using standard CTA imaging protocols. A weight-based

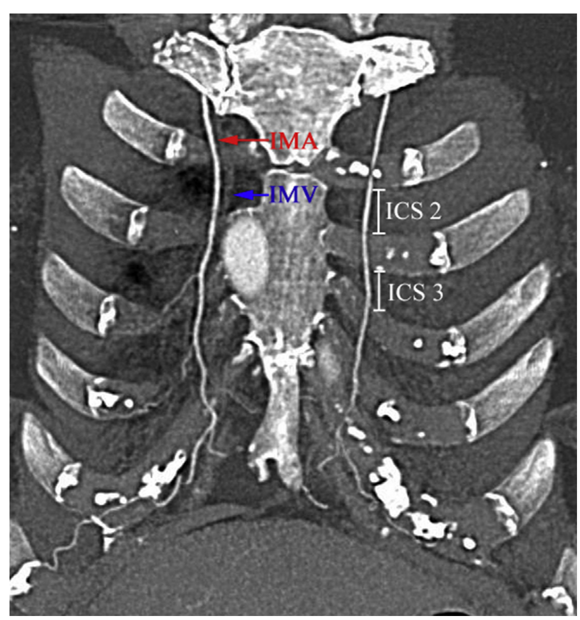

Figure 1 Coronal section of a contrast-enhanced Computed Tomographic Angiography of Anterior Chest wall (IMA: Internal Mammary Artery; IMV: Internal Mammary Vein; ICS: Intercostal Space).