The study of nerves and arteries of upper face: implication for cosmetic procedures.

Miss Dawinee Chinnawong

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การศึกษาเส้นประสาทและหลอดเลือดบริเวณใบหน้าส่วนบนสำหรับหัตถการเสริมความงามของใบหน้าส่วนบน

น.ส.ดาวินี ชิณวงศ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต
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ดาวินี ชิณวงศ์ : การศึกษาเส้นประสาทและหลอดเลือดบริเวณใบหน้าส่วนบนสำหรับหัตถการเสริมความงามของใบหน้าส่วนบน. (The study of nerves and arteries of upper face: implication for cosmetic procedures.) อ.ที่ปรึกษาหลัก : ศ. นพ. ธันวา ตันสถิตย์

การศึกษาเส้นประสาทและหลอดเลือดบริเวณใบหน้าส่วนบนเพื่อหลีกเลี่ยงการบาดเจ็บระหว่างการทำหัตถการดึงกระชับใบหน้าส่วนบน เพื่อศึกษาตำแหน่งอ้างอิงทางกายวิภาคศาสตร์และระนาบของเส้นประสาทและหลอดเลือดบริเวณใบหน้าส่วนบนสำหรับการทำหัตถการดึงกระชับใบหน้าส่วนบนเพื่อหลีกเลี่ยงการบาดเจ็บของเส้นประสาทและหลอดเลือดบริเวณใบหน้าส่วนบน การศึกษาครั้งนี้ทำการศึกษาตำแหน่งและลักษณะทางกายวิภาคศาสตร์ที่สัมพันธ์กับตำแหน่งอ้างอิงบนผิวหนังรวมทั้งความลึกจากระดับผิวหนัง โดยทำการศึกษาในใบหน้าส่วนบนของอาจารย์ใหญ่จำนวน 30 หน้า พบว่า ตำแหน่งของแขนง frontal ของเส้นประสาท facial เมื่อเทียบกับจุดกึ่งกลางของ zygomatic arch หางตาและหางคิ้ว มีค่าเท่ากับ 10.52±2.41, 39.82±7.09 และ 24.10±8.92 มิลลิเมตร ตามลำดับ ส่วนระยะทางระหว่างหลอดเลือด superficial temporal กับจุดกึ่งกลางของ zygomatic arch หางตาและหางคิ้ว มีค่าเท่ากับ 61.72±14.09, 65.79±5.99 และ 60.45±3.64 มิลลิเมตร ตามลำดับ สำหรับเส้นประสาทและหลอดเลือด supratrochlear และ supraorbital นั้น ทำการศึกษาระยะทางระหว่างจุดที่เส้นประสาทและหลอดเลือดแทงทะลุผ่านกล้ามเนื้อ frontalis พบว่า จุดที่เส้นประสาทและหลอดเลือด supratrochlear แทงทะลุผ่านกล้ามเนื้อเมื่อวัดจากเส้นกึ่งกลางใบหน้าและขอบตาบน มีค่าเท่ากับ 20.20±5.04, 22.93±5.28, 13.64±2.2 และ 18.24±6.55 มิลลิเมตร ตามลำดับ สำหรับเส้นประสาทและหลอดเลือด supraorbital จุดที่เส้นประสาทและหลอดเลือด supraorbital แทงทะลุผ่านกล้ามเนื้อเมื่อวัดจากเส้นกึ่งกลางใบหน้าและขอบตาบน มีค่าเท่ากับ 38.22±8.92, 27.07±7.35, 37.55±9.76 และ 26.14±8.78 มิลลิเมตร ตามลำดับ โดยข้อมูลในการศึกษาครั้งนี้น่าจะมีประโยชน์ในการลดโอกาสการเกิดการบาดเจ็บต่อเส้นประสาทและหลอดเลือดในระหว่างการทำหัตถการดึงกระชับใบหน้าส่วนบน

สาขาวิชา วิทยาศาสตร์การแพทย์ ลายมือชื่อนิสิต .....

ปีการศึกษา 2561 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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KEYWORD: Forehead lift Frontal branch of facial nerve Supratrochlear nerve and artery

Dawinee Chinnawong : The study of nerves and arteries of upper face: implication for cosmetic procedures.. Advisor: Prof. TANVAA TANSATIT, M.D.

The study of nerves and arteries of upper face for avoiding injury during the forehead lift procedure was conducted to investigate the anatomical landmark and histological plane of the nerve and artery of the upper face for reduce some injuries during a consequence of forehead lift procedure. Thirty adult soft embalmed cadaveric head were dissected. The distances between the frontal branches of the facial nerve and the mid-point of zygomatic arch, lateral canthus and lateral brow were 10.52±2.41, 39.82±7.09 and 24.10±8.92 mm, respectively. The distances between the superficial temporal artery the mid-point of zygomatic arch, lateral canthus and lateral brow were 61.72±14.09, 65.79±5.99 and 60.45±3.64 mm, respectively. For the supratrochlear and supraorbital nerve and artery, measured the distance from the nerves and arteries pierced through the frontalis muscle. The distances between the point that supratrochlear nerve and artery pierced through the muscle and the midline and orbital rim were 20.20±5.04, 22.93±5.28, 13.64±2.2 and 18.24±6.55 mm, respectively. The point that supraorbital nerve and artery pierced through the muscle locate from the midline and the orbital rim about 38.22±8.92, 27.07±7.35, 37.55±9.76 and 26.14±8.78 mm, respectively. Precise information of this study can help to reduce for reduce some injuries during the consequence of forehead lift procedure.

Field of Study: Medical Sciences Student's Signature .....

Academic Year: 2018 Advisor's Signature .....

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Dawinee Chinnawong

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Chapter I

Background and rationales

Background and rationales

Facial aging is inevitable and caused by both intrinsic (endocrinological status) and extrinsic factors as follows solar exposure, alcohol use, cigarette smoking and medications. The effects of aging consist of wrinkles, age spots, volume loss, sagging of skin and soft tissue, and blemishes. Facial wrinkles can be classified into superficial wrinkles, mimetic wrinkles and folds[(1)]. The facial area that depicts the first sign of wrinkles is the upper third area of the face. Some of the wrinkles that can be seen on the upper third area of the face are vertical and horizontal glabellar skin lines, transverse dorsal nasal skin lines, transverse forehead skin lines, and the lateral canthal lines or “crow’s feet”.

At present, the human life span is longer than ever because of the development of medicine, including, the growth of cosmetic dermatology. There are several cosmetic procedures to treat facial wrinkles, the treatment differs depending on the degree of the wrinkle. To treat the superficial wrinkles chemical peeling or laser is effective, whereas, dermal filler and botulinum toxin injections are effective for mimetic wrinkles and for folds, the most effectiveness procedure is facelift. Nowadays, facelift is widely being performed on the aging population who wish to have a youthful appearance. However, there are various complications that arise, which are inevitable, on account of these procedures. Complications most often

occur in the cranial nerve, especially the frontal branch of the facial nerve, supratrochlear and supraorbital nerve. The damage of these structures leads to the impairment of the sensory or motor nerve and the surrounding mimetic muscles. The former causes loss of sensation in the forehead region and the latter, loss of muscle function in frontalis, corrugator supercilii, and some parts of the orbicularis oculi muscle. Previous studies by Benoit et al. reported complications that occurred form performing a forehead lift procedure, such as, persistent dysesthesias, frontal branch weakness, forehead irregularity and alopecia[2].

It is important for a surgeon to understand in-depth the anatomical structures underneath the skin of the upper face because during the facelift procedures some instruments may damage the nerves that in turn can cause loss of muscle functions and decrease the quality of life. Many authors have examined the plane in which these nerves and arteries run by way of dissection in cadaver, but, they have not examined it minutely by a histological slide. The anatomical studies have failed to describe the actual plane of the nerves and arteries by dissection. It is interesting to see that the histological study can explain the actual plane of the nerves and arteries. Therefore, accurate and in-depth knowledge of the anatomical structure beneath the skin of upper face, especially, the soft tissue and bony landmark related to the plane where the nerve and artery run may help to reduce some injuries while performing a forehead lift procedure.

Research Question

Primary research question

- How deep is the depth from the skin to the nerves and arteries of upper face?

Secondary research question

- How long is the distance between the nerves and arteries of upper face and the surface anatomical landmarks?

- How long is the diameter of the nerves and arteries of upper face?

- Where are the area that the nerves and arteries of upper face change the plane?

Objective

1. To study the depth from the skin to the frontal branch of facial nerve and the superficial temporal artery at the level of lateral canthus, lateral brow and lateral border of frontalis muscle.

2. To study the depth from the skin to the supratrochlear nerve and artery and the supraorbital nerve and artery at the point that of nerve and artery pierce through the frontalis muscle.

3. To study the distance between the frontal branch of facial nerve and the lateral canthus, lateral brow and superior border of the brow at the lateral border of frontalis muscle.

4. To study the distance between the superficial temporal artery and the lateral canthus, lateral brow and superior border of the brow at the lateral border of frontalis muscle.

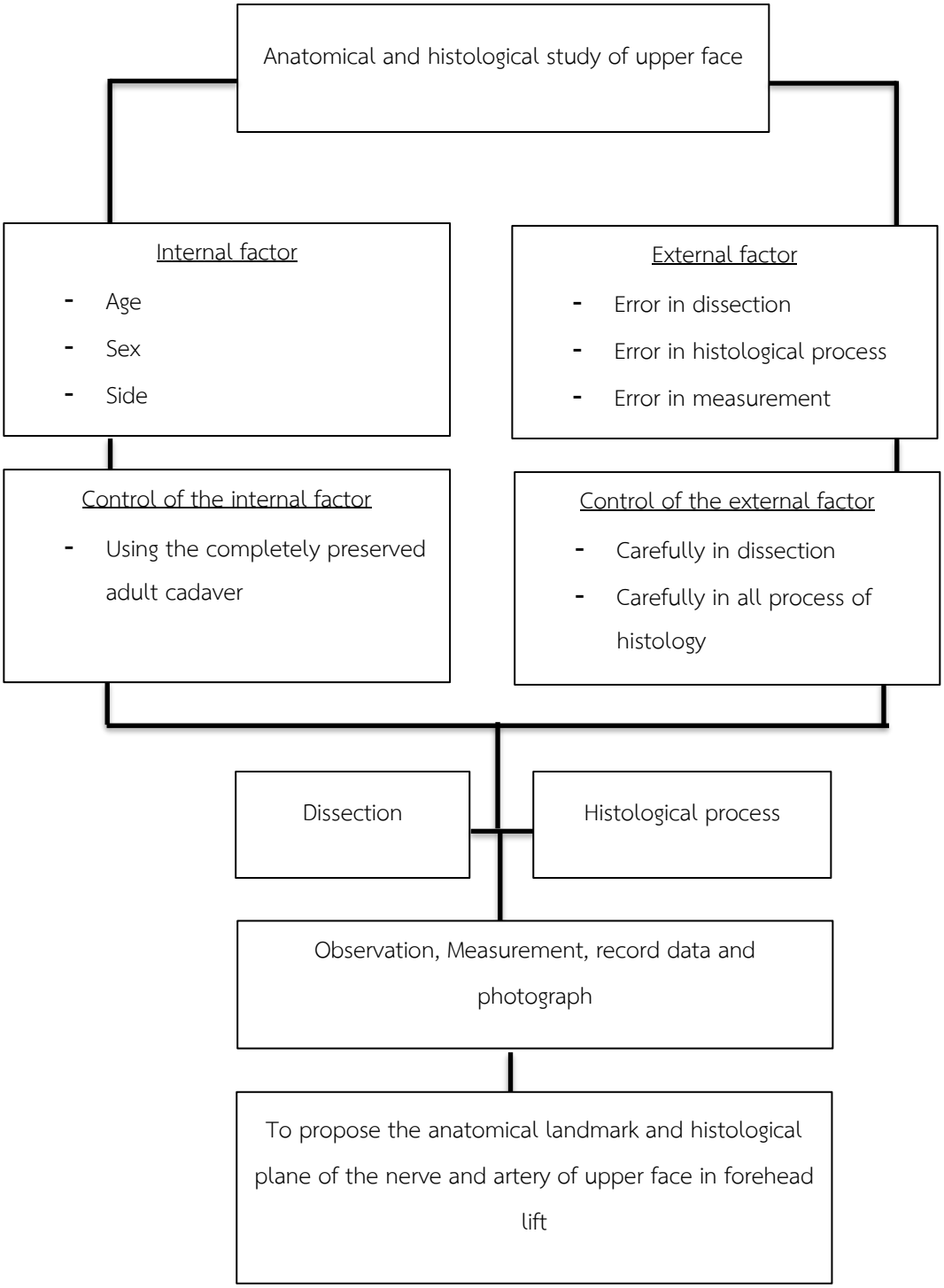
5. To study the distance from the midline and orbital rim to the point that the supratrochlear nerve and artery pierce through the frontalis muscle.

6. To study the distance from the midline and orbital rim to the point that the supraorbital nerve and artery pierce through the frontalis muscle.

7. To study the diameter of the nerves and arteries of upper face.

8. To identify the area that nerves and arteries of upper face change that plane.

Conceptual Framework



Key Words

Forehead lift, Frontal branch of facial nerve, Supratrochlear and supraorbital nerve

Research Design

Descriptive research

Expect Benefits and Applications

This study presents the depth, the plane, and the distance of the supratrochlear nerve and artery, supraorbital nerve and artery, frontal branch of facial nerve and superficial temporal artery (frontal branch) with the anatomical landmark such as the lateral canthus, lateral brow, and lateral border of the frontalis muscle, orbital rim, and midline of the face. These anatomical data can be functionally put to use while performing a forehead lift procedure, thereby, decreasing complications that can or may occur during such a procedure.

Chapter II

Review of the related literatures

Aging Skin

Nowadays, people place importance on maintaining a youthful appearance. Aging face is a process with multifactor: anatomic, bio-chemical, and genetics. Many endogenous and exogenous factors such as body mass index, endocrinological status, solar exposure, use of alcohol, smoking and strong medications have been related as factors that accelerated the aging process of the face[3]. Facial aging is a very complex process that involves three importance factors: facial volume loss (Fig 2.1)[4], repetitive movement of the facial expression muscle and the laxity which is induced by the force of gravity [5].

Figure 2. 1 The anatomy of aging face (Mendelson and Wong (2013)) (4)

Anatomy of upper face

The upper face is an area which is about one third of the surface area of the whole face. The boundaries of the upper face are superiorly by the frontal hairline, inferiorly by the nasal root and laterally by the temporal above the lateral canthal ligament [(6)]. The muscles in this region are consist of brow elevators and depressors. The frontalis muscle is the main muscle of the brow elevator. The brow depressors consist of the corrugator supercilii, procerus, depressor supercilii, and orbicularis oculi muscle (Fig 2.2)[(7)]. The corrugator supercilii muscle produces the vertical glabella lines, whilst the procerus muscle produces the horizontal glabella lines. The medial part of the orbicularis oculi provides some of the glabellar lines while the lateral part produces the crow's feet [(8)]. The forehead region contains many neurovascular systems that supplie the skin and soft tissue to this region. The frontal branch of the facial nerve is a motor nerve that innervate the frontalis, corrugator supercilii, and orbicularis oculi muscle. The supratrochlear and supraorbital nerves, are the terminal branches of the trigeminal nerve, receive the sensation from the soft tissue and skin of the forehead and glabellar region. The superficial temporal artery, especially the frontal branch, the supratrochlear artery and supraorbital artery are the main blood vessels which supply the blood to the skin, soft tissue, and bone at the forehead region.

Figure 2. 2 The anatomy of upper face (Prendergast (2012)) (7)

Forehead Lift

Forehead lift is used to restore a more youthful appearance to an aging population. The techniques of forehead lift consist of the direct brow, coronal, midforehead, and endoscopic technique. These techniques are chosen based on the patient's characteristics. The direct brow technique is suited for men who have thick and bushy eyebrows and people who have brow asymmetries and paralysis. The advantage of the direct technique is a long-sustaining lift from the orbicularis oculi suspension whilst the disadvantage is the conspicuous scar on the face. The coronal technique is appropriate to patients who have a normal hairline. The advantage of this technique is that it enters every area of the aging forehead. The disadvantages of coronal technique are the hairline elevation and hypoesthesia or paresthesia in the area that is posterior to the incision line. The mid-forehead technique is used in men

who have a prominent deep forehead rhytids. This technique has a lower risk of artery and nerve injury and it can be done by carving the entire brow length. The endoscopic technique is used to correct of the brow ptosis and reduce of the forehead rhytids. The patients who are suited for the endoscopic technique should have thin skin, prominent glabellar rhytids, minimal brow ptosis and skin redundancy. The advantages of this technique are smaller incisions, declined sensory neuropathy and scaring, low risk of alopecia and bleeding, and a short recovery period. The endoscopic technique are unsuitable for women with high hairline, men with pattern of baldness, and the patients with thick and tight skin or expanded bony attachments [9].

Forehead lifting may result in several complications if the surgeon does not have enough understanding about the anatomical landmark of the structure beneath the skin of the forehead region. Potential complications of forehead lifting include hematoma or bleeding, sensory or motor nerve injury that cause the numbness or muscle weakness of forehead, alopecia, and scarring [2, 10, 11].

Frontal branch of the Facial Nerve

The frontal branch of the facial nerve crosses over the zygomatic arch into the temporoparietal fascia. After that, entered the frontalis muscle (Fig 2.3). The frontal branch of the facial nerve can get injured in procedures or while operating such as the rhytidectomy, the superficial parotidectomy, or surgical procedure of the

temporomandibular joint and zygomatic arch. Also, anatomical knowledge is required with regard to the plane, how it runs, and its course in order to reduce or prevent the paralysis after the operation of the forehead and the upper eyelid muscle [(12)].

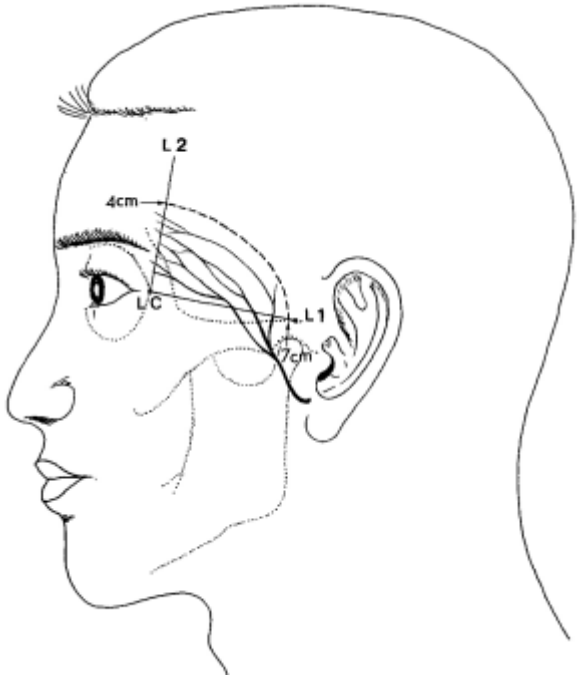


Figure 2. 3 The course of the frontal branch of the facial nerve (12)

In 2005, Tao Lei et al. examined the course of the frontal branch of facial nerve. They found that the frontal branch of facial nerve has two to four rami. The distance at the point where the frontal branch emerges from the parotid gland to the external acoustic meatus and the lateral border of the orbicularis oculi muscle were 2.2 ± 0.5 and 4.0 ± 0.6 cm, respectively (Fig 2.4)[(13)].

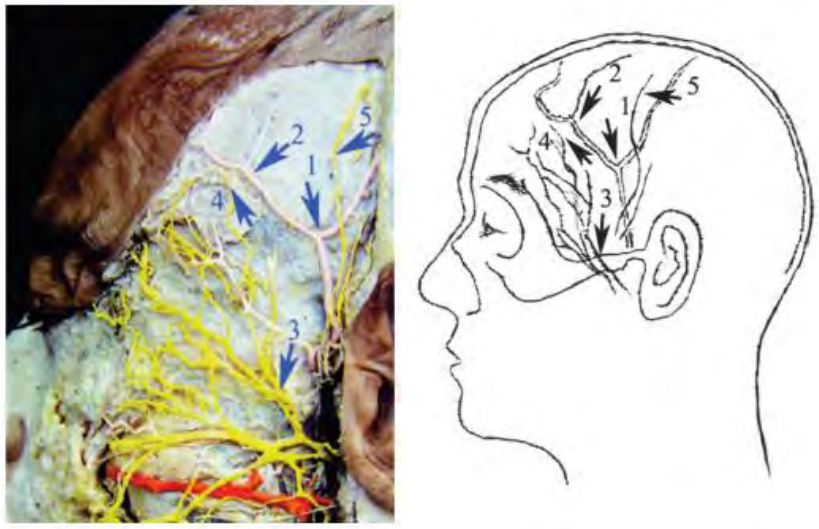


Figure 2. 4 The fontal branch of the facial nerve and its terminal branches, 3: frontal branch of the facial nerve, 4: the frontall branch (terminal branch) ((Lei et al. (2005))*(13)*

In 2010, Babakurban et al. reported that the frontal branch of facial nerve traverse inside the temporoparietal fascia over the zygomatic arch with two branches. They measured the distance from the frontal branch of facial nerve to the zygomatic arch and found the distance between the frontal branch of facial nerve and zygomatic arch was approximately 3 mm [(14)].

In 2015, Bonnecaze et al. represented that the frontal branch where the facial nerve crossed the superior and inferior border of the zygomatic arch were 28.25 and 24.25 mm anterior to the line between the anterior border the helix and the tragus, respectively. The distance between a line tangent to the lateral border of the orbit

and the frontal branch of facial nerve was 19.8 mm [15]. In the same year, Yang, Gil and Lee investigated the anatomical topography of the trigeminal and facial nerves related to the corrugator supercilii muscle. They found that the facial nerve crossed over the superior margin of the zygomatic arch with 1-5 branches. The vertical distance between the lateral canthus and the facial nerve branch was 24.3 ± 2.9 mm. At the lateral aspect of the orbital rim, the vertical distance from the level of lateral canthus to the facial nerve branch was 22.3 ± 3.4 mm. The vertical distance from the superolateral angle of the orbital rim and the midpoint of the superior orbital rim to the facial nerve branch were 11.4 ± 4.5 and 8.4 ± 4.7 mm, respectively. Moreover, they reported the number of the supratrochlear and supraorbital nerve branches by using the modified Sihler's staining. The supratrochlear and supraorbital nerve gave off 5.1 and 7.7 branches emerging from the orbit [16].

Superficial Temporal Artery

The superficial temporal artery is the terminal branches of the external carotid artery. The superficial temporal artery gives off the transverse facial artery to supplies the parotid gland. The superficial temporal artery crosses over the zygomatic arch and gives off the middle temporal artery to supply the temporalis muscle. After that, the superficial temporal artery splits into 2 branches: the frontal branch and parietal branch that are in level of the superior orbital rim. The frontal branch runs from the superficial temporal fascia cranially to the lateral side of the

frontalis muscle. It runs toward the midline above the eyebrow. The frontal branch of the superficial temporal artery supplies the skin of the forehead, the frontalis muscle, and the frontal bone (Fig 2.5)[13].

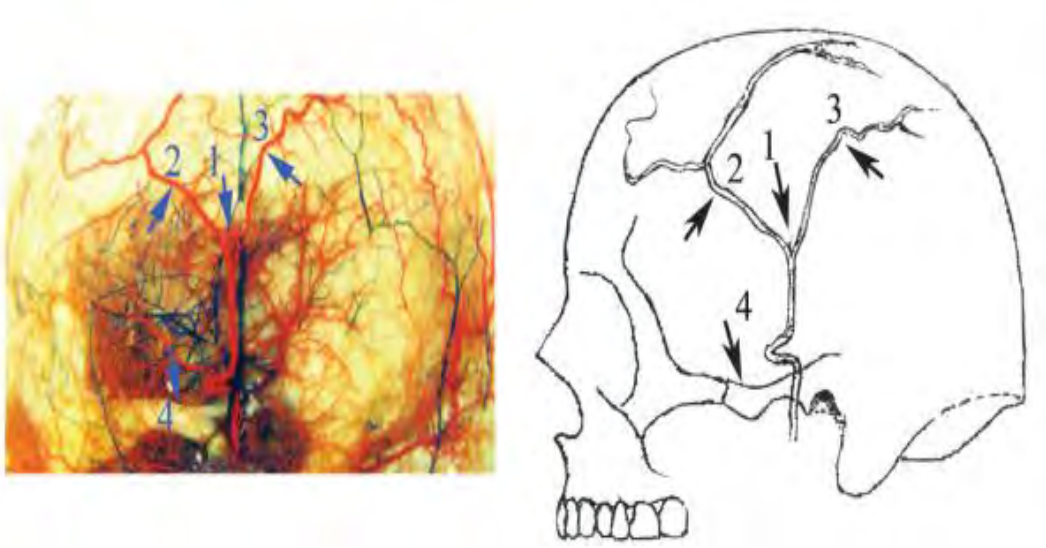


Figure 2. 5 The branch pattern of the superficial temporal artery, 1: the superficial temporal artery, 2: anterior frontal branch, 3: posterior parietal branch (Lei et al. (2005))(13)

In 2006, Pinar and Govsa reported that the diameter of the superficial temporal artery was 2.73 ± 0.51 mm at the zygomatic arch and the diameter of the frontal branch of the superficial temporal artery was 2.14 ± 0.54 mm. At the line between the lateral canthus and the tragus, the distance between the superficial temporal artery and tragus was 16.86 ± 0.35 mm. Moreover, the distance from the superior attachment of the ear to the head and the superficial temporal artery was

20.01 ± 0.54 mm from the line that links the lateral canthus and the superior attachment of the ear to the head [17].

Supratrochlear Nerve and Artery

The supratrochlear nerve travels along the medial part of roof of the orbit which between the trochlear and the supraorbital foramen and exits through the frontal notch into the deep tissues of the forehead. The supratrochlear nerve is sensory nerve that supplies the skin and soft tissue of the lower medial portion of the forehead, glabella, upper eyelid, and conjunctiva (Fig 2.6A).

In 2013, Jeffrey E. Janis et al. divided the relationship pattern between the supratrochlear nerve and the corrugator muscle into 3 types. Type I, in which two branches of nerves enter the muscle (84%). Type II, in which one of the nerve branches going more superficial to enter the muscle and another one stays in the muscle (4%). Type III, in which both branches stay deep in the muscle (12%). The distance between the midline to the point that the nerve enters into the corrugator muscle was approximately 1.9 cm. Moreover, the nerves become superficial plane at about 1.5 cm cranial to the muscle [18].

In 2015, Hyung Jin Lee et al. determined the relationship between corrugator supercilii muscle and supratrochlear nerve at the forehead. They classified the emergence pattern of the supratrochlear nerve into 2 types. Type I, in which the supratrochlear nerve and supraorbital nerve exited separately from the orbit at the medial one-third portion. Type II, in which the supratrochlear nerve emerged from

the orbit at the same location as the supraorbital nerve (Fig 2.6B). The supratrochlear nerve entered the corrugator supercilii muscle at 16.4±4.0 mm from the midline and 2.3±3.9 mm superior to the supraorbital margin. At the level of the supraorbital margin, the distance between the supratrochlear and supraorbital nerve was 7.5±2.3 mm [19].

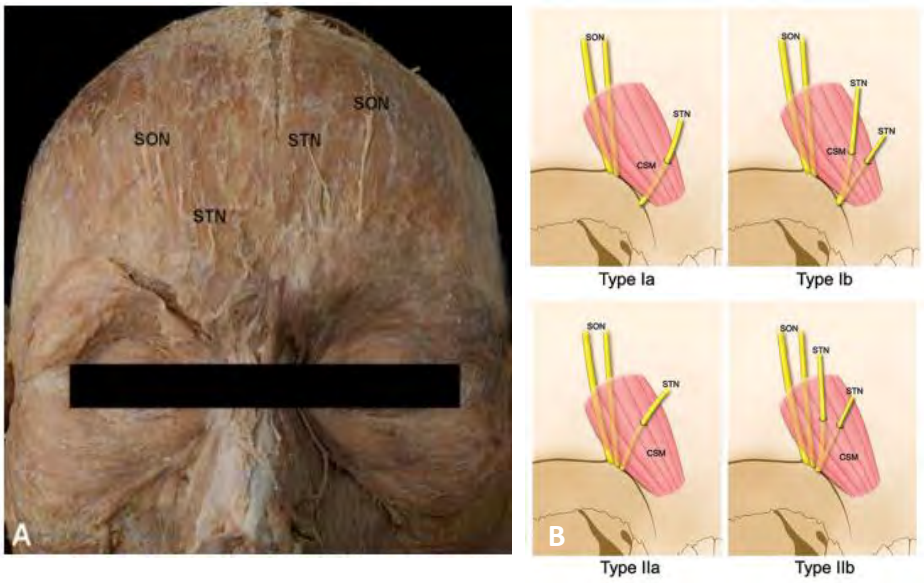


Figure 2. 6 The anatomy of the supratrochlear nerve, A: the cadaveric dissection of the supratrochlear nerve, B: the four patterns of the supratrochlear nerve(STN) within the corrugator supercilii muscle (CSM) (Lee et al.(2015))(19)

Supraorbital Nerve and Artery

The supraorbital nerve branches from the cranial nerve V (ophthalmic division). It emerges from the orbital rim at the foramen or notch. The supraorbital nerve is the sensory nerve that supplies the forehead and scalp [20, 21]. Supraorbital

nerve may injured injury is a complication from the endoscopic forehead lifting and the surgeons should be well-informed about the anatomy of this nerve [22].

In 2005, Angelo and Jon examined the medial margin of the iris as a landmark for the supraorbital nerve at the supraorbital rim. They found that the supraorbital nerve was located at 0.56 ± 0.7 mm to the left and right from the medial limbus. Moreover, they measured the distance between the supraorbital nerve and supratrochlear nerve and found it was about 9.0 mm at the supraorbital rim. They concluded that the medial limbus can be used as a simple and reliability landmark for determining the course of the supraorbital nerve [21].

In 2007, Erdogmus and Govsa investigated the neurovascular bed of the supraorbital region. They found that the supraorbital artery entered the frontalis muscle between 20-30 mm (52.6%) above the supraorbital rim and located approximately in the subcutaneous tissues between 50-60 mm (47.4%) above the supraorbital rim. The mean diameter of the supraorbital artery was 0.84 ± 0.3 mm on the right and 0.87 ± 0.2 mm on the left (Fig 2.7)[23].

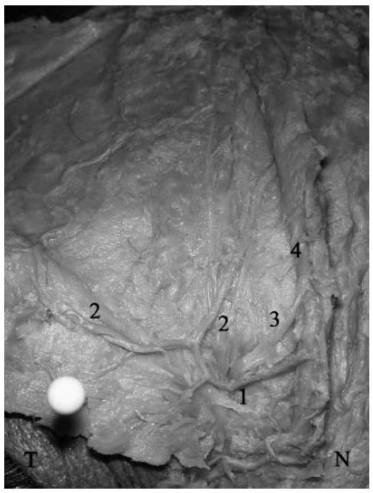


Figure 2. 7 The supraorbital artery and nerve, 1: the supraorbital artery, 2: the superficial branch of supraorbital artery, 3: the supraorbital nerve, 4: the frontalis muscle (Ergogmus and Govsa(2007))[23]

Chapter III

Materials and Methods

Target Populations and Sample Populations

This study is performed on the hemi-face of soft embalm adult cadavers in the Chula Soft Cadaver Surgical Training Center of King Chulalongkorn Memorial Hospital.

Inclusion Criteria

- The cadavers are completely preserved and have no trauma or any surgery on the face.

Exclusion Criteria

- The age of cadavers is less than 30 or over 90 years old.

Sample Size Determination

From pilot study on 5 histological slides, found that the standard deviation of the depth from the skin to the supratrochlear nerve at the point that nerve pierce through the muscle is 1.38 mm which calculated the sample size as follows

<u>95% confidence interval</u>

$$n = Z^2_{\alpha/2}\,\sigma^2 / d^2$$

When $Z_{\alpha/2} = Z_{0.05/2} = 1.96$ (two tail)

σ^2 =Variance= $(1.38)^2$

d = Acceptable error = 0.50 mm

So, $$n = Z^2_{\alpha/2}\,\sigma^2 / d^2$$

$$n = (1.96)^2(1.38)^2 / (0.5)^2$$

$$n = 29.26$$

Therefore, the supratrochlear nerve is studied from the minimum target population is 29.26 ≈ 30 hemi-faces which in this study use the 30 hemi- faces from 15 fixed embalmed cadavers for reliability.

From pilot study on 5 hemi-faces, found that the standard deviation of the distance from the midline to the supratrochlear nerve at the point that nerve pierce through the muscle is 1.21 mm which calculated the sample size as follows

95% confidence interval

$$n = Z^2_{\alpha/2}\,\sigma^2 / d^2$$

When $Z_{\alpha/2} = Z_{0.05/2} = 1.96$ (two tail)

σ^2 =Variance= $(1.21)^2$

d = Acceptable error = 0.50 mm

So, $$n = Z^2_{\alpha/2}\,\sigma^2 / d^2$$

$$n = (1.96)^2(1.21)^2 / (0.5)^2$$

$$n = 22.49$$

Therefore, the supratrochlear nerve is studied from the minimum target population is 22.49 ≈ 23 hemi-faces which in this study use the 30 hemi- faces from 15 soft embalmed cadavers for reliability.

Materials

1. Instruments for operation such as scalpel, scissors, forceps and probe

2. Ruler and Vernier caliper

3. Pins

4. Markers

5. Digital camera

Methods

Dissection

Firstly, 30 hemi-face of soft cadavers are injected the red latex into common carotid artery before dissection. Three reference lines are determined as follow: the first is midline (ML), which divide the face into left and right equal parts. The second line is called the Frankfurt line (FFL), which originates from inferior margin of the orbit to superior margin of the acoustic meatus. The last line is intercanthal line (ICL) that is settled perpendicular with the Frankfurt line at the lateral canthus (Fig 3.1). The cadavers are dissected only skin layer, except the brow region, that skin incisions are made on the midline in vertical and the level of intercanthal line in horizontal. Then, the subcutaneous are removed to expose the structures that beneath the skin as follow: the frontal branch of the facial nerve, the

superficial temporal artery, the supratrochlear nerve and artery, the supraorbital nerve and artery, and the muscles. After that, the pins are used to reference the anatomical landmark such as the lateral canthus, the lateral brow, the supraorbital rim, and the upper and lower border of zygomatic arch.

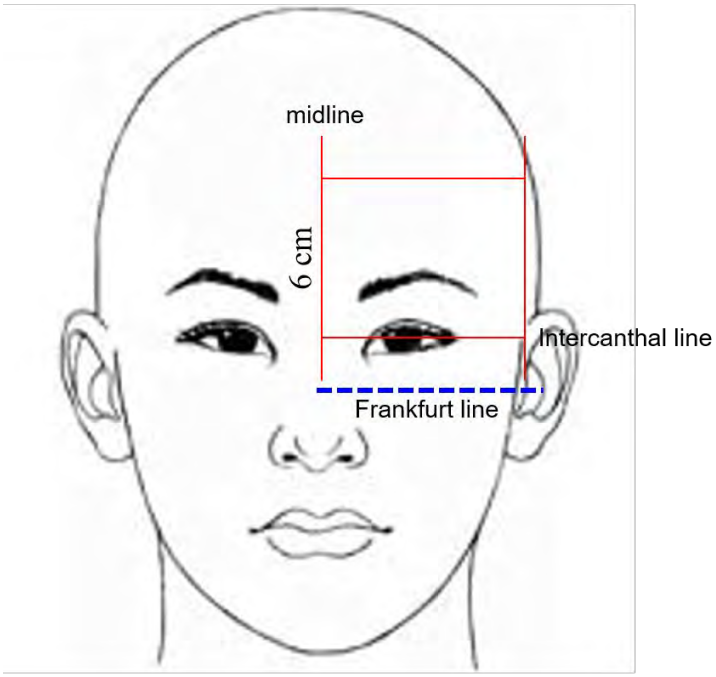


Figure 3. 1 The reference line to made incision in cadaver dissection

Histology

30 hemi-faces of embalmed cadavers are used in histological study. By starting with mark, the vertical line at the midline and the horizontal line at the level of intercanthal line, 2, 4 and 6 cm above the intercantal line (Fig 3.2). Then, the scapel is used to make the incision from the skin to bone. All structures under the skin are removed by lifting from the periosteal layer. After that, it is performed on parasagittal sections (5 mm wide) from medial to lateral side. The specimens are

fixed in 10% formalin for routine histological process and finally processed by paraffin sectioning (4 μm). The masson's trichrome with aniline blue staining is used for the light microscope study.

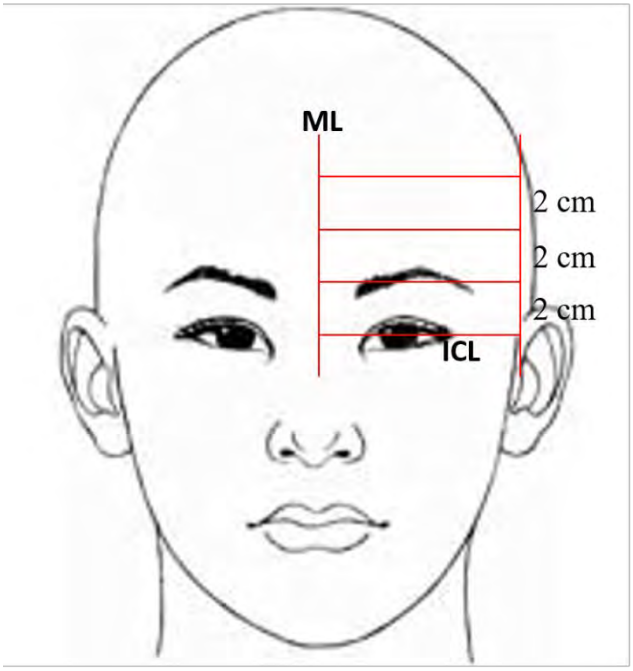


Figure 3. 2 The vertical and horizontal incision line for histological method; ML: midline and ICL: intercanthal line

Observation

To record the plane and the change plane position of the frontal branch of facial nerve, supraorbital nerve, supratrochlear nerve, superficial temporal artery, supraorbital artery and supratrochlear artery from histological slides.

Measurement

For the histological slide, the Axio Scan.Z1 is used to scan the histological slide for photograph the tissue. The ZEN slidescan package program is used to measure the depth from the skin to the nerves and arteries. First point placed at the superior border of the skin and the second one placed at the center of lumen of artery and the nerve. The measurement is performed 3 times for average.

The acronyms are determined as follows (Fig 3.3):

a = the depth from the skin to frontal branch of facial nerve at the level of lateral canthus.

b = the depth from the skin to frontal branch of facial nerve at the level of lateral brow.

c = the depth from the skin to frontal branch of facial nerve at the lateral border of frontalis muscle.

d = the depth from the skin to superficial temporal artery at the level of lateral canthus.

e = the depth from the skin to superficial temporal artery at the level of lateral brow.

f = the depth from the skin to frontal branch of superficial temporal artery at the lateral border of frontalis muscle.

g = the depth from the skin to the supratrochlear nerve at the point that nerve pierce through the muscle.

h = the depth from the skin to the supratrochlear artery at the point that artery pierce through the muscle.

i = the depth from the skin to the supraorbital nerve at the point that nerve pierce through the muscle.

j = the depth from the skin to the supraorbital artery at the point that artery pierce through the muscle.

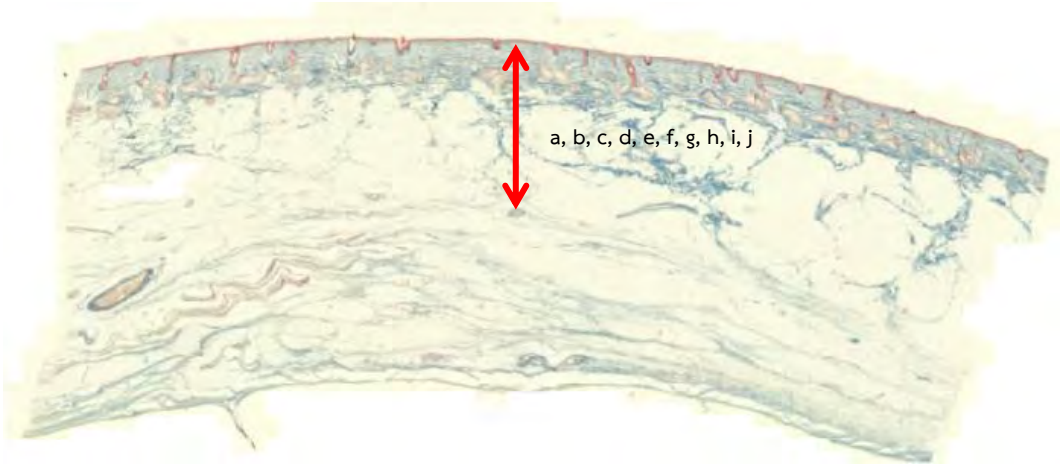


Figure 3. 3 The depth measurement from the skin to the temporal branch of facial nerve, superficial temporal artery, supratrochlear nerve and artery, and supraorbital nerve and artery from the histological slide

From the cadaveric dissection, the acronyms are determined as follows (Fig 3.4):

A = the horizontal distance from the lateral canthus to frontal branch of facial nerve.

B = the horizontal distance from the lateral canthus to superficial temporal artery.

C = the horizontal distance from the lateral brow to frontal branch of facial nerve.

D = the horizontal distance from the lateral brow to superficial temporal artery.

E = the vertical distance from the mid-point of zygomatic arch to the frontal branch of facial nerve.

F = the vertical distance from the mid-point of zygomatic arch to the frontal branch of superficial temporal artery.

G = the distance from the superior border of the brow to the frontal branch of facial nerve at the lateral border of frontalis muscle.

H = the distance from the superior border of the brow to the frontal branch of superior temporal artery at the lateral border of frontalis muscle.

I = the horizontal distance from the midline to the point that the supratrochlear nerve pierce through the muscle.

J = the horizontal distance from the midline to the point that the supratrochlear artery pierce through the muscle.

K = the horizontal distance from the midline to the point that the supraorbital nerve pierce through the muscle.

L = the horizontal distance from the midline to the point that the supraorbital artery pierce through the muscle.

M = the vertical distance from the orbital rim to the point that the supratrochlear nerve pierce through the muscle.

N = the vertical distance from the orbital rim to the point that the supratrochlear artery pierce through the muscle.

O = the vertical distance from the orbital rim to the point that the supraorbital nerve pierce through the muscle.

P = the vertical distance from the orbital rim to the point that the supraorbital artery pierce through the muscle.

Q = the diameter of the frontal branch of the facial nerve at the level of lateral canthus.

R = the diameter of the superficial temporal artery at the level of lateral canthus.

S = the diameter of the frontal branch of the facial nerve at the level of the lateral brow.

T = the diameter of the frontal branch of the superficial temporal artery at the level of the lateral brow.

U = the diameter of the frontal branch of facial nerve at the lateral border of the frontalis muscle.

V = the diameter of the frontal branch of superficial temporal artery at the lateral border of the frontalis muscle.

X = the diameter of the supratrochlear nerve at the point that nerve and artery pierce through the muscle.

Y = the diameter of the supratrochlear artery at the point that nerve and artery pierce through the muscle.

Z = the diameter of the supraorbital nerve at the point that nerve and artery pierce through the muscle.

AA = the diameter of the supraorbital artery at the point that nerve and artery pierce through the muscle.

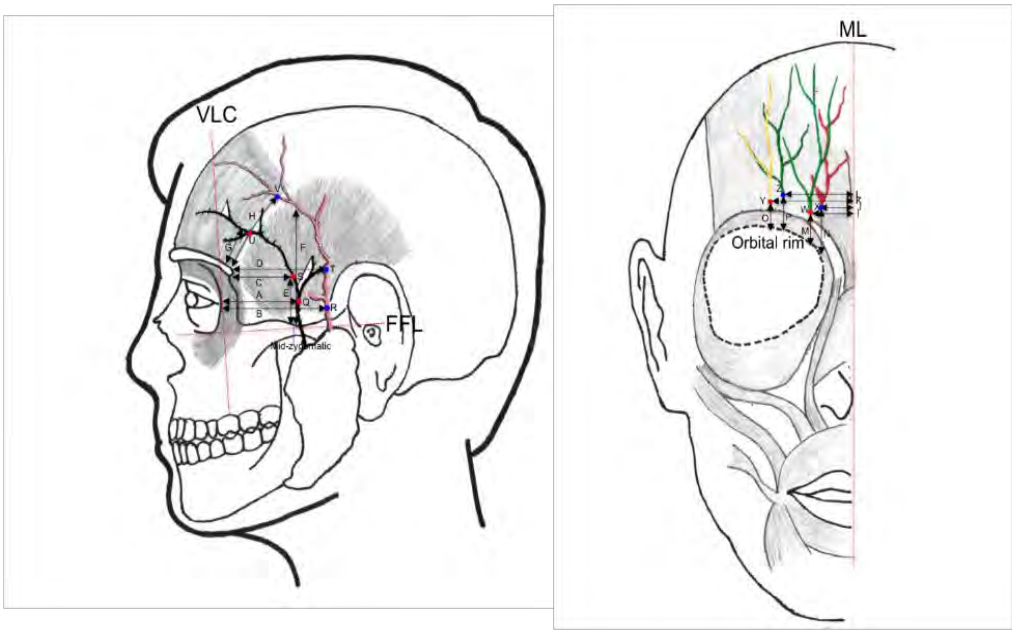


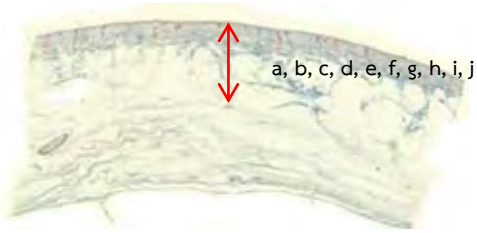
Figure 3. 4 The horizontal and vertical distance from the surface landmark to the temporal branch of facial nerve, superficial temporal artery, supratrochlear nerve and artery, and supraorbital nerve and artery

Data Collection

The collected data are recorded in the case record form (CRF)

Cadaver Code..... Sex ☐ Male ☐ Female

Side..... Age.....



Depth

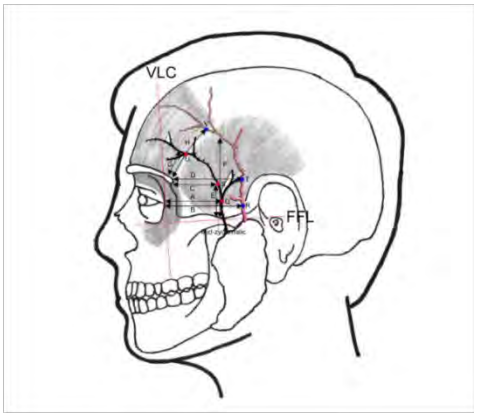
a = ...mm b = ...mm

c = ...mm d = ...mm

e = ...mm f = ...mm

g = ...mm h = ...mm

I = ...mm j = ...mm



Tempotal branch of facial nerve and superficial temporal artery

A= .....mm B= .....mm

C= .....mm D= .....mm

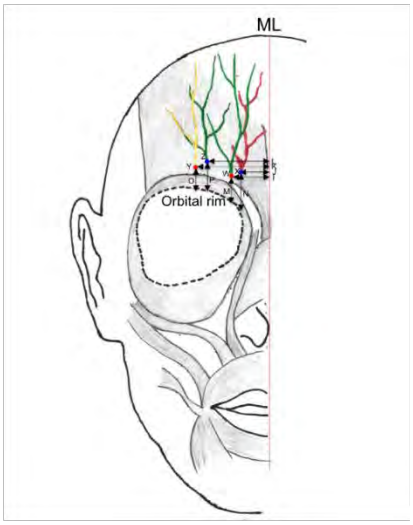
E= .....mm F= .....mm

G= .....mm H= .....mm

Supratrochlear nerve and artery

I= .....mm J= .....mm

M= .....mm N= .....mm



Supraorbital nerve and artery

K = ...mm L = ...mm

O = ...mm P = ...mm

Diameter

Q = ...mm R = ...mm

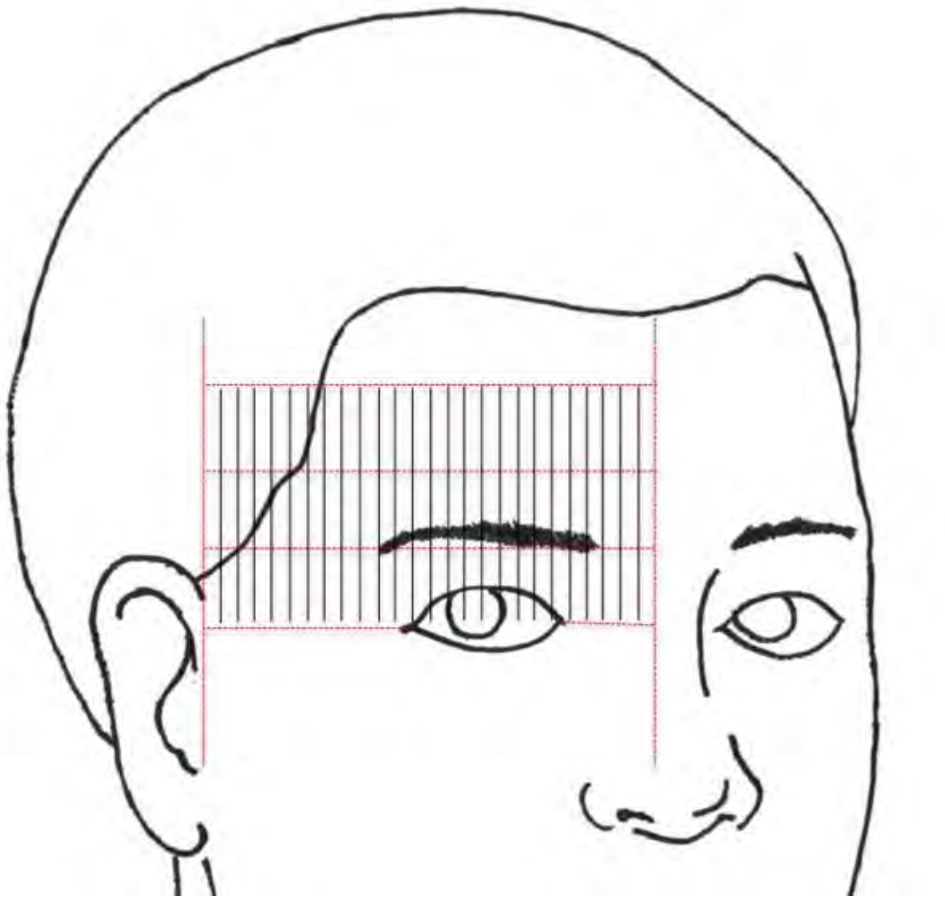
S = ...mm T = ...mm

U = ...mm V = ...mm

W = ...mm X = ...mm

Y = ...mm Z = ...mm

The change plane position



Data Analysis

The statistical analysis is performed with computer software SPSS version 22.0. The data are calculated the mean, minimum, maximum and standard deviation.

Ethical Consideration

In this study, all cadavers are donated for medical education and research. The Human Research Ethics Committee and the director of King Chulalongkorn Memorial Hospital must approve it.

Chapter IV

Results

The hemi-face of soft embalmed adult cadavers from 17 males and 13 females provided by Chula Soft Cadaver Surgical Training Center of King Chulalongkorn Memorial Hospital. All cadavers were completely preserved and had no trauma or surgery on the face. The average age of the cadavers was 78.35±9.04 years (range age 36-90). The demographic data is shown in table 4.1

Table 4. 1 The demographic data of the cadavers

Parameters	Mean ± SD (range)		
	Male	female	total
Age	79.26±9.17 (36 – 89)	78.88±10.47 (50 - 90)	78.35±9.04 (36 – 90)

4.1 The depth of the nerves and arteries of the upper face from the histological slide

The depth of the nerves and arteries of the upper face were examined from the histological slide. The mean depth from the skin to the frontal branch of the facial nerve and the superficial temporal artery at the level of lateral canthus were 7.28±2.75 and 6.59±3.91 mm (Fig 4.1). The mean depth from the skin to the frontal branch of the facial nerve and the superficial temporal artery at the level of lateral brow were 6.93±2.38 and 6.18±2.19 mm (Fig 4.2). The mean depth from the skin to the frontal branch of the facial nerve and the superficial temporal artery at the lateral border of the frontalis muscle were 4.19±3.53 and 3.91±2.96 mm (Fig 4.3). The mean depth from the skin to the supratrochlear nerve and artery at the point that nerve and artery pierce through the muscle were 3.79±2.94 and 3.45±3.05 mm (Fig 4.4). The mean depth from the skin to the supraorbital nerve and artery at the point that nerve and artery pierce through the muscle were 3.92±2.53 and 4.17±1.97 mm (Fig 4.5).

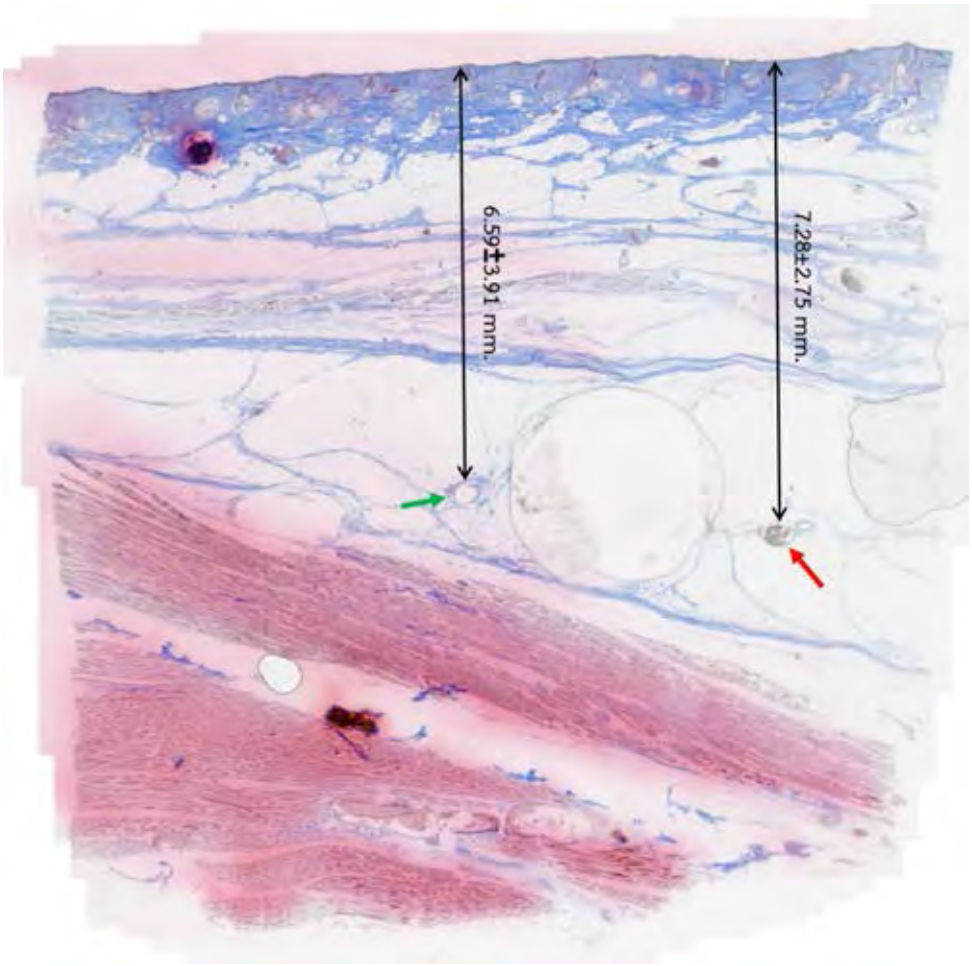


Figure 4. 1 At the level of lateral canthus, the frontal branch of the facial nerve is shown by the red arrow and the superficial temporal artery is shown by the green arrow. FM: Frontalis muscle

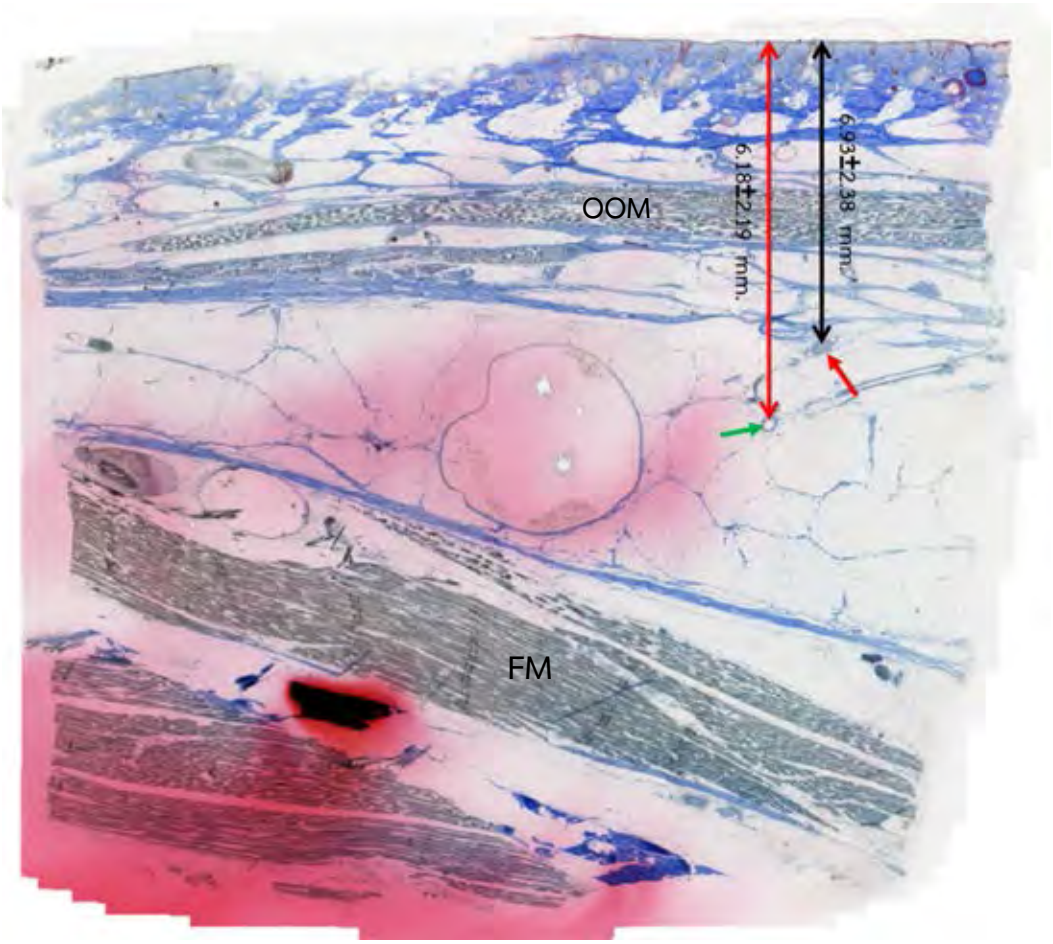


Figure 4. 2 At the level of lateral brow, the frontal branch of the facial nerve is shown by the red arrow and the superficial temporal artery is shown by the green arrow. The depth of the frontal branch of facial is shown by the black arrow and the depth of the superficial temporal artery is shown by the red arrow. FM: frontalis muscle, OOM: orbicularis oculi muscle.

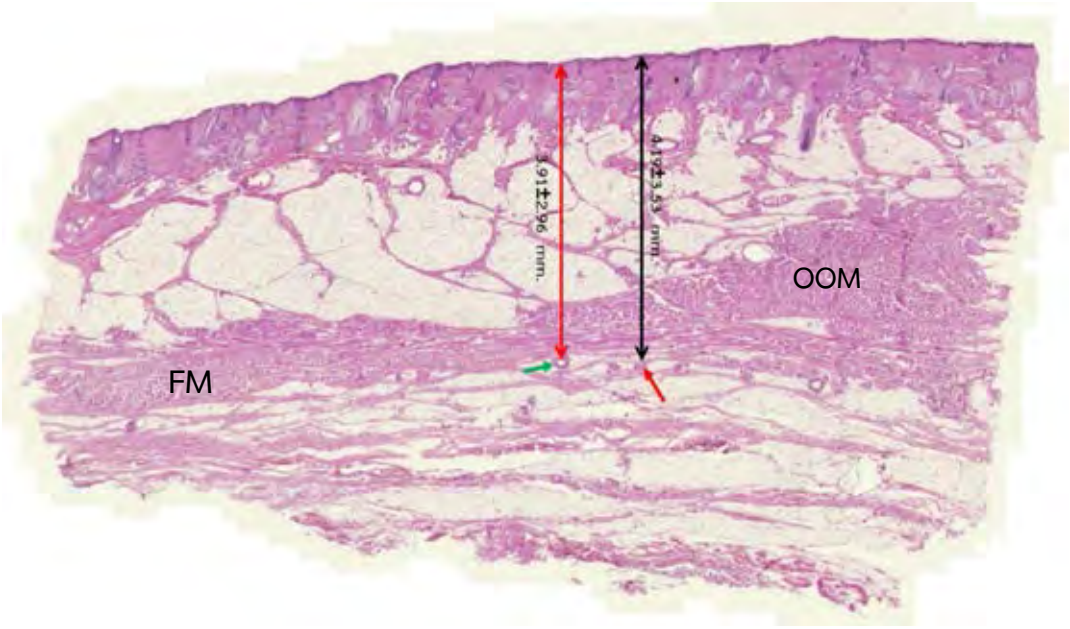


Figure 4. 3 At the lateral border of frontalis muscle, the frontal branch of the facial nerve is shown by the red arrow and the superficial temporal artery is shown by the green arrow. The depth of the frontal branch of facial is shown by the black arrow and the depth of the superficial temporal artery is shown by the red arrow. FM: frontalis muscle, OOM: orbicularis oculi muscle.

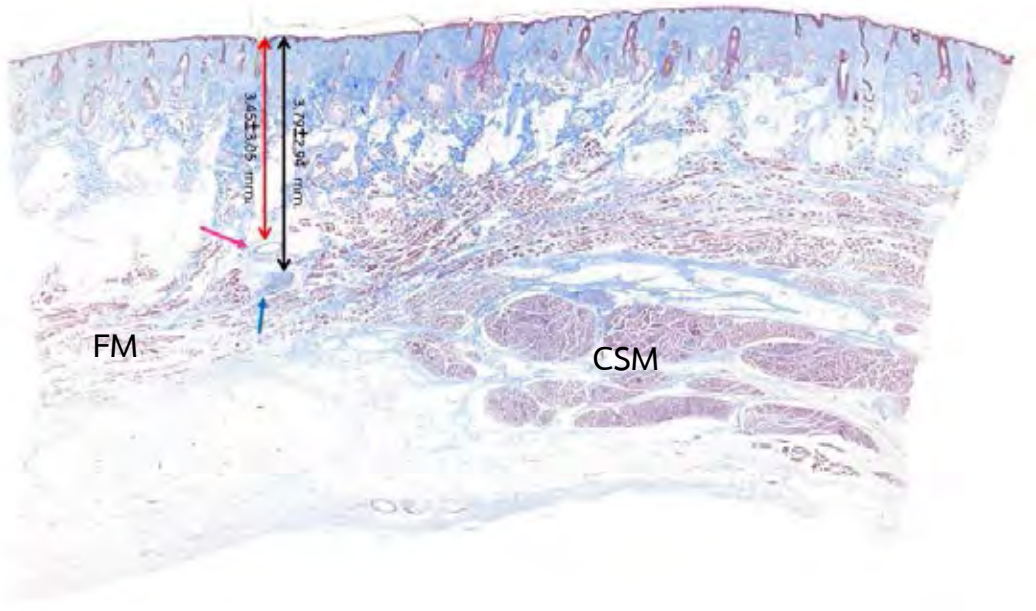


Figure 4. 4 The supratrochlear nerve is shown by the blue arrow and the supratrochlear artery is shown by the pink arrow. The depth of the supratrochlear nerve and artery is shown by the black and red arrow, respectively. FM: frontalis muscle, CSM: corrugator supercilia muscle.

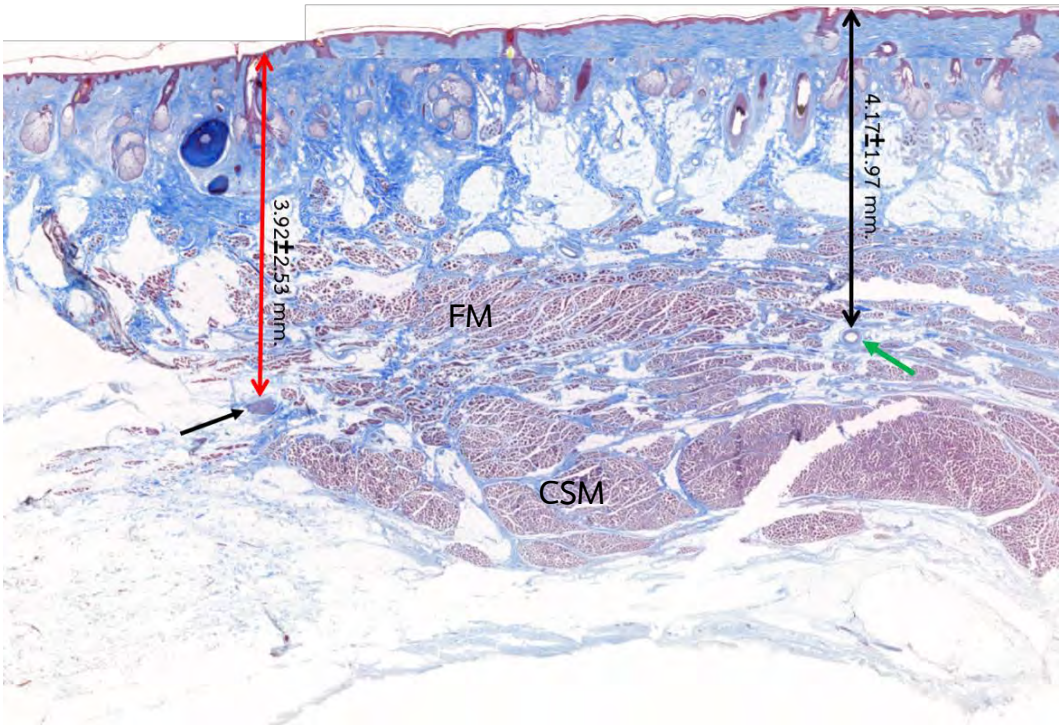


Figure 4. 5 The supraorbital nerve is shown by the black arrow and the supratrochlear artery is shown by the green arrow. The depth of the supraorbital nerve and artery is shown by the red and black arrow, respectively. FM: frontalis muscle, CSM: corrugator supercilia muscle.

4.2 The change plane position of the nerves and arteries of the upper face

Plane of the nerves and arteries of upper face were identified by the histological slide. The histological slide of upper face was divided into 3 level; the first level which 2 cm above the intercanthal line, the second level which 4 cm above the intercanthal line, and the last level which 6 cm above the intercanthal line. Moreover, the plane in this study were described in 4 planes: 1) subcutaneous plane (SC), 2) supramuscular plane (SPM), 3) intramuscular plane (IM), and 4) submuscular plane (SM).

At the level 1, the frontal branch of facial nerve located in the subcutaneous plane at the section 21 or 10.5 cm from the midline. After that, the frontal branch of facial nerve runs upward medially into the level 2 and located at the section 20 or 10 cm from the midline in the subcutaneous plane. For the level 3, the frontal branch of facial nerve located in subcutaneous plane at the section 19 or 9.5 cm from the midline. Therefore, the frontal branch of facial nerve travels in the subcutaneous plane in the temporal region approximately 9.5-10.5 cm from the midline (Fig 4.6). The superficial temporal artery located in the supramuscular plane at the section 24 or 12 cm from the midline at the level 1. After that, the superficial temporal artery runs upward medially and located in the subcutaneous plane at the section 23 or 11.5 cm from the midline. At the level 3, the superficial temporal artery located in the subcutaneous plane at the section 22 or 11 cm from the midline (Fig 4.7). Also, the superficial temporal artery travels in supramuscular plane at the level

of lateral canthus and runs superficially into the subcutaneous plane at the next level.

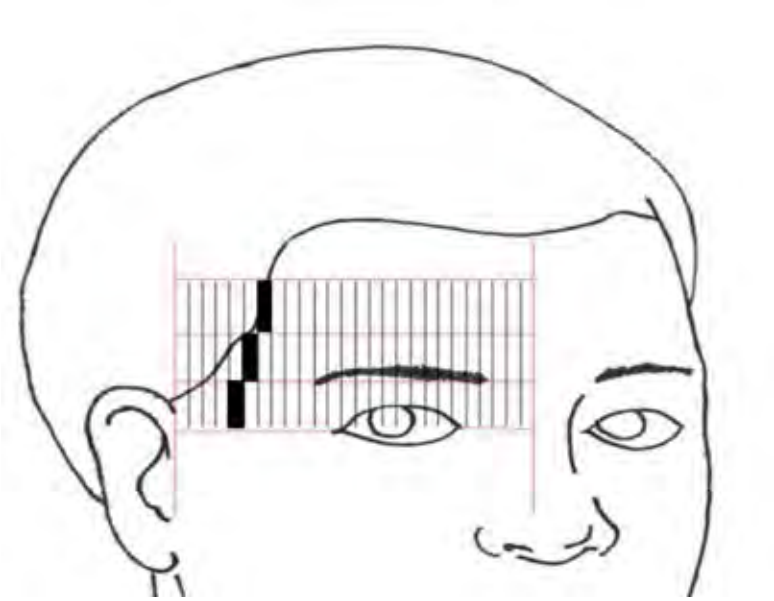


Figure 4. 6 Diagram of the course of the frontal branch of facial nerve related with the plane from the histological slide. ■ *Subcutaneous plane*

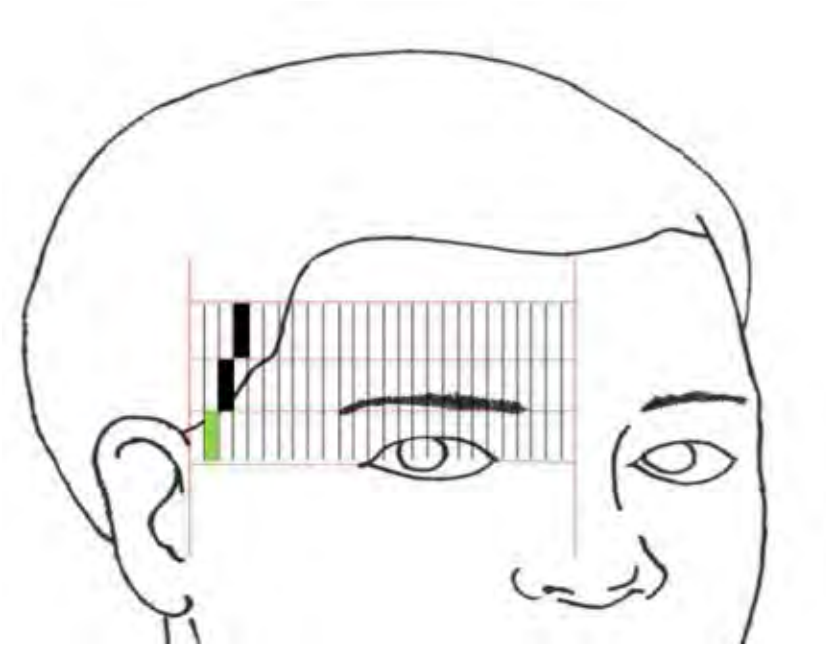


Figure 4. 7 Diagram of the course of the superficial temporal artery related with the plane from the histological slide. ■ *Subcutaneous plane,* ■ *Supramuscular plane.*

The supratrochlear nerve and artery located in submuscular plane at the section 6 or 3 cm from the midline in the level 1. After that, the supratrochlear nerve and artery runs upward medially into the level 2 and located in the intramuscular plane at the section 5 or 2.5 cm from the midline. At the level 2, the supratrochlear nerve and artery travel medially into the superficial layer in the supramuscular plane at the section 4 or 2 cm from the midline. At the level 3, the supratrochlear nerve and artery located in the subcutaneous plane at the section 3

or 1.5 cm from the midline (Fig 4.8). The supraorbital nerve and artery run in the submuscular plane at the section 9 or 4.5 cm from the midline at the level 1. At the level 2, the supraorbital nerve and artery travel laterally in the intramuscular plane at the section 10 or 5 cm from the midline and the supramuscular plane at the section 11 or 5.5 cm from the midline. After that, the supraorbital nerve and artery runs laterally into the superficial plane or subcutaneous plane at the section 12 or 6 cm from the midline at the level 3 (Fig 4.9).

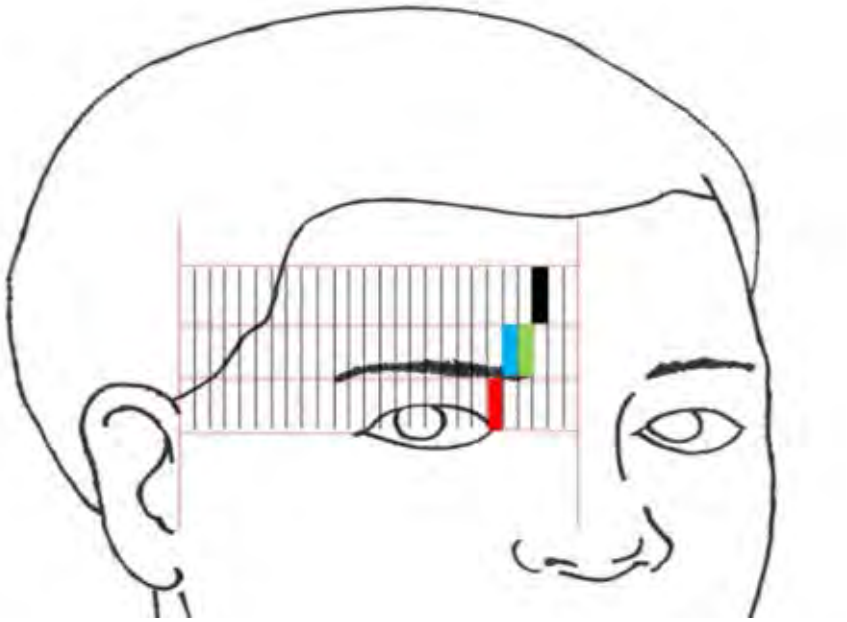


Figure 4. 8 Diagram of the course of the supratrochlear nerve and artery related with the plane from the histological slide. ■ *Subcutaneous plane,* ■ *Supramuscular plane,* ■ *Intramuscular plane, and* ■ *Submuscular plane.*

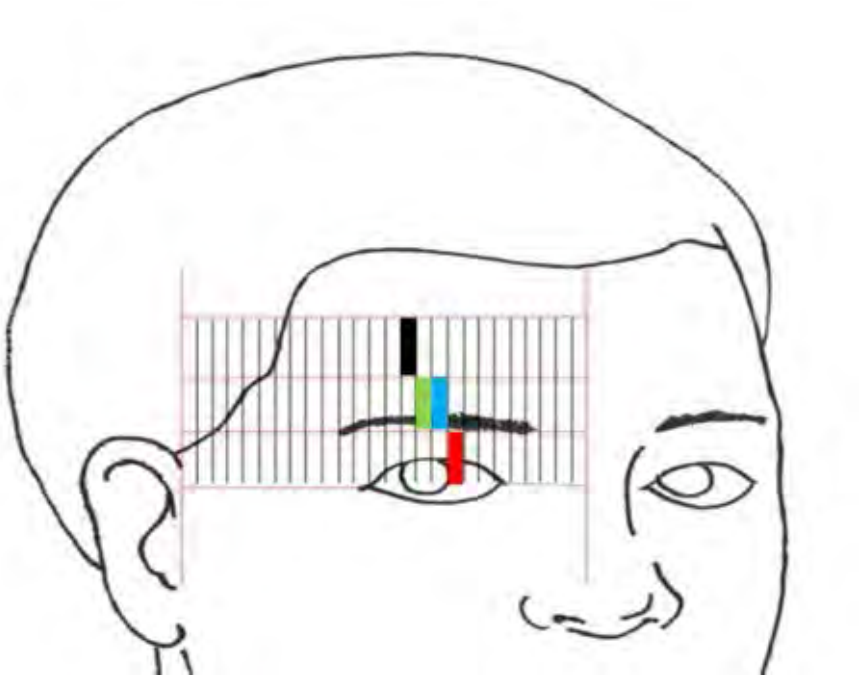


Figure 4. 9 Diagram of the course of the supraorbital nerve and artery related with the plane from the histological slide. ■ *Subcutaneous plane,* ■ *Supramuscular plane,* ■ *Intramuscular plane, and* ■ *Submuscular plane.*

4.3 The frontal branch of facial nerve

The frontal branch of the facial nerve traverse inside the temporoparietal fascia and crossed the superior and inferior margin of the zygomatic arch. The mean vertical distance from the mid-point of the zygomatic arch to the frontal branch of facial nerve was 10.52±2.41 mm (Fig 4.10B). In the temporal region, the mean

horizontal distance from the lateral canthus to the frontal branch of the facial nerve was 39.82±7.09 mm. At the level of the lateral eyebrow, the mean horizontal distance from the lateral eyebrow to the frontal branch of the facial nerve was 24.10±8.92 mm. At the lateral border of the frontalis muscle, the mean distance from the superior border of the brow to the frontal branch of facial nerve was 8.08±5.17 mm. The mean diameter of the frontal branch of the facial nerve at the mid-point of the zygomatic arch was 1.50±0.45 mm, the level of the lateral canthus was 1.12±0.1 mm, the level of the lateral brow was 0.90±0.38 mm and the lateral border of the frontalis muscle was 0.63±0.3 mm, respectively (Fig 4.10A). (Table 4.2)

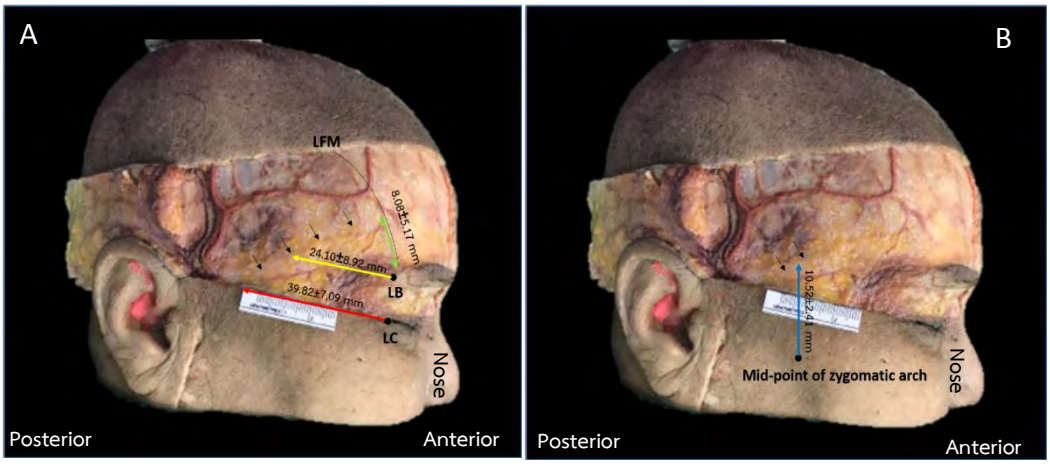


Figure 4. 10 The frontal branch of the facial nerve (FFN) is shown by the black arrow. The distance between the lateral canthus and the FFN is shown by the red arrow. The distance between the lateral brow and FFN is shown by the yellow arrow. The distance between the superior brow and the FFN is shown by the pink

arrow (A). The distance between the mid-point of zygomatic arch and the FFN is shown by the blue arrow (B).

Table 4. 2 The surface landmark of the frontal branch of the facial

Measurements	Mean ± SD (range)	
	Male (mm)	Female (mm)
The vertical distance from the mid-point of zygomatic arch	10.52±2.41 (6.81 – 13.07)	
	11.99±1.08(13.07-10.9)	8.31±2.12(9.82-6.82)
The horizontal distance from the lateral canthus	39.82±7.09 (26.11 – 47.78)	
	35.84±5.01(47.11-26.11)	45.77±2.83(43.77-47.78)
The horizontal distance from the lateral eyebrow	24.10±8.92 (15.5 – 31.65)	
	28.27±5.26(35.31-21.25)	21.31±4.19(31.65-15.5)
The distance from the superior border of the brow at the lateral border of frontalis muscle	8.08±5.17 (4.4 – 13.99)	
	11.28±2.40(13.99-9.39)	7.38±1.03(10.13-5.86)
The diameter at the mid-point of zygomatic arch	1.50±0.45 (1.00 – 2.14)	
	1.64±0.18(1.52-1.74)	1.29±0.28(1.00-1.35)
The diameter at the level of lateral canthus	1.12±0.1 (0.95 – 1.24)	
	1.18±0.04(1.24-1.15)	1.01±0.08(1.07-0.95)
The diameter at the level of the lateral brow	0.90±0.38 (0.32 – 1.39)	
	1.06±0.28(1.39-0.89)	0.85±0.48(1.32-0.71)
The diameter at the lateral border of the frontalis muscle	0.63±0.3 (0.3 – 0.89)	
	0.78±0.06(0.84-0.71)	0.76±0.18(0.63-0.89)

4.4 The superficial temporal artery

The superficial temporal artery is a terminal branch of the external carotid artery. It is given off the transverse facial artery to supplies the parotid gland. The superficial temporal artery crosses over the zygomatic arch. At the temporal region, the mean vertical distance from the mid-point of zygomatic arch to the frontal branch of superficial temporal artery was 61.72±14.09 mm (Fig 4.12). The mean horizontal distance from the lateral canthus to the superficial temporal artery was 65.79±5.99 mm. At the level of the brow, the mean horizontal distance from the lateral brow to superficial temporal artery was 60.45±3.64 mm. After that, the superficial temporal artery runs into the forehead region and the mean distance from the superior border of the brow to the frontal branch of superior temporal artery at the lateral border of frontalis muscle was 34.40±7.83 mm (Fig 4.11). The mean diameter of the superficial temporal artery at the mid-point of the zygomatic arch was 2.19±0.59 mm, the level of lateral canthus was 2.55±0.67 mm, the level of the lateral brow was 2.28±0.64 mm, and the lateral border of the frontalis muscle was 1.45±0.29 mm, respectively. (Table 4.3)

Table 4. 3 The surface landmark of the superficial temporal artery

Measurements	Mean ± SD (range)	
	Male (mm)	Female (mm)
The vertical distance from the mid-point of zygomatic arch	61.72±4.09 (33.75 – 89.80)	
	62.75±5.31(33.75-89.8)	61.03±3.66(36.57-88.89)
The horizontal distance from the lateral canthus	65.79±5.99 (50.53 – 78.52)	
	65.52±5.85(50.53-73.47)	66.02±6.28(55.65-78.52)
The horizontal distance from the lateral eyebrow	60.45±3.64 (29.06 – 78.32)	
	62.42±2.22(36.36-78.32)	58.72±4.93(29.06-77.69)
The distance from the superior border of the brow at the lateral border of frontalis muscle	34.40±7.83 (16.84 – 65.35)	
	36.89±6.1(17.38-48.26)	31.32±3.52(16.84-65.35)
The diameter at the mid-point of zygomatic arch	2.19±0.59 (0.80 – 3.75)	
	1.95±0.65 (1.50-3.75)	2.40±0.45(0.80-2.75)
The diameter at the level of lateral canthus	2.55±0.67 (0.76 – 3.75)	
	2.33±0.75(0.76-3.65)	2.74±0.53(1.73-3.75)
The diameter at the level of the lateral brow	2.28±0.64 (1.42 – 4.28)	
	2.24±0.70(1.42-3.28)	2.31±0.60(1.51-4.28)
The diameter at the lateral border of the frontalis muscle	1.45±0.29 (0.84 – 2.11)	
	1.40±0.29(0.84-2.03)	1.49±0.28(1.13-2.11)

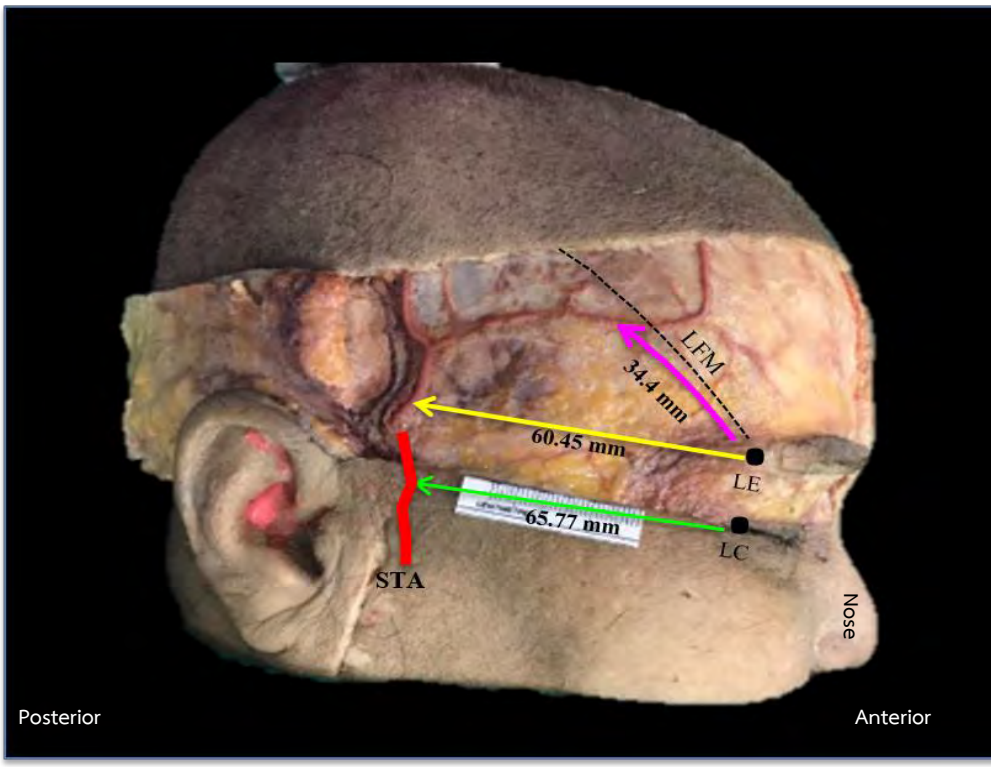


Figure 4. 11 The distance between the lateral canthus and the superficial temporal artery (STA) is show by the green arrow. The distance between the lateral brow and STA is despite by the yellow arrow. The distance between the superior brow and the STA is shown by the pink arrow.

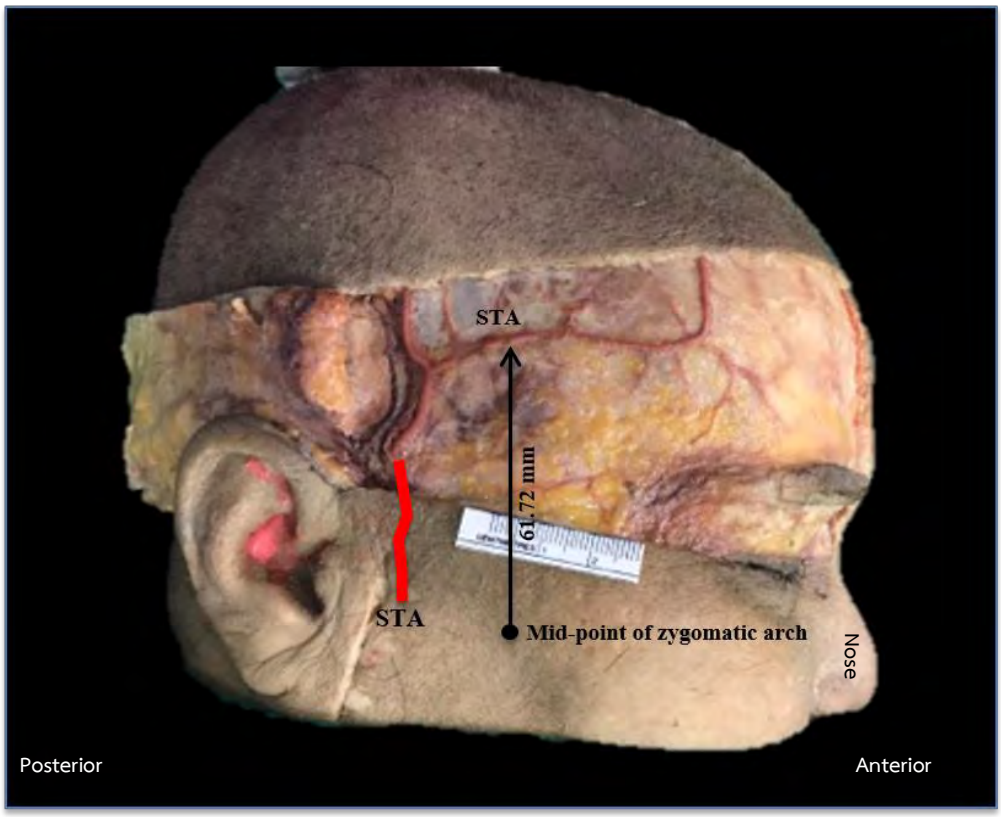


Figure 4. 12 The distance between the mid-point of zygomatic arch and the STA is shown by the black arrow.

4.5 The supratrochlear nerve

The supratrochlear nerve is the sensory nerve that supplies the skin and soft tissues of the glabella, lower medial part of the forehead, upper eyelid and conjunctiva, which travel along the medial part of the roof of the orbit and between the trochlear and the supraorbital foramen. It exits through the frontal notch into the deep tissues of the forehead and after that pierces through the frontalis muscle to supply the forehead. The mean horizontal distance from the midline to the point where the supratrochlear nerve pierced through the muscle was 20.20±5.04 mm. The mean vertical distance from the orbital rim to the point where the supratrochlear nerve pierced through the muscle was 22.93±5.28 mm. The mean diameter of the supratrochlear nerve at the point where the nerve and artery pierced through the muscle was 0.83±0.19 mm (Fig 4.13). (Table 4.4)

Table 4. 4 *The surface landmark of the supratrochlear nerve pierce through the frontalis muscle*

Measurements	Mean ± SD (range)	
	Male (mm)	Female (mm)
The horizontal distance from the midline	20.20±5.04 (12.61 – 26.94)	
	21.14±4.52(13.71-26.13)	18.91±5.11(12.61-26.94)
The vertical distance from the orbital rim	22.93±5.28 (16.02 - 27.73)	
	23.62±4.78(17.9-31.27)	23.39±3.77(16.02-27.23)
The diameter	0.83±0.19 (0.40 – 1.13)	
	0.93±0.16(0.71-1.13)	0.74±0.17(0.40-0.92)

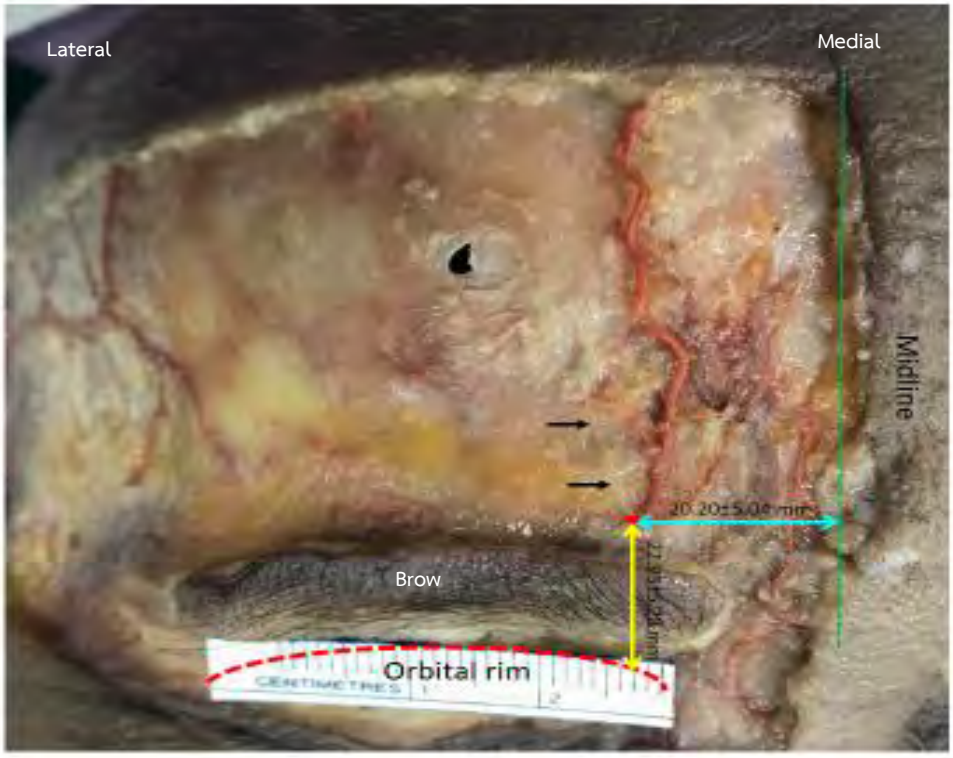


Figure 4. 13 The supratrochlear nerve is show by the black arrow. The horizontal distance from the point that supratrochlear nerve pierced through the frontalis muscle is presented by blue arrow. The vertical distance from the point that supratrochlear nerve pierced through the frontalis muscle is presented by yellow arrow.

4.6 The supratrochlear artery

The mean horizontal distance from the midline to the point where the supratrochlear artery pierced through the muscle was 13.64±2.2 mm. The mean vertical distance from the orbital rim to the point where the supratrochlear artery pierced through the muscle was 18.24±6.55 mm. The mean diameter of the supratrochlear artery at the point where the nerve and artery pierced through the muscle was 0.83±0.11 mm (Fig 4.14). (Table 4.5)

Table 4. 5 The surface landmark of the supratrochlear artery at the point nerve pierce through the frontalis muscle

Measurements	**Mean ± SD (range)**	
	Male (mm)	**Female (mm)**
The horizontal distance from the midline	13.64±2.2 (10.25 – 16.79)	
	14.12±2.15(11.22-16.79)	13.15±2.28(10.25-15.14)
The vertical distance from the orbital rim	18.24±6.55 (10.17 – 31.53)	
	18.66±4.84(10.17-25.61)	16.81±4.74(11.08-31.53)
The diameter	0.83±0.11 (0.67 – 0.98)	
	0.84±0.13(0.67-1.03)	0.81±0.09(0.70-0.98)

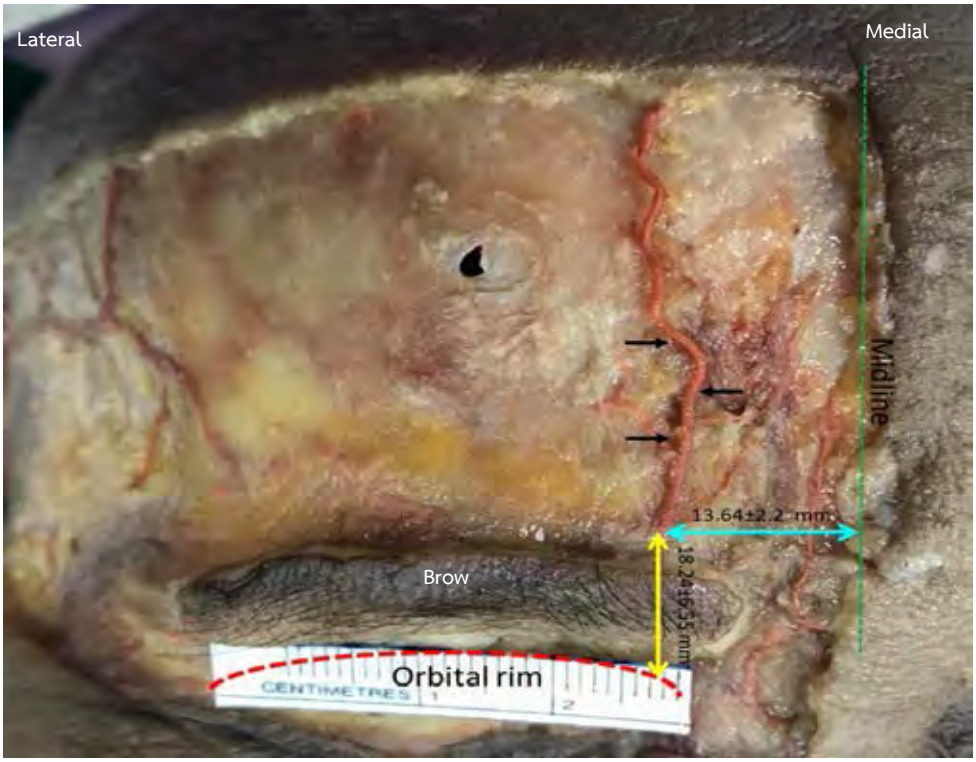


Figure 4. 14 The supratrochlear artery is show by the black arrow. The horizontal distance from the point that supratrochlear artery pierced through the frontalis muscle is presented by blue arrow. The vertical distance from the point that supratrochlear artery pierced through the frontalis muscle is presented by yellow arrow.

4.7 The supraorbital nerve

The supraorbital nerve originates from the cranial nerve V. It exits from the orbital rim by the foramen or notch. The supraorbital nerve supplies sensation to the forehead and scalp region. At the forehead region, the mean horizontal distance from the midline was 38.22±8.92 mm and the vertical distance from the orbital rim to the point that the nerve pierce through the frontalis muscle was 27.07±7.35 mm. At the point where the nerve pierced the frontalis muscle the mean diameter of the supraorbital nerve was 1.02±0.21 mm (Fig 4.15). (Table 4.6)

Table 4. 6 The surface landmark of the supraorbital nerve at the point nerve pierce through the frontalis muscle

Measurements	Mean ± SD (range)	
	Male (mm)	Female (mm)
The horizontal distance from the midline	38.22±8.92 (18.52 – 51.37)	
	38.82±7.03(28.67-47.91)	37.31±7.01(18.52-51.37)
The vertical distance from the orbital rim	27.07±7.35 (18.38 – 41.82)	
	28.91±6.31(18.89-36.69)	25.42±8.03(18.38-41.82)
The diameter	1.02±0.21 (0.71 – 1.30)	
	1.04±0.19(0.84-1.30)	0.97±0.21(0.71-1.25)

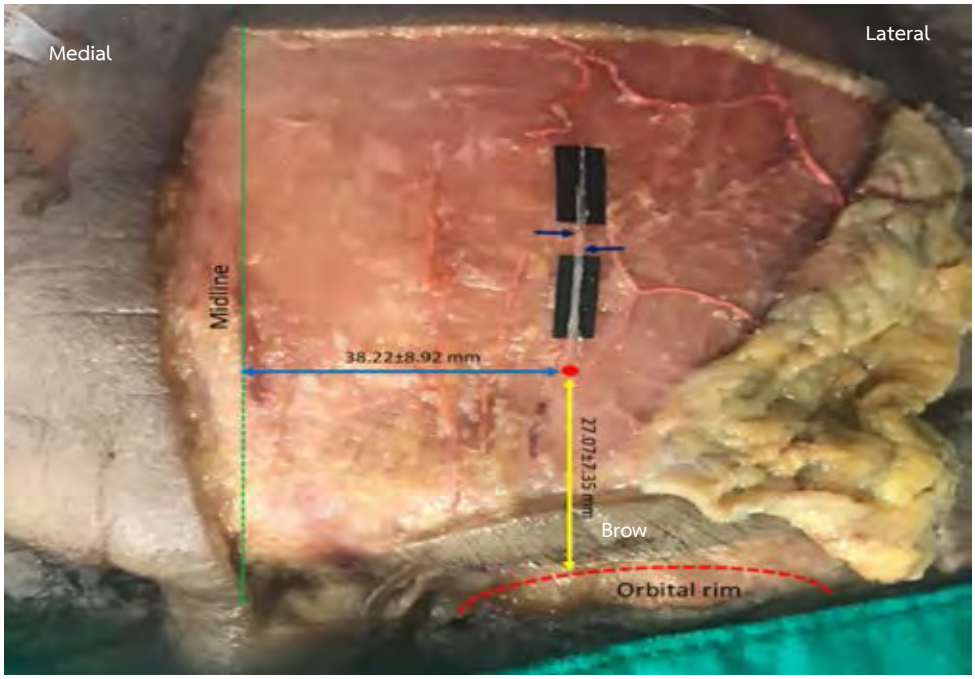


Figure 4. 15 The supraorbital nerve is show by the black arrow. The horizontal distance from the point that supraorbital nerve pierced through the frontalis muscle is presented by blue arrow. The vertical distance from the point that supraorbital nerve pierced through the frontalis muscle is presented by yellow arrow.

4.8 The supraorbital artery

At the forehead region, the mean horizontal distance from the midline was 37.55±9.76 mm and the vertical distance from the orbital rim to the point where the artery pierced through the frontalis muscle was 26.14±8.78 mm. At the point where the artery pierced the frontalis muscle the mean diameter of the supraorbital artery was 0.98±0.24 mm (Fig 4.16). (Table 4.7)

Table 4. 7 The surface landmark of the supraorbital nerve at the point nerve pierce through the frontalis muscle

Measurements	Mean ± SD (range)	
	Male (mm)	Female (mm)
The horizontal distance from the midline	37.55±9.76 (23.46 – 53.96)	
	38.98±9.68(26.84-49.80)	36.10±10.27(23.46-53.96)
The vertical distance from the orbital rim	26.14±8.78 (15.06 – 47.43)	
	27.11±10.41(15.92-47.43)	25.15±7.39(15.06-38.77)
The diameter	0.98±0.24 (0.68 – 1.24)	
	0.99±0.20(0.68-1.24)	0.96±0.28(0.71-1.56)

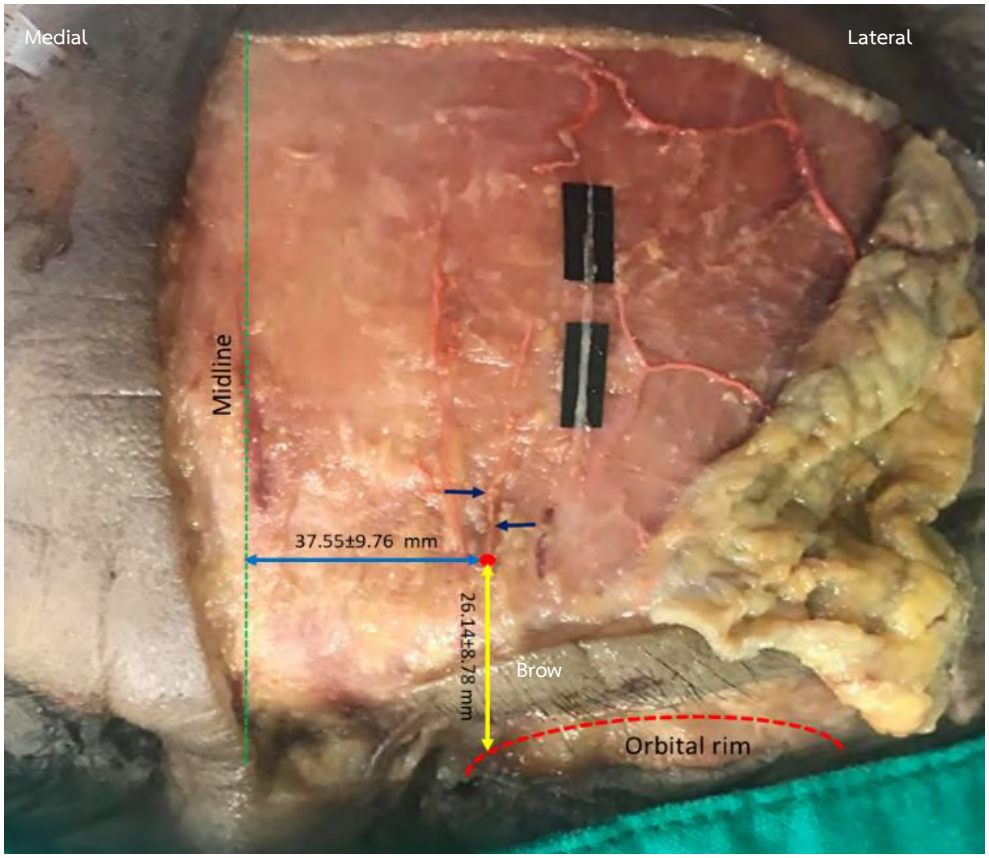


Figure 4. 16 The supraorbital artery is show by the black arrow. The horizontal distance from the point that supraorbital artery pierced through the frontalis muscle is presented by blue arrow. The vertical distance from the point that supraorbital artery pierced through the frontalis muscle is presented by yellow arrow.

Chapter V

Discussion

The depth and the plane of the nerves and arteries of the upper face from the histological slide

The depth of the nerves and arteries of the upper face had not been described in previous studies. In this study, the depth of the nerves and arteries of the upper face were examined by the histological slide. The surface landmarks are used to examine the depth include the lateral canthus, the lateral brow, and the lateral border of frontalis muscle. At the level of lateral canthus, the frontal branch of the facial nerve and the superficial temporal artery located at 7.28±2.75 and 6.59±3.91 mm from the skin. At the level of lateral brow, the frontal branch of the facial nerve and the superficial temporal artery located at 6.93±2.38 and 6.18±2.19 mm from the skin. At the level border of the frontalis muscle, the frontal branch of the facial nerve and the superficial temporal artery located at 4.19±3.53 and 3.91±2.96 mm from the skin. The supratrochlear nerve and artery were located at the depth approximately 3.79±2.94 and 3.45±3.05 mm. The supraorbital nerve and artery were located at the depth approximately 3.92±2.53 and 4.17±1.97 mm. The depth of the nerves and arteries of upper face can use to help the surgeon to ensure that the nerves and arteries are safe when insert the instruments.

The plane in which the nerves and arteries of upper face runs was examined by many authors by cadaver dissection, but they did not examine by the histological slide. Also, in this study represented the plane in which the nerves and arteries of upper face runs by using the histological slide. The planes are described in this study consist of the submucular, intramuscular, supramuscular, and subcutaneous plane. The plane of the frontal branch of the facial nerve in this study located subcutaneous plane was different from the results of Ishikawa (1990), reported that the frontal branch of the facial nerve passed into the temporoparietal fascia after crossing the zygomatic arch, but after that it ran obliquely along the undersurface of the facial layer[12]. The superficial temporal artery was in the supramuscular plane above the lateral canthus level and after that the superficial temporal artery located in the subcutaneous plane. The supratrochlear nerve and artery located in the submuscular plane at the 3 cm from the midline and the intramuscular plane at 2.5 cm. After that the supratrochlear nerve and artery emerged the muscle into the supramuscular plane and subcutaneous plane at 2 and 1.5 cm, respectively was similar to the result of Janis et al.(2013), reported that the supratrochlear nerve pierce through the corrugator supercilii muscle at 1.8 cm lateral to the midline[18]. The supraorbital nerve and artery plane was described in the study of Konofaos et al. (2013) that the supraorbital nerve pierced the musculoaponeurotic layer at 2.4 cm above the SO notch[24], but in this study, the supraorbital nerve and artery located in

the submuscular, intramuscular, supramuscular, and subcutaneous plane at 4.5, 5, 5.5, and 6 cm from the midline

The distance between the nerves and arteries of the upper face with the anatomical landmarks.

The surface landmark of the nerves and arteries of the upper face; the frontal branch of the facial nerve, the superficial temporal artery, the supratrochlear nerve and artery, and the supraorbital nerve and artery have been described in the previous reports[12, 14, 16, 17, 19, 21, 23, 25]. The data of this study has to propose the location of nerves and arteries of upper face which related with the surface landmark such as the lateral canthus, the lateral brow, and the lateral border of frontalis muscle, and has suggested the safe area based on the findings to avoiding the complications.

The frontal branch of the facial nerve

The frontal branch of the facial nerve can be injured during the forehead lift procedure. Also, knowledge of the anatomical landmark is required to reduce the post-operative paralysis of the forehead and the upper eyelid muscle [12]. The distance between the frontal branch of the facial nerve and the zygomatic arch has been previously reported by Babakurban et al., 2010. They found that the distance between the frontal branch of the facial nerve and zygomatic arch was approximately 3 mm [14]. But, in this study investigated distance between the frontal

branch of the facial nerve related with the zygomatic arch. The results shown that the frontal branch of the facial nerve located above the zygomatic arch about 10.52 mm at the mid-point of zygomatic arch. After that, the frontal branch of the facial nerve runs in to the temporal region and is located at 39.82 mm from the lateral canthus and 24.10 mm from the lateral brow, respectively. However, the distance from the frontal branch of the facial nerve to the lateral canthus was longer than the other. The distance between the lateral canthus and the facial nerve branch was 24.3 mm from previous reports [16]. Moreover, this study examined the distance between the frontal branch of the facial nerve and the superior border of the brow at the lateral border of the frontalis muscle and found it to be about 8.08 mm. To conclude based on the results, the surgeon should be aware of the frontal branch of facial nerve when insert some instruments at the area about 2- 4 cm from the lateral canthus and lateral brow for avoiding the paralysis or weakness of forehead muscle.

In this study, the diameter of the frontal branch of the facial nerve was investigated in many surface landmarks such as the mid-point of the zygomatic arch, the level of lateral canthus, the level of lateral brow and the lateral border of the frontalis muscle. The results show that the diameter of the frontal branch of the facial nerve at the mid-point of zygomatic arch was 1.50 mm. The diameter of the frontal branch of the facial nerve at the level of lateral canthus was 1.12 mm. The diameter of the frontal branch of the facial nerve at the level of the lateral brow was

0.90 mm and the diameter of the frontal branch of the facial nerve at the lateral border of the frontalis muscle was 0.63 mm.

The superficial temporal artery

The superficial temporal artery, the terminal branch of the external carotid artery, which crosses over the zygomatic arch and gives off the middle temporal artery that supplies the temporalis muscle. In our study, the distance from the mid-point of zygomatic arch to the superficial temporal artery was 61.72 mm. The superficial temporal artery runs cranially to the lateral side of the frontalis muscle. At the temporal region, the distance between the superficial temporal artery and the lateral canthus was 65.79 mm and the lateral brow was 60.45 mm. Previous study claimed that the distance between the superior attachment of the ear and the tragus were 20.01 mm and 16.86 mm [17]. After that, the superficial temporal artery crossed the lateral border of the frontalis muscle into the forehead area. At this point, the distance between the superficial temporal artery and the superior border of the brow was 34.40 mm. To summarize, the forehead lift procedure at the temporal region may damage the superficial temporal artery when insert the instrument at the area about 6-7 cm from the lateral canthus and lateral brow. So, the surgeon should be more aware at this area.

In this study, the diameter of the superficial temporal artery at the level of the lateral canthus and the lateral brow were 2.55 and 2.28 mm. The diameter of

the superficial temporal artery was previously reported at the 2.14 mm – 2.73 mm at the zygomatic arch [17], but the diameter of the superficial temporal artery in the temporal region at the line of mid-point of the zygomatic arch was 2.19 mm as described in this study. Additionally, the diameter of the superficial temporal artery at the lateral border of the frontalis muscle was examined and found to be about 1.45 mm.

The supratrochlear nerve and artery

The supratrochlear nerve emerged from the orbit at the notch above the trochlea. The distance between the point where the nerve pierced the frontalis muscle and the orbital rim was 22.93 mm, but the study by Hyung Jin Lee et al., 2015, it was reported that the distance between the point where the nerve entered the corrugator superciili muscle was about 2.3 cm [19]. After that, the nerve pierced through the corrugator supercilii and the frontalis muscle toward the skin. In our study, the distance between the point where the nerve pierced the frontalis muscle and the midline was investigated and found to be about 20.20 mm. Some previous studies reported that the distance between the midline and the point where the nerve pierced the corrugator supercilia were 1.9 and 1.6 cm [18, 19]. The diameter of the supratrochlear nerve at the point where the nerve pierced through the frontalis muscle was 0.83 mm. To conclude base on this result, this study has suggested to the surgeon to should be aware the supratrochlear nerve and artery at the area

about 2 cm from the midline and orbital rim. for avoiding the loss of sensation at the forehead region.

The supratrochlear artery emerges from the orbital rim and runs between the corrugator supercilii and the frontalis muscle. After that, the supratrochlear artery runs vertically upward under the frontalis muscle. The point where the artery pierces the frontalis muscle is located at about 13.64 mm lateral to the midline and 18.24 mm above the orbital rim. The diameter of the supratrochlear artery at the point where the artery pierces the frontalis muscle was 0.83 mm.

The supraorbital nerve and artery

The supraorbital nerve branches from the ophthalmic division of the cranial nerve V. It exits from the orbital rim by the foramen or notch. After that, it pierces through the frontalis muscle to supply sensation to the forehead and scalp region. The point where the nerve pierces the frontalis muscle is located at 38.22 mm horizontal to the midline and about 27.07 mm vertical to the orbital rim. The study by Cuzalina and Holmes in 2005 claimed that they used the medial limbus as a landmark for locating the supraorbital nerve. They reported that the supraorbital nerve was located at 0.56 mm to the left and right of the medial limbus [21]. The diameter of the supraorbital nerve at the point where the nerve pierced through the frontalis muscle was 1.02 mm. To summarize, the instruments of forehead lift

procedure have a high risk to damage the supraorbital nerve and artery at the area about 2-4 cm from the midline and orbital rim.

The supraorbital artery, the terminal branch of the ophthalmic artery, emerges from the orbit and entered the corrugator supercilii. After that, it runs superomedially into the forehead region and pierces through the frontalis muscle to supply the skin, muscle and pericranium. The point where the artery pierces the frontalis muscle is located at about 37.55 mm from the midline horizontally and 26.14 mm from the orbital rim vertically. This location of the supraorbital artery in this study is similar to previous studies which reported that the supraorbital artery pierced through the frontalis muscle about 20-30 mm above the supraorbital rim [23]. Moreover, the diameter of the supraorbital artery at the point where the artery pierced the frontalis muscle was 0.98 mm. Previous studies reported that the diameter of the supraorbital artery was about 0.84 mm on the right and 0.87 mm on the left [23].

Chapter VI

Conclusion

The surface landmark of the nerves and arteries of the upper face were described. The anatomical knowledge of the structure beneath the skin is important for the surgeons. The surface landmark is used to locate the structure of the forehead and temporal region so as to avoid injuries during the forehead lift procedure. At the temporal region, the frontal branch of the facial nerve located above the zygomatic arch is about 10.52 mm and is lateral to the lateral canthus at about 39.82 mm and the lateral brow at about 24.10 mm. The superficial temporal artery is located at 65.79 mm lateral to the lateral canthus, 60.45 mm lateral to the lateral brow and 61.72 mm above the zygomatic arch. The landmark can help reduce paralysis of the forehead and upper eyelid muscles.

In the forehead region, the supratrochlear and supraorbital nerve supply the sensation to the forehead skin, upper eyelid, conjunctiva and scalp. The supratrochlear and supraorbital nerve pierce through the frontalis muscle at 20.20 mm and 38.22 mm from the midline. Vertically, the point where the supratrochlear and supraorbital nerve pierces through the muscle is located at 22.93 and 27.07 mm from the orbital rim. For the supratrochlear and supraorbital artery, the distance between the point where the supratrochlear and supraorbital artery pierce through the frontalis muscle and the midline are at 13.64 and 37.55 mm. The location of the

point that the supratrochlear and supraorbital artery pierce through the muscle are at 18.24 and 26.14 mm above the orbital rim. Based on the finding of this study, the upper face may have a low risk of complications if the surgeon understands about the anatomical landmarks of the nerves and artery

Limitation in this study are the facial tissue is used in this study may have the shrink to be a result of the embalmed cadavers and some solutions are used to fix and dehydrate during the histological process and the average age of cadaver is approximately 78 years, that have the loss of fat and muscle volume. Therefore, the facial tissues thickness is difference from the most patients in cosmetic procedures.

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