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ARTICLE

Comparison of vertical and extended vertical rectus abdominis myocutaneous flaps. An anatomical study

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ABSTRACT

The extended vertical rectus abdominis myocutaneous (eVRAM) flap has been proposed for reconstruction of large pelviperineal defects where traditional VRAM flap could be insufficient. To compare the dimensions of VRAM and eVRAM flaps an anatomical study was performed. Ten VRAM and ten eVRAM flaps were dissected in ten fresh adult cadavers. Length, width and volume of all the flaps were measured. Length and volume were significantly larger in eVRAM flap compared to VRAM flap (36.55 cm *vs.* 30.15, $p=.005$; and 315.5 *vs.* 244 mL, $p=.012$, respectively). No differences were observed in flap width. The eVRAM flap could be a better option than traditional VRAM for reconstruction of big pelviperineal defects when bulkier tissue, larger skin paddle and/or longer arch of rotation are needed for reconstruction.

Abbreviations: eVRAM: extended vertical rectus abdominis myocutaneous; SD: standard deviation; VRAM: vertical rectus abdominis myocutaneous

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Introduction

Flaps based on deep inferior epigastric vessels are widely used in reconstructive surgery. The pedicled vertical rectus abdominis myocutaneous (VRAM) flap is currently the most employed option for reconstruction of big pelviperineal defects after oncologic resection [1–3]. It provides bulky tissue to fill the dead space and a skin paddle for cutaneous closure without tension. This is essential in cases of preoperative radiation [4]. Thigh flaps have also been broadly employed for perineal reconstruction, and they are a good alternative to reduce abdominal wall morbidity [5,6].

Some modifications of the rectus abdominis flap, such as the oblique rectus abdominis myocutaneous flap, the transverse rectus abdominis myocutaneous flap, the extended deep inferior epigastric perforator flap or the fascia sparing VRAM have been proposed to improve recipient and donor site outcomes in pelvic reconstruction [7–10]. Villa et al. demonstrated the adequate perfusion of the extended VRAM flap (eVRAM) and recommended it for pelvic reconstruction requiring large volume or additional flap reach, when the traditional VRAM flap is not enough [11].

The former study was carried out in order to compare the dimensions of the conventional VRAM and the extended modification.

Method

We performed a dissection study of 10 fresh adult cadavers, four females and six males, in collaboration with the Department of Anatomy and Embryology of University of Valencia. The cadaver specimens were obtained through strict body donation legislation and regulations, which are subject to the Spanish national law. VRAM and eVRAM flaps were both harvested in every specimen, one on each randomly decided side.

The VRAM flap was marked from the xiphoid to the suprapubic zone (Figure 1). The medial limit corresponded to the midline laparotomy incision. Flap width was determined by the pinch test to ensure primary wound closure. Dissection was performed according to the usual technique that is widely described in the literature [4]. It started on the superior aspect and was carried in a suprafascial plane above the umbilicus, in order to preserve the anterior rectus fascia sheat and muscle. The rectus muscle was included in the flap from the supraumbilical zone to the insertion on the pubis.

The extended modification includes a superolateral oblique prolongation instead of the vertical supraumbilical design of the conventional VRAM. This combination of the vertical and the oblique design allows harvesting a large skin paddle and including the entire ipsilateral periumbilical perforator zone, which improves the viability over traditional oblique design. The oblique component is based on an axis drawn from the umbilicus to the tip of the scapula, and the skin island of the flap can reach the anterior axillary line, just below the inframammary fold (Figure 1). In this study, the width of this extension was also limited by the pinch test. EVRAM infraumbilical marking and dissection is the same that of the VRAM. The eVRAM flap dissection starts in the lateral margin of the flap, raising the oblique component from lateral to medial in a suprafascial plane until the anterior rectus sheat (Figure 2). It is important to preserve the paraumbilical perforator vessels in the flap to guarantee the perfusion of the

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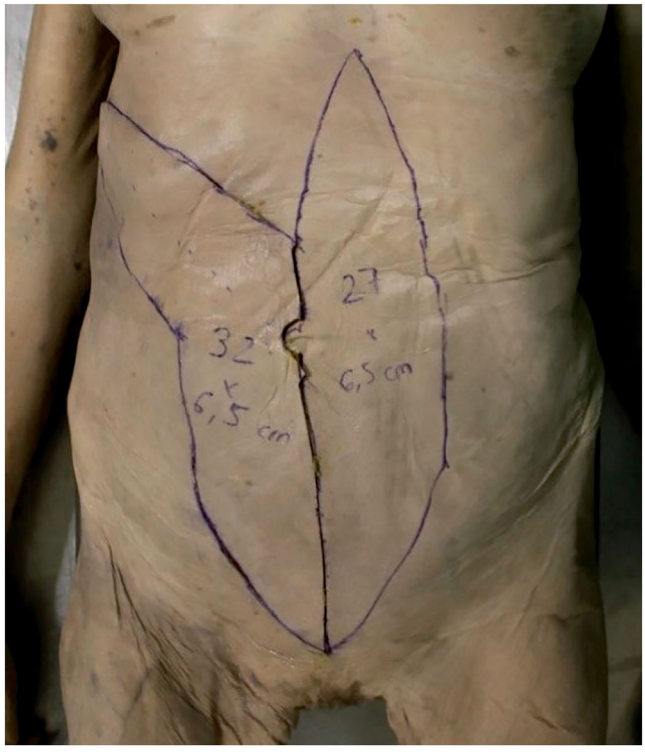

Figure 1. Right eVRAM and left VRAM flaps design on cadaver.

oblique prolongation. The anterior rectus sheat is opened supraumbilical and the rectus abdominis muscle is separated from the posterior sheat and transected. From this point, the dissection proceeds identically to standard VRAM flap.

After flap dissection, the following parameters were determined: flap length, from the more proximal to the more distal point of the skin island; flap width, as a perpendicular segment in the midpoint of the longitudinal axis, which used to be the widest site of the flap; and the volume of the flap, which was determined by the displaced liquid volume after flap submersion in a graduated container.

Statistical package SPSS version 22.0 (SPSS Inc., Chicago, IL) for Windows was used for the statistical analysis. Wilcoxon test was used to make pairwise comparisons between both flaps. p Value$<$.05 were considered statistically significant.

Clinical video

A clinical video is also presented (Supplementary Video 1). It shows a 76-year-old woman who underwent reconstruction with eVRAM after pelvic exenteration.

Results

In the 10 VRAM flaps harvested from the 10 body donors, the mean length was found to be 30.15 cm (SD 3.23) while in the 10

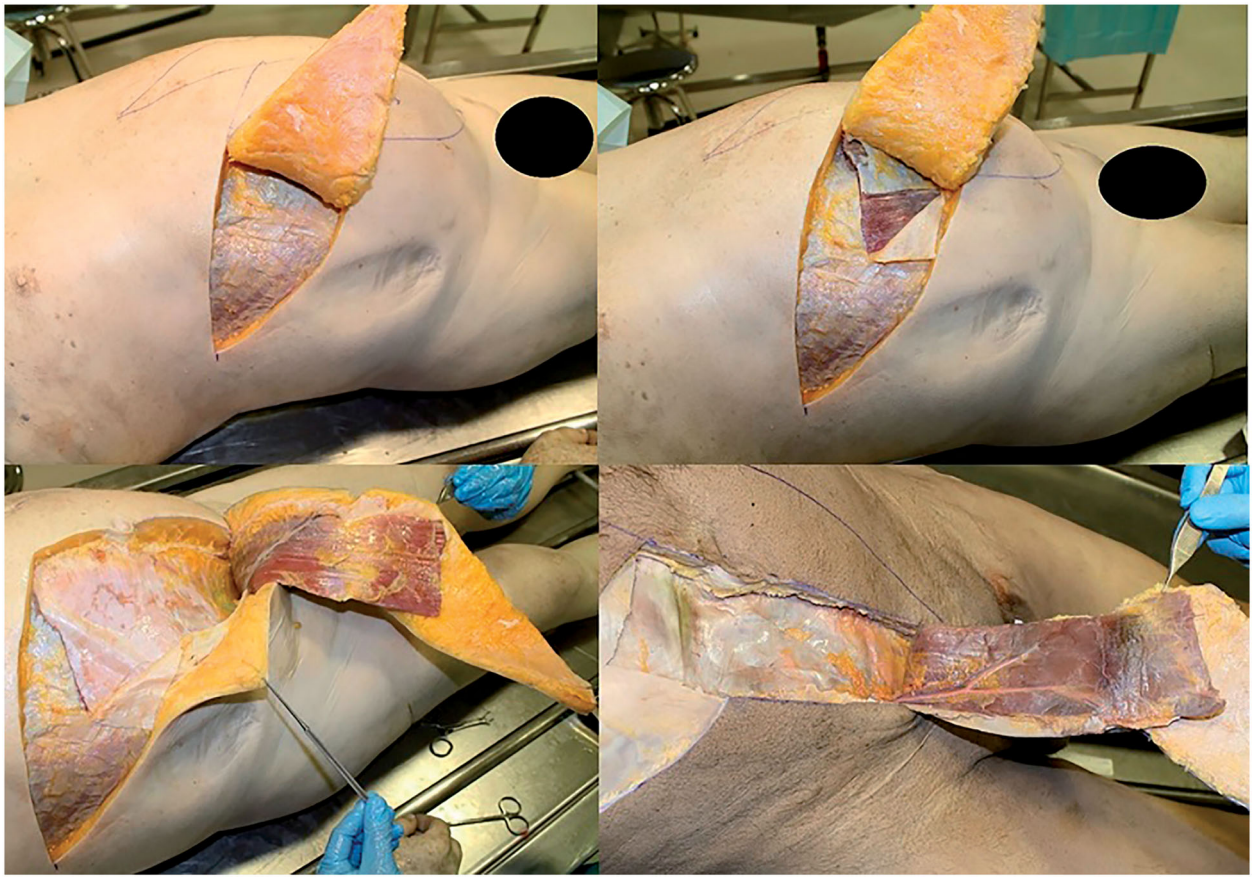

Figure 2. Up-left: The oblique component of the eVRAM flap is dissected in a suprafascial plane. Up-right: The anterior rectus sheat is opened supraumbilical and the superior pole of the muscle is cut. Down-left: Complete dissection of the eVRAM flap. Down-right: Deep inferior epigastric vessels on the deep surface of the muscle.

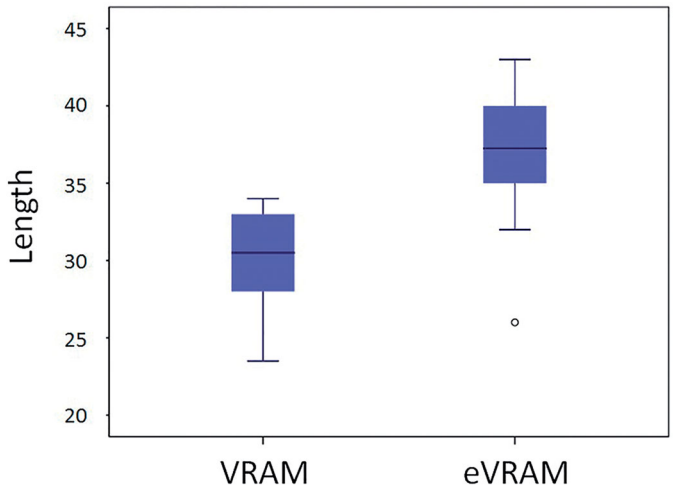

Figure 3. Box plot for length (cm) comparison between VRAM and eVRAM flaps.

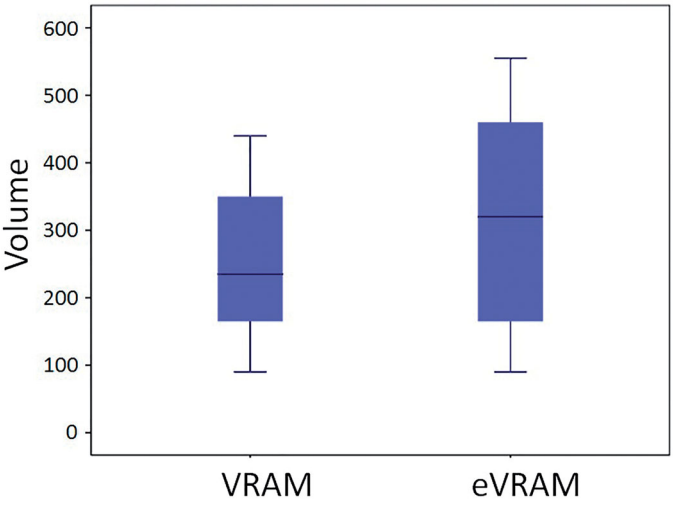

Figure 4. Box plot for volume (mL) comparison between VRAM and eVRAM flaps.

eVRAM flaps the mean length was 36.55 cm (SD 4.81). In terms of volume, the mean of the VRAM group was 244 ml (SD 111.38) and the mean eVRAM volume was 315.5 ml (SD 158.65). The mean width was 6.65 cm (SD 0.86) for both VRAM and eVRAM.

Differences in length and volume between VRAM and eVRAM were statistically significant (p=.005 and .012, respectively) (Figures 3 and 4). In contrast, there was no statistically significant difference in width.

Discussion

This anatomical study demonstrates that the eVRAM design results in a longer skin island and in more flap volume than traditional VRAM flap.

Taylor et al. reported the extended deep inferior epigastric flap in 1983, which is the origin of the eVRAM design [7]. Although they presented an angiographic study that revealed the vascular supply of this skin extension, some authors have questioned the viability of the oblique extension, and the popularity of this flap has been limited [9].

Villa et al. reconsidered Taylor's work and proposed a new design of the skin paddle of the rectus abdominis myocutaneous flap, the extended VRAM flap (eVRAM), which comprises the vertical component and the oblique extension [10]. They performed a perfusion study with computed tomography angiography in fresh cadavers to prove the robust blood supply throughout the eVRAM flaps [11]. They also presented their clinical experience, where there were no major complications and all the flaps survived completely, and suggested using the eVRAM for pelviperineal reconstruction when standard VRAM flap would provide insufficient tissue volume, surface area, and/or flap reach. Other authors have published their experience with the oblique rectus abdominis myocutaneous flap, demonstrating that the oblique extension is safe and provides well-vascularized tissue [9,12,13]. Nevertheless, to our knowledge, this work is the first study that analyzes the dimensions of the eVRAM flap and compares it with the traditional VRAM. The results of our study corroborate that extended design gives a larger and more voluminous flap, which could be very useful to reconstruct huge defects.

Some limitations of this study must be considered. The size of the sample is small and some characteristics are different between live and cadaveric tissues, such as consistency and water proportion, which may imply that flap dimensions could be different in specimens and live humans. However, as both flaps were harvested in every single cadaver, these conditions did not significantly affect the comparison between flaps. The conclusions of this study should be supported by comparative clinical studies, but based on our findings, eVRAM flap, compared to traditional VRAM flap, provides more tissue for dead space filling, a larger skin island for wound closure, and a longer arch of rotation to reach distant defects, which are the key points for successful reconstruction of big pelviperineal defects.

Disclosure statement

The authors have no financial interest to declare; they have no conflicts of interest.

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