The Change of Plane of the Supratrochlear and Supraorbital Arteries in the Forehead – An Ultrasound-Based Investigation

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ABSTRACT

Background: Injecting soft tissue fillers into the deep plane of the forehead carries the risk of injection related visual compromise due to the specific course of the arterial vasculature.

Objectives: To investigate the 2- and 3-dimensional location of the change of plane of the deep branch of the supratrochlear and supraorbital artery, respectively.

Methods: A total of 50 patients (11 males and 39 females, mean age: 49.76 (13.8) years, mean body mass index of 22.53 (2.6) kg/m^2) were investigated with ultrasound imaging. The total thickness, and the distance of the arteries from the skin and bone surface were measured using a 15-7 MHz broadband compact linear array transducer.

Results: The deep branch of the supraorbital artery changed plane from deep to superficial to the frontalis muscle at a mean distance of 13 mm [range: 7.0 – 19.0] in males and at 14 mm [range: 4.0 – 24.0] in females and for the deep branch of the supratrochlear artery at a mean distance of 14 mm in males and females [range: 10.0 – 19.0 in males, 4.0 – 27.0 in females} when measured from the superior orbital rim.

Conclusions: Based on the ultrasound findings in this study, it seems that the supraperiosteal plane of the upper and lower forehead could be targeted during soft tissue filler injections as the deep branches of both the supraorbital and supratrochlear arteries do not travel within this plane. The superficial plane of the lower forehead, however, should be avoided due to the unpredictability and inconsistent presence of the central and paracentral arteries.

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Age-related changes of the forehead include the rhytid formation and soft tissue volume loss, also termed frontal hollowing. The pathophysiology behind frontal hollowing can be attributed either to the volume loss of the superficial and/or deep frontal compartments [1] or to the changes of the underlying frontal bone.[2] The age-related changes of the frontal bone have recently been described in a cross-sectional CT-imaging study in which the authors reported on the complex 3-dimensional structural changes with high gender variation.[2]

Clinically, frontal hollowing can be treated by the administration of fillers to compensate for the volume loss and/or re-shape the bony contour resulting in a smooth, symmetric and rounded skin surface. Due to the thin soft tissue coverage of the forehead, aesthetic improvements are immediately visible resulting in high patient satisfaction with filler treatments.

Techniques to treat frontal hollowing include a perpendicular bolus injection utilizing a needle and a fanning cannula technique parallel to the bone surface. Both techniques aim to place the product into the supraperiosteal plane but recent studies provide evidence that the perpendicular needle injection is less precise[3] and can position the product in all fascial layers including the subdermal plane.[4,5]

The rationale to target the supraperiosteal plane is based on both aesthetic and safety considerations; observations indicate that the loose areolar tissue of the supraperiosteal plane is free of major arteries and thus safer when targeted with fillers. Recent studies show that injection-related visual compromise leading to irreversible blindness following filler injections is related to vascular connections between arteries and the ophthalmic artery circulation.[6] Of these, injection into the supratrochlear and supraorbital arteries can lead to such devastating adverse events as they are direct branches of the ophthalmic artery.[7–9]

To avoid such catastrophic adverse events it was recently recommended that the upper forehead could be targeted deep in the supraperiosteal plane whereas injections in the lower forehead should not be performed in this plane as the arteries emerge from their respective foramen/notch and have not changed their plane to become more superficial.[6] Despite its widespread acceptance in the aesthetic medical field, this “change of plane” has not been objectively investigated to define safer from less safe volumizing procedures of the forehead.

The objective of this study is to identify with ultrasound imaging the precise 2- and 3-dimensional location where the deep branch of the supratrochlear and the deep branch of the supraorbital artery change plane, thus providing reliable and clinically relevant information to perform safer frontal procedures.

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METHODS

Study setup

This observational ultrasound-based study was conducted in 50 patients between March 2020 and May 2020 at the Medisch Laser Centrum, Amsterdam, Netherlands and at the Department of Dermatology, Erasmus MC, Rotterdam, Netherlands.

The study did not require ethics committee approval as ultrasound imaging is considered standard of care before routine soft tissue filler injections by the respective approval board (Medisch Ethische Toetsingsingscommissie) according to The Medical Research Involving Human Subjects Act.[10]

Study participants were consecutive patients of two dermatologic centers in Amsterdam and Rotterdam. Patients were not included in this study if they had previous soft tissue filler treatments or surgical procedures of their forehead that could have disrupted the integrity of the layered fascial or vascular anatomy.

This study was performed in adherence with the Declaration of Helsinki (1996), and in accordance with regional laws and Good Clinical Practice for studies in human subjects.[11] Written informed consent was obtained for all participants prior to inclusion into the study for use of their images and data for research purposes.

Ultrasound imaging

All ultrasound measurements were carried out with the same Affiniti 70 device using a 18 MHz broadband compact linear array transducer (Philips N.V., Amsterdam, Netherlands). Measurements were conducted with patients in a 30-45 degree reclined seated position. The linear transducer was positioned in the contact gel with only minimal skin contact so as to avoid compression of forehead soft tissues.

The length of the forehead was defined as the mean vertical distance between the upper margin of the hairy eyebrow and the frontal hairline on each side of the face. The total length of the forehead was then divided into five equidistant segments resulting in a total of six measurement locations: 0%, 20%, 40%, 60%, 80% and 100% of total forehead length (Figure 1).

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Measurements Conducted

On each side of the face, the supraorbital and supratrochlear foramen or notch were identified based on their medial/lateral location. The deep branch of the supratrochlear and deep branch of the supraorbital artery were identified with the color-coded Doppler function of the ultrasound device. The respective artery was then followed along its cranially oriented course from the superior orbital rim toward the hairline. The following parameters were captured by the distance measurement tools of the ultrasound device for each of the respective arteries and facial side at each of the six measurement locations noted above:

- Thickness of the frontal soft tissues = distance between skin surface and periosteum
- Depth of the respective artery from skin surface = distance between skin surface and main arterial trunk
- Depth of the respective artery from bone surface = distance between main arterial trunk and periosteum
- Location of change in plane of the respective main arterial trunk = change from a location deep to frontalis muscle to superficial to frontalis muscle (Figure 2)

All measurements were conducted by the same investigator (L.S.) for consistency purposes.

Statistical analysis

A total of 600 measurements were conducted in 50 patients. Differences between genders were calculated using independent Students t-test. Bivariate correlations relied on the calculation of Pearson's correlation coefficient whereas linear regression models were utilized to identify the multivariate influence of age, gender and body mass index on the ultrasound-based measurements. All calculations were run using SPSS Statistics 25 (IBM, Armonk, NY, USA) and differences were considered statistically significant at a probability level of ≤ 0.05.

RESULTS

Patient demographic data

The study sample consisted of 11 males and 39 females (48 Caucasians and 2 Asians) with a mean age (mean value and standard deviation) of 49.76 (13.8) years [range: 20 – 79] and a mean body mass index of 22.53 (2.6) kg/m^2 [range: 18.34 – 29.98]. Older age was statistically significantly

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correlated with higher BMI values for females with $r_p = 0.266$; p = 0.018; this was not observed for males $r_p = 0.128$; p = 0.571.

The length of the forehead was in 74.45 (8.5) mm [range: 58.0 – 85.0] in males and 68.12 (8.0) mm [range: 50.0 – 81.0] in females (p = 0.002). No difference was detected between the two sides of the face (p = 1.00).

Forehead soft tissue thickness

The mean thickness of the frontal soft tissues was 5.34 (0.6) mm [range: 4.29 – 6.37] in males and 4.94 (0.7) mm [range: 2.97 – 6.67] in females (p = 0.017). Older age was correlated with greater overall frontal soft tissue thickness in males $r_p = 0.501$; p = 0.018 but with decreased overall frontal soft tissue thickness in females $r_p = -0.167$; p = 0.158. Higher BMI values did not show a statistically significant influence on the frontal soft tissue thickness in either gender (p ≥ 0.348).

Change of plane

The supraorbital artery (deep branch) changed its plane from deep to superficial to the frontalis muscle along its cranially directed course. This "change of plane" occurred at a mean distance of 13.32 (2.5) mm [range: 7.0 – 19.0] in males and at a mean distance of 14.10 (3.4) mm [range: 4.0 – 24.0] in females (p = 0.311 for gender differences) when measured from the superior orbital rim. This change in planes corresponded to 17.94% (2.9) [range: 10.3 – 24.4] and 20.91% (5.5) [range: 5.1 – 41.5] of the total forehead length for males and females, respectively.

The "change in plane" of the supratrochlear artery (deep branch) occurred at a mean distance of 13.64 (2.3) mm [range: 10.0 – 19.0] in males and at a mean distance of 13.67 (3.9) mm [range: 4.0 – 27.0] in females (p = 0.972) when measured from the superior orbital rim. This change in plane corresponds to 18.48% (3.3) [range: 11.8 – 24.4] and 20.30% (6.2) [range: 5.7 – 43.4] of the total forehead length for males and females, respectively.

Distance between skin surface and main arterial trunk (Figure 3)

The mean depth of the supraorbital artery independent of its location within the forehead was 2.89 (0.3) mm [range: 2.36 – 3.50] in males and was 2.76 (0.4) [range: 1.68 – 3.67] in females with no statistically significant difference between genders (p = 0.227). Detailed information on the depth of the artery in relation to total forehead length is shown in Table 1.

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The mean depth of the supratrochlear artery independent of its location within the forehead was 2.83 (0.3) mm [range: 2.38 – 3.45] in males and was 2.66 (0.4) mm [range: 1.71 – 3.74] in females, again with no statistically significant difference between genders (p = 0.079). Detailed information on the depth of the artery in relation to total forehead length is provided in Table 2.

In males, older age tended to correlate with an increased distance between skin surface and both arteries whereas in females this distance decreased with older age; this tendency was observed at each of the measured locations (Table 3). BMI did not show any influencing trend when repeating these bivariate correlations.

Distance between main arterial trunk and bone surface (Figure 4)

The mean distance between the deep branch of the supraorbital artery and bone surface at the various locations within the forehead was 2.46 (0.4) mm [range: 1.78 – 3.09] in males and 2.18 (0.4) mm [range: 1.19 – 3.37] in females (p = 0.007). Detailed information on the depth of the artery in relation to the total forehead length is shown in Table 1.

The mean distance between the deep branch of the supratrochlear artery and bone surface at the various locations within the forehead was 2.43 (0.5) mm [range: 1.09 – 3.29] in males vs. 2.16 (0.4) mm [range: 1.17 – 3.26] in females (p = 0.018). Detailed information on the depth of the artery in relation to the total forehead length is shown in Table 2.

Starting at 60% (and continuing to 100%) of the total forehead length, the previously observed trend in both males and females in their correlation with age was observed again: males displayed positive correlation coefficients and females displayed negative correlation coefficients (Table 4). This indicates that the distance between both the supratrochlear and the supraorbital arteries and the bone surface was increased in males and was decreased in females with older age.

Additional observations

Including age, gender, BMI and the distance between skin surface and the investigated arteries into a linear regression model was only able to explain 37% (R^2 = 0.37) of the variation within the results, suggesting that a large proportion of the remaining variability is influenced by factors that were not captured. Running the same analyses but focusing on the distance between the investigated arteries and the bone surface, 51% (R^2 = 0.508) of the variation could be explained. This difference in R-squared values could be related to the underlying anatomy and their respective thickness influencing factors.

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The central artery of the forehead was identified in the superficial plane of the lower forehead in 12 cases (24%) by ultrasound imaging whereas the paracentral artery was identified in 10 cases (20%) out of the 50 investigated foreheads (Figure 5,6).

DISCUSSION

The results of this clinical observational study conducted in 50 healthy volunteers utilizing ultrasound imaging provides new insights into the vascular anatomy of the forehead relevant to soft tissue filler augmentation procedures.

One of our key findings is the confirmation of the "change of plane" of the deep branch of the supraorbital and the deep branch of the supratrochlear artery. The change of plane as identified in this study does not refer to the change of the arterial course from the supraperiosteal plane to the subdermal plane with the frontalis muscles being the separating structure. It was further more revealed that both arteries were coursing deep to the orbicularis oculi (orbital part) muscle after emerging from their respective foramen/notch and not within the supraperiosteal plane. The arteries were separated by a fascia from this space and travelled within a thin fatty layer located deep and in immediate proximity to the muscle. This interesting anatomic behavior is special. A previously published anatomic review of the facial arterial vasculature stated that the facial arterial vessels are tortuous in their 2-dimensional course but rather constant in their 3-dimensional pathway indicating that facial vessels maintain their planes.[9] However, the present study revealed that both the deep branches of the supraorbital and of the supratrochlear arteries changed their planes from deep to the frontalis muscle to superficial to the frontalis muscle. Along their cranially oriented course both arteries connect to superficially located arteries: the supraorbital artery connects to the anterior/frontal branch of the superficial temporal artery and the supratrochlear artery connects to the subdermal arterial plexus together with the central artery (of the forehead) and the paracentral artery.[12] To reach their destined locations both investigated arteries have to change their planes and become more superficial. This change of plane occurred for the deep branch of the supraorbital artery at a mean distance of 13 mm [range: 7.0 – 19.0] in males and at 14 mm [range: 4.0 – 24.0] in females and for the deep branch of the supratrochlear artery at a mean distance of 14 mm [range: 10.0 – 19.0] in males and at 14 mm [range: 4.0 – 27.0] in females when measured from the superior orbital rim. This landmark was chosen to provide a palpable and clinically reproducible location for estimating the position of the change of plane in a vertical (but not horizontal) orientation. Previously the change in plane of the arteries was used to separate safer from less safe soft tissue filler injections to treat frontal hollowing by targeting the supraperiosteal

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plane.[9] It was assumed that in the lower forehead deep injection can lead to an injection related visual compromise.

However, the results of the present study expand on this dichotomous separation of upper forehead = safer vs. lower forehead = less safe. The results presented herein potentially indicate that soft tissue fillers can also be administered into the supraperiosteal plane in the lower forehead with a certain degree of safety. Our ultrasound measurements showed that the mean overall distance between the deep branch of the supraorbital artery and the periosteum was 2.5 mm in males and 2.2 mm in females; the distances for the deep branch of the supratrochlear artery were 2.4 mm in males and 2.2 mm in females. This indicates that both arteries do not course in direct contact with the periosteum = within the supraperiosteal plane but at a certain distance from it. Detailed ultrasound imaging additionally confirmed that both arteries are separated by the subfrontalis fascia [1] from the supraperiosteal layer which is composed of loose areolar connective tissue. These results are in alignment with a previous histologic study, which has identified a fascia deep to the frontalis muscle.[13] A large diameter blunt-tip cannula (eg 22G) can be inserted into the supraperiosteal layer of the lateral lower forehead to treat age-related bony changes that result in visible skin surface changes. [2] The supraorbital and supratrochlear arteries would be separated from the in medial direction advancing cannula by the subfrontalis fascia enabling experienced practitioners to target this plane comparable to the upper forehead. The identification of the supraperiosteal plane with a cannula can be achieved by establishing bone contact and advancing the cannula in contact with the bone until reaching the aesthetic area of interest; no ultrasound guidance should be needed to identify if a cannula has bone contact. However, it has to be noted that despite the reduced vascularity of this plane and the presence of the shielding subfrontalis fascia, arteries are still present that can cause an injection related visual compromise if cannulation and embolization of the filler material occurs. These potential culprit arteries and their branches are connecting vessels between the investigated supraorbital/supratrochlear arteries and periosteal arteries which should not be underestimated in number and diameter.[14] Thus, sharp-tip needles should be avoided for treating the supraperiosteal plane of the forehead due to the unpredictability of the arterial vascular connections and due to their proximity to the ophthalmic artery circulation.[9] A cannula seems to be of additional benefit when trying to increase safety during deep forehead soft tissue filler augmentations due to increased injection precision,[3] reduced unwanted product spread into more superficial layers (which are inherent in perpendicular needle injections)[4] and reduced ability to penetrate arterial vessel walls.[15] However it should be noted that arterial cannulation have also been reported to occur with a cannula.

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The present study also revealed that the mean depth of the deep branch of the supraorbital artery was 2.9 mm in males and 2.8 mm in females; similar values were obtained for the deep branch of the supratrochlear artery: 2.8 mm in males and 2.7 mm in females. Interestingly, even though a change in plane was identified for both arteries, the depth (distance between skin surface and artery) did not change dramatically after the arteries became more superficial (see Table 1 & 2). Additional calculations detected also that the percentage of soft tissue coverage for both arteries is relatively constant, ranging between 52 – 62% of the total forehead soft tissues across the entire forehead (see Figure 5). These results however, should be translated into clinical practice with care. We found that especially in the lower forehead, branches of the central artery (of the forehead) and paracentral artery are present in in the superficial fatty layer in 24% and 20% of the cases, respectively. These superficial arteries contribute to the 3-dimensional vascular network of the glabella which is strongly connected to the bilateral angular arteries and to the bilateral ophthalmic arteries and their respective branches. Given the inconsistency and the unpredictability of these superficial vessels, soft tissue filler deposition into the superficial fatty layer of the lower forehead should be avoided.

The superficial fatty layer of the forehead was revealed to have different associations between gender and age. Bivariate correlations have identified a tendency that the superficial fatty layer (corresponding to the distance measured between skin surface and main arterial trunk) was increased in males of older age but was decreased in females of older age (see Tables 3 & 4). This tendency was observed in the upper forehead (after the change in plane occurred, the arteries are located inside the superficial fatty layer) starting from 60% moving cranially the distance between the main arterial trunk and the periosteum likewise followed the same tendency: increase in males and decrease in females at older age. This was represented by the positive correlations for males and the negative correlations for females. In the lower forehead (before the change in plane occurred, the arteries are located deep to frontalis muscle), ultrasound imaging identified a fatty layer located between the frontalis muscle and the subfrontalis fascia. This fatty layer seemed to be of different echogenicity and did not follow the trend that was observed for the superficial fatty layer; indicating a potentially separate fat compartment with different age-related behavior. The investigated arteries travelled within this fat compartment after emerging from their respective foramen/notch (Figure 7). Even though this deep fatty layer was previously mentioned in a side note,[1] further research is warranted to investigate the fascial relationships of the forehead.

One limitation of the present study is the ultrasound methodology utilized. It is known that ultrasound imaging has inherent observer bias and is dependent of the technology applied. In the

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present study, all measurements were performed by the same investigator and were conducted on the same device to provide reliable outcomes. Comparing the values obtained from this study to another ultrasound study measuring the frontal soft tissue thickness of 40 healthy Korean volunteers[16] revealed similar values; the total soft tissue thickness ranged from 4.3 – 5.3 mm (unstratified by gender) with males having statistically significantly increased overall soft tissue thickness. This provides support for the validity of the measurements presented in this study.

CONCLUSIONS

The results of this ultrasound-based investigation have identified that the change of plane (ie, change in position from deep to frontalis muscle to superficial to frontalis muscle) for the deep branches of the supraorbital and supraorbital arteries occurred at a mean of 13.8 mm cranial to the superior orbital rim (range: 4 – 27 mm). Based on the arterial pathways ascertained in this study, soft tissue fillers can be injected into the supraperiosteal plane of the lower forehead utilizing a cannula as the arteries travel at a mean distance of 2.3 mm superficial to the periosteum and are separated from the periosteum by a protective fascia. The superficial plane of the lower forehead should however be avoided due to the unpredictability and inconsistent presence of the central and paracentral arteries. Additionally, the supraperiosteal plane should be avoided at the site where the artery exits from its respective foramen/notch.

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Table 1. Mean Values With Accompanying Standard Deviations (SD) at Each of the Measured Locations in Percent of the Total Forehead Length for the Deep Branch of the Supraorbital Artery (SOA).

	0%	20%	40%	60%	80%	100%
Overall thickness (male)	5.34 (0.6)	6.29 (1.3)	5.14 (0.8)	5.27* (0.9)	5.05* (0.8)	4.96* (0.9)
Overall thickness (female)	4.94 (0.7)	6.14 (1.4)	4.83 (0.8)	4.61* (0.9)	4.55* (0.9)	4.42* (0.9)
Distance: Skin surface to SOA (male)	3.92 (1.3)	2.80 (0.5)	2.76 (0.5)	2.68 (0.5)	2.62* (0.4)	2.53 (0.6)
Distance: Skin surface to SOA (female)	3.80 (1.1)	2.88 (0.8)	2.60 (0.6)	2.52 (0.6)	2.38* (0.5)	2.28 (0.5)
Distance: SOA to Bone surface (male)	2.36 (0.6)	2.54* (0.7)	2.38 (0.6)	2.59* (0.7)	2.43 (0.7)	2.43 (0.7)
Distance: SOA to Bone surface (female)	2.34 (1.2)	2.06* (0.6)	2.23 (0.6)	2.10* (0.7)	2.17 (0.7)	2.15 (0.7)

*, statistically significant differences between genders

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Table 2. Mean Values With Accompanying Standard Deviations (SD) at Each of the Measured Locations in Percent of the Total Forehead Length for the Deep Branch of the Supratrochlear Artery (STA).

	0%	20%	40%	60%	80%	100%
Overall thickness (male)	5.89 (1.1)	5.35 (1.0)	5.22* (0.9)	5.09* (0.9)	5.26* (1.4)	4.71* (0.9)
Overall thickness (female)	5.95 (1.2)	5.02 (0.8)	4.78* (0.9)	4.57* (0.8)	4.34* (0.9)	4.27* (0.9)
Distance: Skin surface to STA (male)	3.40 (0.8)	2.94 (0.6)	2.67 (0.6)	2.69* (0.6)	2.90* (1.6)	2.38 (0.5)
Distance: Skin surface to STA (female)	3.57 (1.0)	2.85 (0.6)	2.57 (0.6)	2.39* (0.6)	2.33* (0.5)	2.25 (0.6)
Distance: STA to Bone surface (male)	2.50 (1.0)	2.42 (0.6)	2.55* (0.7)	2.40 (0.5)	2.37* (0.7)	2.32* (0.7)
Distance: STA to Bone surface (female)	2.38 (1.0)	2.16 (0.6)	2.21* (0.6)	2.18 (0.6)	2.01* (0.7)	2.02* (0.6)

*, statistically significant differences between genders

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Table 3. Pearson Correlation Coefficients and the Accompanying P-Value for the Bivariate Correlation Between Age and the Distance Between Skin Surface and the Deep Branch of the Supraorbital Artery (SOA) and the Deep Branch of the Supratrochlear Artery (STA)

	0%	20%	40%	60%	80%	100%
Skin to SOA (male)	0.300 (0.175)	-0.460 (0.839)	0.008 (0.973)	0.039 (0.863)	0.188 (0.403)	0.157 (0.484)
Skin to SOA (female)	0.021 (0.854)	-0.260 (0.822)	-0.232* (0.041)	-0.262* (0.021)	-0.234* (0.041)	-0.150 (0.206)
Skin to STA (male)	-0.183 (0.416)	0.412 (0.057)	0.066 (0.770)	0.198 (0.376)	-0.176 (0.432)	0.239 (0.285)
Skin to STA (female)	0.053 (0.648)	-0.024 (0.832)	0.016 (0.889)	-0.177 (0.122)	-0.520 (0.651)	-0.101 (0.379)

*, statistically significant correlations

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Table 4. Pearson Correlation Coefficients and the Accompanying P-Value for the Bivariate Correlation Between Age and the Distance Between the Deep Branch of the Supraorbital Artery (SOA) and the Deep Branch of the Supratrochlear Artery (STA) and the Bone Surface

	0%	20%	40%	60%	80%	100%
SOA to Bone (male)	0.132 (0.558)	0.323 (0.142)	0.297 (0.179)	0.623* (0.002)	0.311 (0.159)	0.272 (0.221)
SOA to Bone (female)	-0.102 (0.374)	0.191 (0.094)	0.188 (0.100)	-0.750 (0.512)	-0.320 (0.786)	-0.184 (0.120)
STA to Bone (male)	0.584* (0.04)	0.335 (0.127)	0.347 (0.113)	0.614* (0.002)	0.520* (0.13)	0.767* (0.000)
STA to Bone (female)	0.170 (0.137)	0.054 (0.638)	0.028 (0.808)	-0.125 (0.275)	-0.047 (0.682)	-0.023 (0.845)

*, statistically significant correlations

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FIGURE LEGEND

Figure 1. Clinical image of a 28-year-old female patient with the markings drawn on her forehead to guide the ultrasound based measurements. The markings divide the total forehead into 5 equidistant segments: 0%, 20%, 40%, 60%, 80% and 100% of the total forehead length.

Figure 2. Longitudinal ultrasound scan of the left forehead showing the course of the supratrochlear artery and the respective change of plane. CD = caudal, CR = cranial. White arrows indicate the subfrontalis fascia.

Figure 3. Transverse ultrasound scan of the right lower forehead showing the supraorbital artery deep to the frontalis muscle. White arrows indicate the subfrontalis fascia.

Figure 4. Transverse ultrasound scan of the left upper forehead showing the supratrochlear artery superficial to the frontalis muscle. White arrows indicate the subfrontalis fascia.

Figure 5. Longitudinal ultrasound scan of the right forehead showing the plethora of arteries and veins within the superficial fatty layer ie above the muscle.

Figure 6. Illustration of the soft tissue thickness of the forehead at each of the measured locations in a 33-year-old male. The percent of soft tissue thickness separating the supraorbital (SOA) and supratrochlear (STA) from the periosteum in relation to the total frontal soft tissue thickness (100%) is shown. Asterisk indicates a statistically significant difference between genders.

Figure 7. Artistic drawing of the most probable course of the deep branch of the supraorbital and supratrochlear artery with its respective change of plane 13 mm in males and 14 mm in females cranial to the superior orbital rim from deep to superficial to frontalis muscle.

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Figure 1

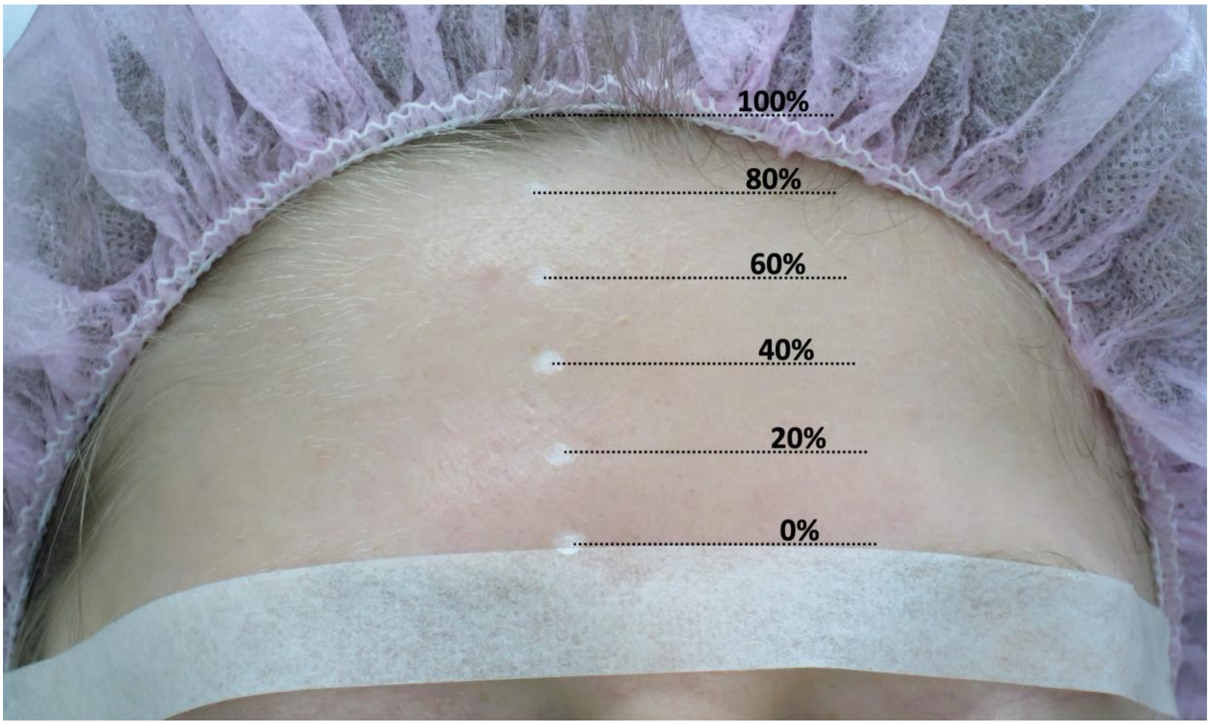

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Figure 2

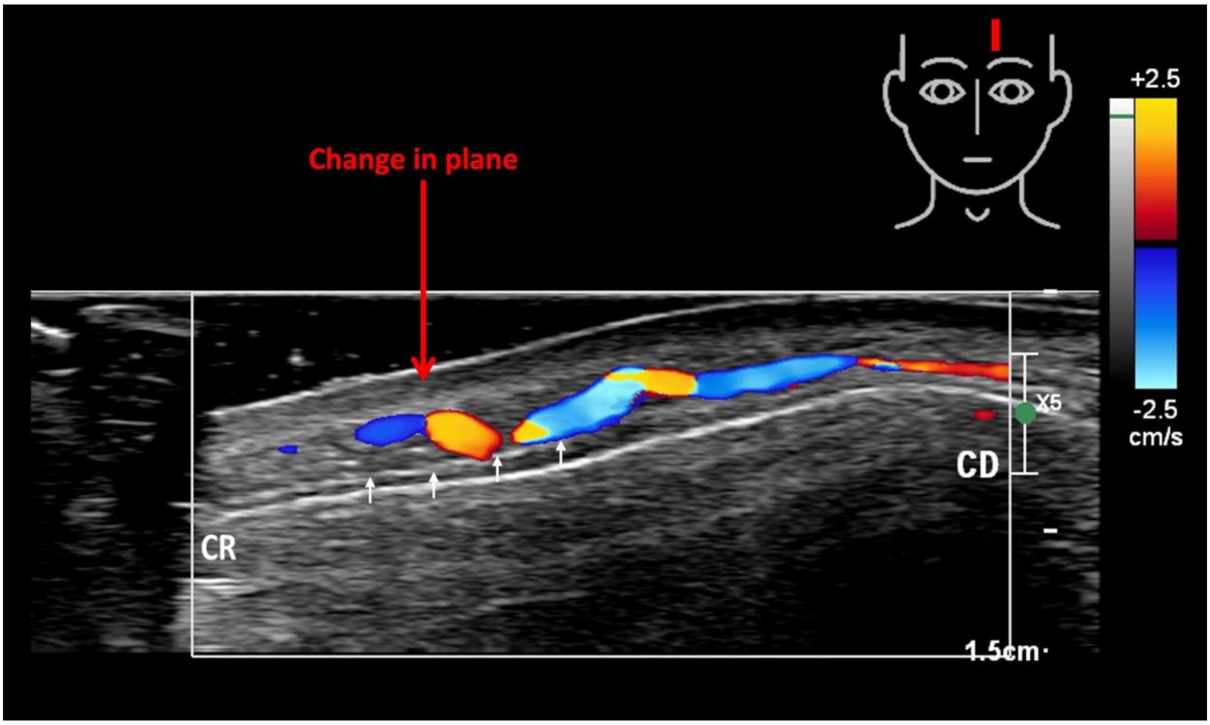

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Figure 3

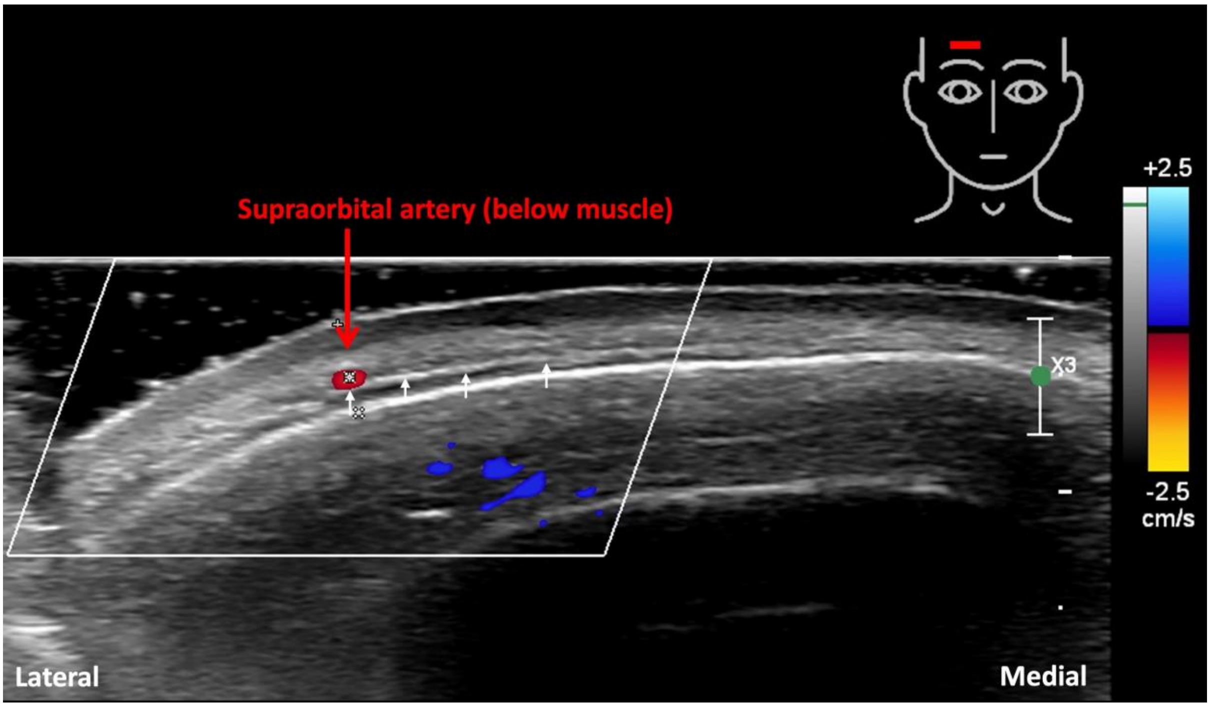

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Figure 4

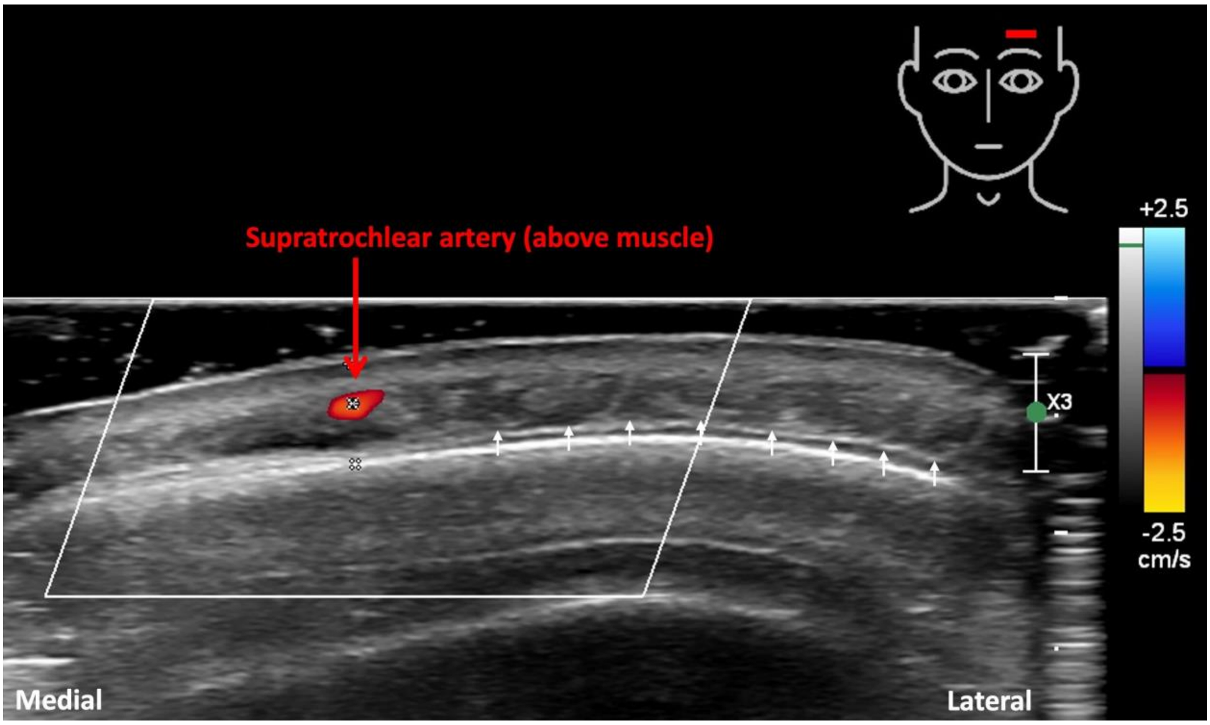

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Figure 5

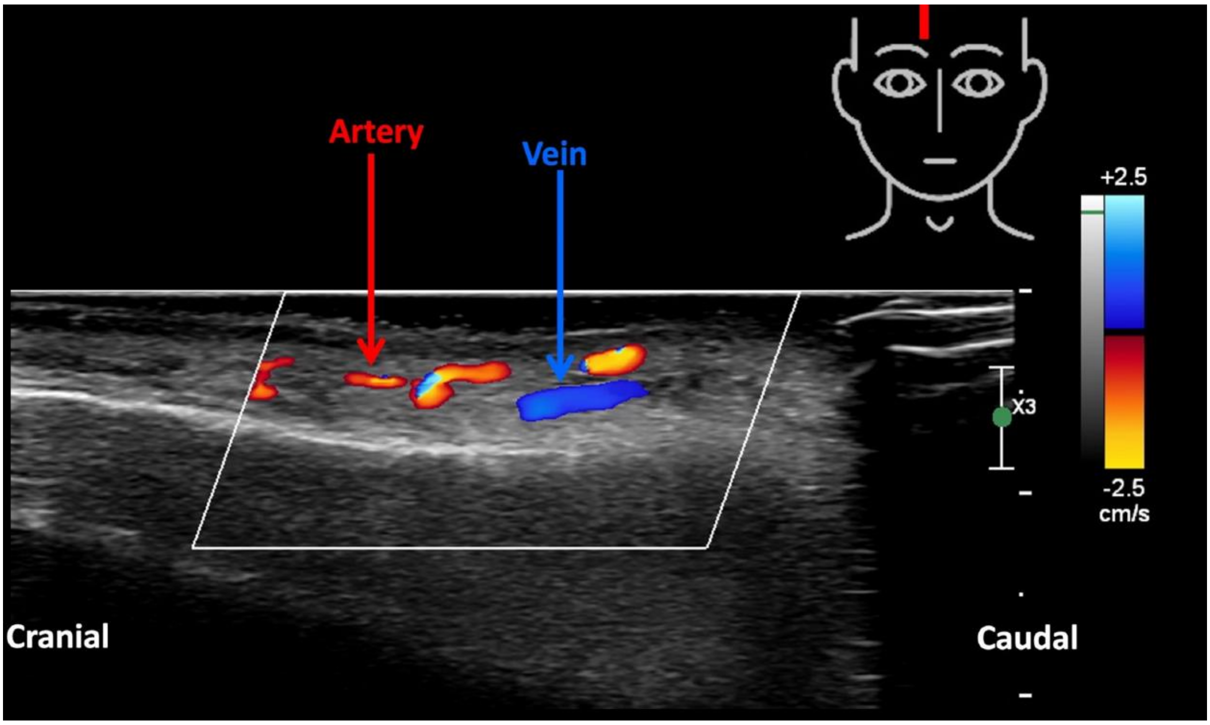

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Figure 6

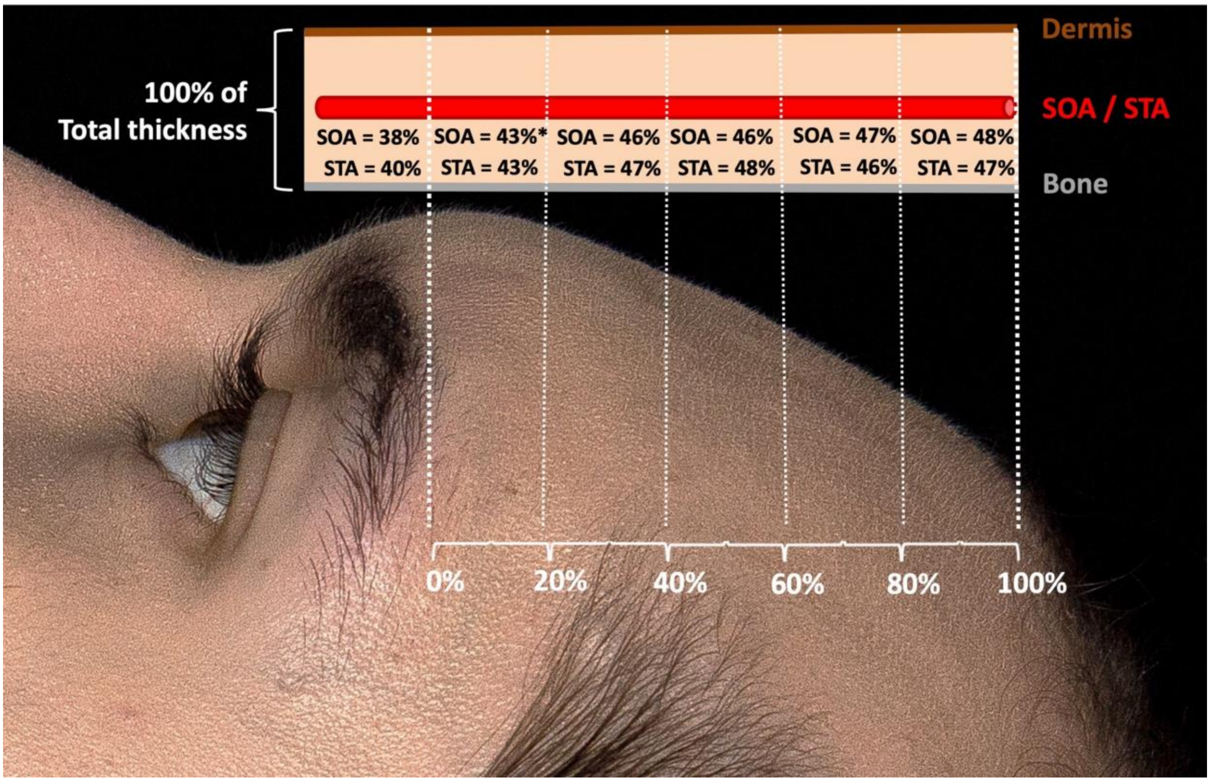

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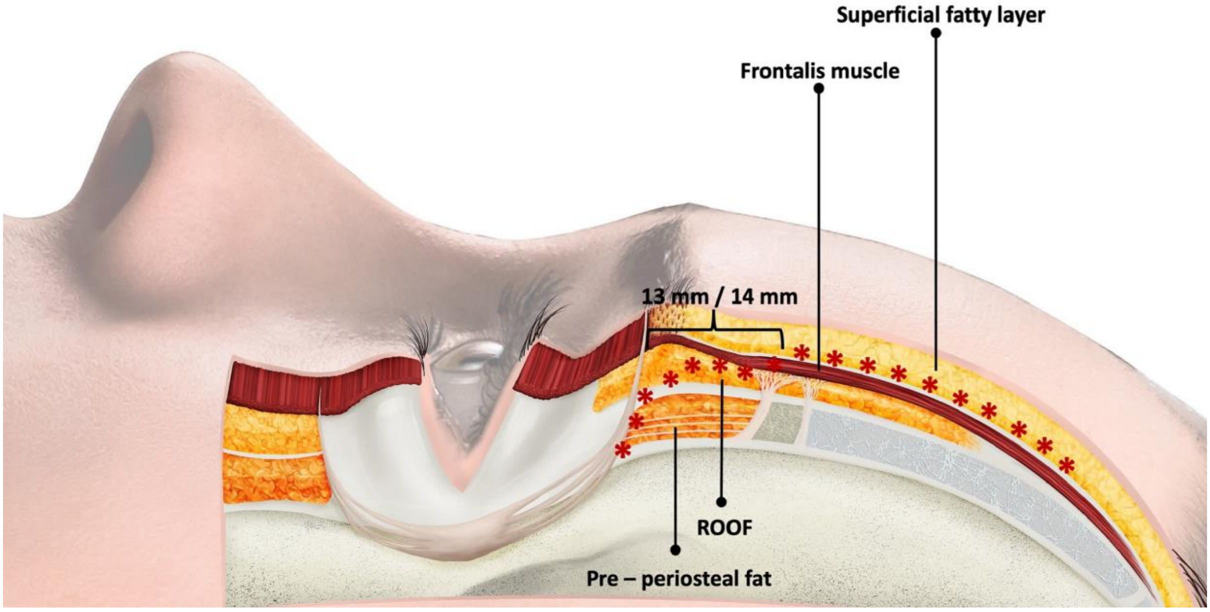
Figure 7



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