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Ethnic differences in platysmal perforators and its relevance for the platysma myocutaneous flap

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Summary *Background:* Variable flap loss rates for the platysma myocutaneous flap have been reported for the Caucasian and the Asian population, which are 10.1% and 1.6%, respectively. This study was designed to investigate ethnic differences in the number and location of platysmal perforators that influence flap survival rates.
Methods: The number and location of platysmal perforators were investigated in a total of 60 platysma muscles: bilaterally in 20 Caucasian (13 males and 7 females) and 10 Asian (5 males and 5 females) specimens using cadaveric dissections. Adjustment for inter-individual variability in platysma length and width was performed by standardizing each *x*-value to mandibular length and each *y*-value to mandibulo-clavicular distance.
Results: A total of 64% of all detected platysmal perforators were found in the medial half of the muscle following the pathway of the external carotid artery. Individuals of Caucasian ethnicity had a mean number of 7.60 $\pm$ 2.0 perforators per side, whereas individuals of Asian ethnicity had a mean number of 13.05 $\pm$ 1.76 perforators per side ($p < 0.001$). Individuals of Asian ethnicity had a statistically significant increased number of platysmal perforators in the

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medial middle (2.95 ± 1.05 vs. 1.60 ± 1.08; $p < 0.001$) and lower (1.60 ± 1.35 vs. 0.73 ± 0.85; $p = 0.003$) regions of the platysma compared to those of Caucasian individuals.
Conclusion: A significantly higher number of platysmal perforators were identified in the investigated Asian population. This provides a potential explanatory model for the reported lower platysma myocutaneous flap loss rates in the Asian population than in the Caucasian population.

Introduction

Since its first reported use in 1887 by the Austrian surgeon Robert Gersuny[1] and its primary introduction in the literature in 1978 by Futrell et al.[2], the platysma myocutaneous flap has gained increasing significance.[3-6] Common indications for its use include chronic osteomyelitis of the mandible and reconstruction after extirpation of intraoral squamous cell carcinoma and carcinomas of the perioral salivary glands.[3]

The platysma myocutaneous flap is easy to harvest, thin and pliable in texture, offers a good color match, and has been shown to have shorter surgery times than microvascular free tissue transfers.[3,4,6,8,9] Despite its ability to be used in a wide array of small- and medium-sized reconstructive procedures for the lower face and neck surgeries, it has not gained widespread popularity as some other pedicled flaps such as the pectoralis, trapezius, radial forearm, or the antero-lateral thigh flap.[3,7,8]

One of the potential reasons for the limited use of the platysma myocutaneous flap is the relatively high rate of flap loss, with reports ranging as high as 29.6% (mean value 10.1%)[1-15] when reviewing literature published in patients of Caucasian ethnic background. In reports based on the Asian population, however, the platysma myocutaneous flap loss rate reached as high as 6.25% (mean value 1.56%)[16-19], which represents an average difference of 8.54%. This difference could be due to several external (surgical training, experience, s.o.) or internal factors (patient comorbidities, radiation, previous surgical interventions, or anatomical variations).

The latter, however, i.e., anatomical variation, is of considerable interest because no study has currently investigated the influence of Caucasian and Asian background on the number and the location of platysmal perforators providing blood supply to the overlying skin and subcutaneous fat of the neck. Identifying such ethnic differences in anatomy would provide valuable information about the performance of the platysma myocutaneous flap, as surgeons could plan the procedure based on knowledge of the underlying anatomic differences according to the patient's ethnic background.

Materials and methods

Study sample

Twenty Caucasian (13 males, 7 females; mean age: 76.86 ± 8.6 years) and ten Asian (5 males, 5 females; mean age: 75.36 ± 11.5 years) cephalic specimens were investigated in this study using cadaveric dissections. Caucasian specimens were dissected at the Department of Medical Education, Albany Medical College, Albany, NY, USA, whereas the Asian specimens were dissected at the Department of Anatomy, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand. All Caucasian specimens were not embalmed (fresh), whereas Asian specimens were embalmed with a modified Thiel solution to preserve the cadavers from the influences of temperature and humidity. Each body donor included in this study provided informed consent while alive for the use of their body for medical, scientific, and educational purposes. Body donors were not included in the study if records indicated any type of previous neck surgery, irradiation, or any other intervention affecting the vascular anatomy of the neck.

Anatomical dissection procedures

The skin and the subcutaneous fat, i.e., fat located superficial to the platysma, were removed *en block* between the clavicle and a horizontal line 1 cm superior and parallel to the mandible. The posterior (lateral) margin of the skin-subcutaneous fat-flap was parallel to a vertical line at the level of the angle of the mandible and the anterior (medial) margin of the flap was the midline (Figure 1). Vessels perforating the platysma and entering the subcutaneous fat were termed platysmal perforators and marked during the dissection process based on the location where they perforated the platysma (Figures 2 and 3). No magnification was used to determine the presence/absence of the platysmal perforators. The distance from the mandible (*y*-value) and from the midline (*x*-value) of each perforator was measured and recorded. Identification of arterial perforators was facilitated through a red latex injection bilaterally into the common carotid artery (Figure 1). Standardized images were taken according to a central protocol and analyzed by one investigator to limit a multicentric bias.

Mapping procedure

To account for the inter-individual variability in platysma length and width, the distance between the mandible and the clavicle and the length of the mandible was measured. A ratio was calculated between each *y*-value and the distance between mandible and clavicle (= adjustment for length) and between each *x*-value and mandibular length (= adjustment for width). Adjusted values were plotted for analytical purposes on a standardized grid, with one grid representing

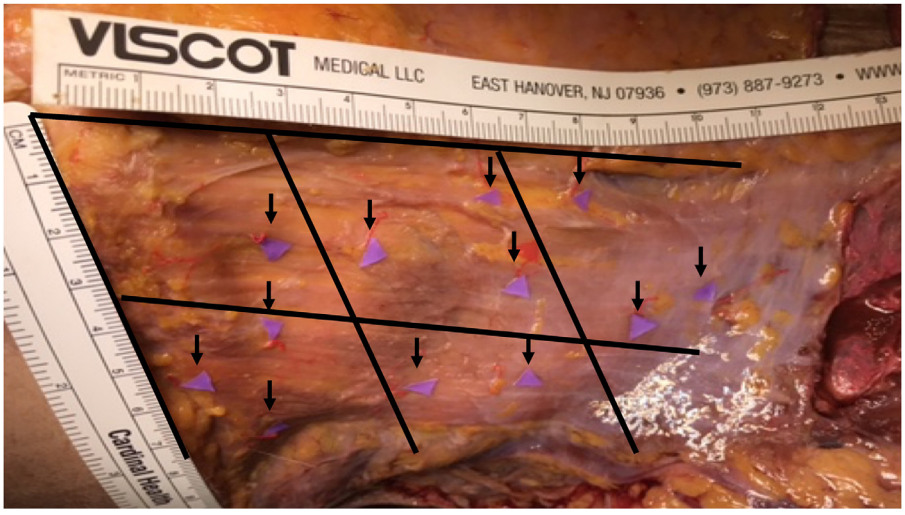

Figure 1 Cadaveric dissection of the right platysma muscle exposing the platysmal perforators from the mandible to the clavicle. A grid was created using rulers, which allowed to standardize the platysma into six different areas of interest. Perforators were marked consecutively, and photographs were taken for further statistical analyses. *Note:* in the infraclavicular portion of the neck, access to the common carotid artery was used to apply latex into the arterial system.

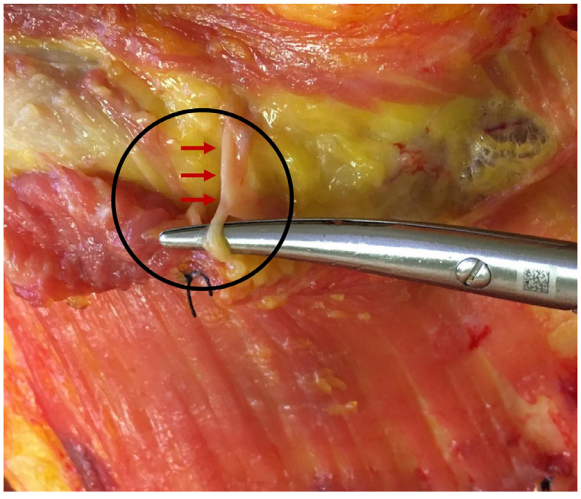

Figure 2 Cadaveric dissection of the left platysma muscle in its infra-mandibular portion exposing a perforator and its connection to the submental artery (red arrows encircled in black).

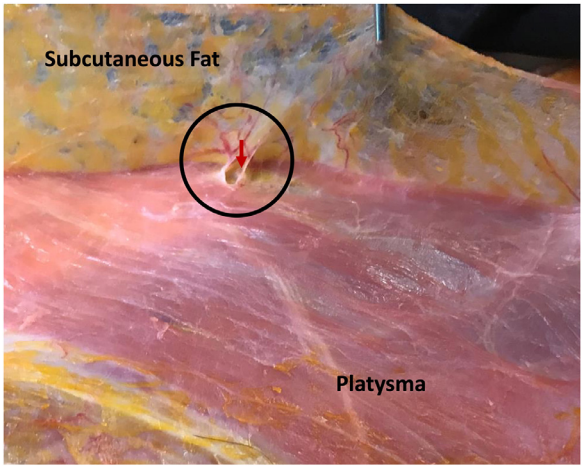

Figure 3 Cadaveric dissection of the right platysma muscle exposing a perforator (red arrows encircled in black); the subcutaneous fat has been elevated.

one side of the neck. The *y*-axis was positioned in the midline, whereas the *x*-axis was positioned along the mandible.

Statistical analysis

The applied standardized grid was divided into six adjusted regions of interest, generating three medial and three lateral regions (each upper, middle, and lower regions) (a total of six) (Figure 1). The presence of the platysmal perforators was assessed quantitatively per each region of interest (dichotomous outcome = presence/absence). Multivariate analysis (ANOVA) and Student's *t*-test were applied to calculate differences in number and location of perforators between genders, ethnicities, and sides. All analyses were performed using SPSS Statistics 25 (IBM, Armonk, NY, USA), and results were considered statistically significant at a probability level of $p \leq 0.05$.

Results

Independent of ethnic background or gender, an average of 9.20 $\pm$ 3.9 perforators was found on the right side and 9.63 $\pm$ 3.2 was found on the left side, and there was no statistically significant difference ($p = 0.641$). Sixty-four percent out of all perforators were identified in the medial regions (independent of locations), whereas 36% were identified in the lateral regions.

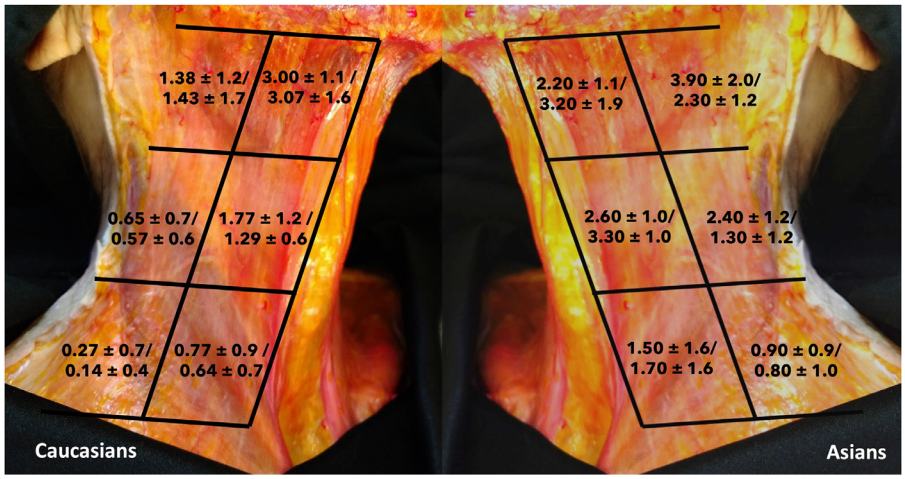

Figure 4 Mean number +/−1 standard deviation of platysmal perforators for males/females per region. Caucasian sample on the right side, and Asian sample on the left side.

Location of perforators

The majority of platysmal perforators were found in the medial regions (upper, middle, and lower). The upper medial region was identified to have the highest number of platysmal perforators (5.83 ± 2.4; range [3 - 13]), followed by the middle medial region (4.10 ± 2.0; range [0 - 8]) and the upper lateral region (3.93 ± 2.8; range [0 - 13]). Further, 2.07 ± 1.9; range [0 - 7] perforators could be found in the middle lateral region, 2.03 ± 1.7; range [0 - 7] in the lower medial region, and 0.87 ± 1.2; range [0 - 4] in the lower lateral region ($p < 0.001$). No statistically significant differences were observed between the left and the right side (all $p > 0.317$).

Ethnic differences

Caucasian individuals had a mean number of 7.60 ± 2.0 perforators per side, whereas Asian individuals had a mean number of 13.05 ± 1.76 perforators per side with statistically significant difference of $p < 0.001$. In the upper medial region, Caucasians had a mean number of 3.03 ± 1.31 perforators, whereas Asians had 2.70 ± 1.59 with $p = 0.403$; in the middle medial region, Caucasians had a mean number of 1.60 ± 1.08 perforators, whereas Asians had 2.95 ± 1.05 with $p < 0.001$; in the lower medial region, Caucasians had a mean number of 0.73 ± 0.85 perforators, whereas Asians had 1.60 ± 1.35, with $p = 0.003$. In the upper lateral third, Caucasians had a mean number of 1.40 ± 1.37 perforators, whereas Asians had 3.10 ± 1.80 with $p < 0.001$; in the middle lateral third, Caucasians had a mean number of 0.63 ± 0.67 perforators, whereas Asians had 1.85 ± 1.39 with $p < 0.001$; in the lower lateral third, Caucasians had a mean number of 0.23 ± 0.58 perforators, whereas Asians had 0.85 ± 0.93 with $p = 0.002$.

Gender differences

Independent of ethnic background, males had a mean number of 9.41 ± 3.18 perforators, whereas females had 9.41 ± 3.44, with $p = 1.00$. In Caucasians, males had an average of 7.85 ± 1.80 and females had 7.14 ± 2.44 platysmal perforators ($p = 0.471$); Asian males had an average of 13.50 ± 2.15 and females had 12.60 ± 1.34 ($p = 0.450$) platysmal perforators. In males, the region with the highest number of perforators was the upper medial region with 5.56 ± 1.95, followed by the upper lateral region, with 4.17 ± 3.31, and by the middle medial region, with 4.00 ± 1.94. In females, the region with the highest number of perforators was the upper medial region, with 6.25 ± 2.90, followed by the middle medial region, with 4.25 ± 2.26, and by the upper lateral region, with 3.58 ± 1.83. No statistically significant gender differences were detected in any of the investigated regions of interest: all $p > 0.445$ (Figure 4).

Discussion

The results of the present study revealed that in the medial half of the platysma muscle (separated by a vertical line at the mid portion of the mandible), statistically significantly more platysmal perforators could be observed. This corresponds to the course of the external carotid artery and its branches. The highest number of platysmal perforators could be identified in the upper medial region, followed by the middle medial region and upper lateral region in Caucasians, while the most perforators could be identified in the upper lateral region in Asians, followed by the middle medial region and upper medial region (Figure 4) with no statistically significant differences between genders. Individuals of Asian ethnic background had a statistically significant increased number of platysmal perforators in the middle and lower medial region ($p < 0.001$ and $p = 0.003$, respectively), and in the upper, middle, and lower lateral regions ($p < 0.001$ for all three) but not in the upper medial region ($p = 0.403$). No statistically significant gender differences were observed. There were significantly more perforators in the medial thirds than in the lateral thirds ($p \leq 0.001$ for the upper, middle, and lower thirds).

The strength of the present investigation was the large number of platysma muscles dissected ($n = 60$) obtained

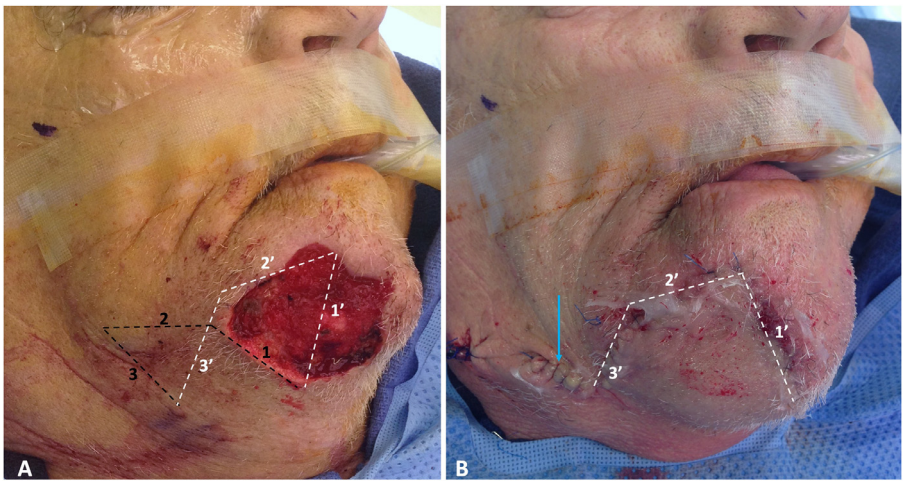

Figure 5 A patient case with a full-thickness right-sided chin defect with exposed mandible following excision of squamous cell carcinoma. Black dotted lines indicate the skin incision, and white dotted lines indicate the flap rotation and future position (A). Immediate postoperative image following an inferiorly based rotational platysma myocutaneous flap with the inclusion of platysmal perforators intended to improve flap viability. White dotted lines represent flap rotation and future position from (A). Blue arrow indicates "dog ear" excision for flap adjustment (B).

from body donors of both Caucasian and Asian ethnic backgrounds. Use of a multiethnic approach provides the possibility to compare anatomical variation between ethnicities; this will ultimately benefit the preoperative assessment and contribute to the explanation for the differences observed in surgical outcomes. Another strength of the present investigation is the mapping procedure performed; this enables a standardized comparison between the investigated individuals, as each perforator was measured in *x*- and *y*-coordinates. These values were normalized to the absolute length and width of the neck, i.e., mandibular length for width and mandibulo-clavicular distance for length.

A limitation of this study is the different numbers of investigated body donors with Caucasian ($n = 20$) and Asian ($n = 10$) ethnic background. A larger sample of Asian population would have revealed more robust data; however, post-hoc analyses using Levene's test calculated to assess the equality of variances did not show statistically significant differences ($p > 0.005$), providing evidence for the equality of variances in the calculated groups. Another limitation of this study could be the difference in tissue quality owing to the different embalming techniques: Caucasian specimens were not embalmed, and Asian specimens were embalmed with a modified Thiel embalming solution. This difference influenced the tissue quality and the dissection process; however, the number and the location of platysmal perforators are unlikely to be influenced by this difference, as only the presence of platysmal perforator was evaluated.

The platysma myocutaneous flap has many advantages compared to other local or microvascular free flaps (Figure 5). However, it has not gained widespread popularity owing to its variable vascular supply and high complication rate. Reports have discouraged its use when facial artery sacrifice is planned or if the patient received radiation.[4,6-9,12,14] Despite this, interest has slowly continued to better design myocutaneous flaps and improve the relatively high flap loss rate.[18] One possible mechanism to improve flap survival is to design a flap that integrates as many perforators as possible, providing sufficient vascular supply for the overlying subcutaneous fat and skin (Figure 5). Our study identified the upper medial third as the location where the highest number of perforators could be observed; this was independent of gender or ethnic background. These perforators were majorly connected to the submental, mental, and facial arteries (Figure 2).[20]

To illustrate the utility of incorporating platysmal perforators, we present a case of a 76-year-old male with a full-thickness right-sided chin defect with exposed mandible following excision of a cutaneous squamous cell carcinoma. An inferiorly based myocutaneous flap including platysmal perforators from the right upper medial third was used under general anesthesia with endotracheal intubation to protect the airway (as compared to using a supraglottic airway with a laryngeal mask). Rhomboid flaps of the head and neck are very reliable; however, this patient had vascular comorbidities, and to ensure better viability, platysmal perforators were specifically included in the design of the flap. It should be noted that the total surgical time for this case was 60 min, which makes this approach clinically feasible even in patients with multiple risk factors.

Interestingly, our study revealed that in the middle and in the lower medial thirds, individuals of Asian ethnic background had a statistically significant higher number of perforators per side than Caucasian individuals, (Caucasian vs. Asian) 1.60 ± 1.08 vs. 2.95 ± 1.05 with $p < 0.001$ (middle medial region) and 0.73 ± 0.85 vs. 1.60 ± 1.35 with $p < 0.001$ (lower medial region). This significant difference in number could potentially explain why recent reports investigating the platysma myocutaneous flap in Asian populations have reported lower flap loss rates for inferiorly based vertical flaps than reports from Caucasian-based cohorts: (Caucasian vs. Asian) 10.1% vs. 1.56%.[1-19] A higher number of platysmal perforators could indicate a better vascularization of the respective flap, which was particularly observed in Asian body donors during dissection and which is supported by clinical data based on our literature review.

Appreciating these anatomical variations could facilitate the preoperative surgical planning. On the basis of the results of the present study, a more inferiorly based flap could lead to a better outcome (with a potentially reduced rate of flap loss) in Asian patients, whereas for the same surgical indication, a free flap could be of greater benefit in Caucasian patients. The latter have been shown to display a significant reduction of platysmal perforators in the middle and the lower medial regions; this may provide evidence for the increased rates of flap loss in the Caucasian population.

Conclusion

The results of this study revealed that, independent of gender, the location of the highest number of platysmal perforators was the upper medial region of the muscle.

Our study located the platysmal perforators along the course of the carotid arteries and its branches. A significantly higher number of platysmal perforators were identified in the investigated Asian population, especially for the middle and lower medial regions of the muscle. This provides a potential explanation for the lower platysma myocutaneous flap loss rates originating from Asian populations than those given in reports from Caucasian populations.

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Author disclosures

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