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ANATOMICAL STUDY OF THE MIDDLE TEMPORAL VEIN WITH SPECIAL EMPHASIS ON ITS CLINICAL IMPORTANCE IN FILLER INJECTION

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Abstract

Background: Understanding the anatomy of the temporal region, especially the middle temporal vein, is essential for addressing aesthetic concerns related to facial aging. Patients often seek aesthetic interventions for issues like soft tissue atrophy, volume loss, and changes in skin texture and color, leading to a hollow or sunken appearance. Addressing aesthetic concerns in the temporal region may involve interventions such as temporal augmentation with dermal fillers, fat grafting, or surgical treatments like temporal implants. These interventions aim to restore volume, improve contours, and rejuvenate the appearance of the temporal region, enhancing overall facial aesthetics.

Materials and Methods: The anatomical study involved the use of fifteen formaldehyde preserved adult human cadaveric heads, and three fresh frozen adult male human heads dissected bilaterally. Dissection of each layer of the temporal region was done separately to demonstrate the ten layers. The middle temporal vein (MTV) was located within the superficial temporal fat pad in the temporal region, positioned between the two layers of the deep temporal fascia.

Results: It began as a continuation of the sentinel vein (SV) in 77.78%. In 19.44%, the MTV was formed by two transversely oblique veins draining the periorbital region. In 2.78%, the MTV was formed by two vertical descending tributaries. The mean distance between the beginning of

the MTV and the lateral orbital rim by using metal ruler at level of lateral canthus of the eye, was 53.61 ± 8.02 mm on the right side and 55.72 ± 7.59 mm on the left side. In the superficial temporal fat pad, the MTV with its main tributaries exhibits one of five morphological patterns.

Conclusion: The superficial temporal fat pad (layer 6), which contains the MTV, is commonly considered as the safest space for temporal augmentation by fillers, but it also provides the best aesthetic result. The safe areas for filler injection in the inter-fascial space of the temporal region are within 1.5 cm above the zygomatic arch and additionally, from 3.5 cm above the zygomatic arch till the temporal crest.

Keywords: MTV, Anatomical study, temporal fat, filler, facial aesthetics

Introduction

The temporal region is located above the level of zygomatic arch (ZA) and in front of the external ear. The superior and inferior temporal lines, as well as the zygomatic arch, serve as its superior and inferior borders, respectively. The floor of the temporal fossa is formed by the greater wing of the sphenoid and squamous part of temporal bone inferiorly, as well as the frontal and parietal bones superiorly[1].

There are ten parallel layers make up the temporal soft tissues, and it is important to note that the thickness of each layer varies with age [2].

The middle temporal vein (MTV) is known as a venous sinus, because of its large caliber that ranging from 0.7 to 2.5 mm. It is found embedded in the superficial temporal fat pad (STFP) between the superficial and deep layers of the deep temporal fascia. The MTV begins its course as

sentinel vein (SV) which receives the superciliary vein (SCV) and the lacrimal vein (LV) to drain the area around the lateral orbital rim. It also receives various small periorbital veins [3].

The SV pierces the superficial temporal fascia and the superficial layer of deep temporal fascia close to the upper end of the lateral orbital rim and form the MTV which located between the superficial and deep layers of the deep temporal fascia within the STFP. Additionally, the MTV receives few tributaries originated from the temporalis muscle. These tributaries are distributed parallel to the muscle fibers and descend toward the main stem of the MTV[3].

Near its termination, it pierces the superficial layer of the deep temporal fascia and runs for few mms on its outer surface then pierces the loose areolar tissue and the superficial temporal fascia. It ends by joining the STV about 1 cm below the superior border of the zygomatic arch and about 1 cm anterior to ear tragus. After that the STV joins the maxillary vein to form the retromandibular vein [3].

Aesthetic importance of temporal fossa

The multifactorial process of facial ageing has an impact on all facial tissues, including the skin, fat, muscles, ligaments, and bone. Each person exhibits the clear signs of facial ageing, in spite of that each tissue ages at a different rate and begins at a different period [4-7].

Addressing aesthetic concerns in the temporal region may involve interventions such as temporal augmentation with dermal fillers, fat grafting, or surgical treatments like temporal implants. These interventions aim to restore volume, improve contours, and rejuvenate the appearance of the temporal region, enhancing overall facial aesthetics [8,9]. Complications of filler injections in the temporal fossa can lead to serious issues, as arterial and venous complications. Venous complications, although rare, pose significant risks such as visual loss, cerebral embolism,

and non-thrombotic pulmonary embolism (NTPE). Cases of NTPE have been reported in the correction of temporal atrophy, attributed to the presence of the large-caliber venous sinus, the middle temporal vein [10-14]. The aim of the present study was to identify the anatomical features of the MTV and its tributaries and to describe the venous dangerous zone in the temporal fossa to avoid severe complications associated with inadvertent intravenous injection of filler during the correction of the temporal hollowing.

MATERIALS

Cadaveric head specimens

Fifteen formaldehyde preserved adult human cadaveric heads (with their age ranged from 40 to 75 years old) 10 males and 5 females and three fresh and frozen adult male human heads obtained from the morgue of the anatomy department of Alexandria faculty of medicine.

Equipment used: dissecting tools and digital Vernier caliper

METHODS

A. Ethical approval and consent to participate

All research was performed in accordance with guidelines and regulations of our institution (Faculty of Medicine, Alexandria University). This work was done on cadaveric specimens obtained from the dissection room of Anatomy department, Faculty of Medicine, Alexandria University. With no violations to any rights and or ethics. All were for unknown individuals and the Alexandria faculty of medicine is the legally authorized for the cadaveric specimens and the research protocol was approved by the local ethics committee of Faculty of

Medicine, Alexandria University (IRB No: 00012098-FWA No: 00018699). Consent to participate was not applicable.

B. Head specimens' dissection

A total of thirty temporal fossae, belonging to fifteen formaldehyde preserved adult human cadaveric heads (10 males and 5 females), and an additional six temporal fossae, belonging to three fresh frozen adult male human cadaveric heads, were carefully dissected to demonstrate the middle temporal vein, in order to determine its beginning, termination, tributaries, course and relations [15].

C. Steps of dissection procedure

1. A curved incision starting above the middle of the superior orbital ridge deviating upward and backward to end behind the ear auricle, was made through the skin and the underlying fascia using scalpel no.22 [16].
2. Dissection of each layer of the temporal region was done separately to demonstrate all layers of the temporal region, as well as the middle temporal vein (MTV), which is the core of the present study[16].
3. Normal saline was injected between the deep and superficial temporal fasciae (into layer 4) to facilitate dissection of the tissue layers.

D. Beginning, course, tributaries, diameter, length, and termination of MTV were delineated in layer 6 of the temporal region. Dissections were performed using the lateral orbital rim at level of lateral canthus of the eye, the middle of the anterior border of the external auditory meatus and the most prominent part of zygomatic arch as anatomical landmarks (Figs. 28, 29)[17,18].

E. Measurements

- Measuring the site of the beginning of the middle temporal vein in relation to the lateral orbital rim at the level of lateral canthus of the eye using a metal ruler.
- Its diameter at its junction with the superficial temporal vein was measured using a Vernier caliper.
- The length of the vein was measured using rope and pin to determine its actual length and then measured by a metal ruler.

- During its course the vertical distance between the most prominent part of the zygomatic arch and the middle temporal vein was measured by a vertical line drawn from the most prominent part of the zygomatic arch to meet the main trunk of the MTV by using a metal ruler.

F. Measuring the site of termination of the middle temporal vein in relation to the middle of the anterior border of the external auditory meatus using a metal ruler.

- All these measurements were estimated by millimeter (mm).

G. Photography was performed with a Canon EOS 2000D digital camera. The lens was a Canon EF-S 18-55mm f/3.5-5.6 IS Lens.

Statistical analysis of the data: Data were input to the computer and analyzed using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**)**. The **Shapiro-Wilk** test was used to verify the normality of distribution. The quantitative data were described using range (minimum and maximum), mean, standard deviation. Significance of the obtained results was detected at the 5% level.

Paired t-test

For normally distributed quantitative variables, to compare between both sides of the temporal region.

RESULTS

The temporal region proved to consist of ten layers from superficial to deep as follows: skin (S), superficial fatty layer (SFL), superficial temporal fascia (STF), temporo-parietal fat pad (TPFP), superficial layer of the deep temporal fascia (SL/DTF), superficial temporal fat pad (STFP), deep layer of the deep temporal fascia (DL/DTF), deep temporal fat pad (DTFP), temporalis muscle (TM), and periosteum. (Fig.1)

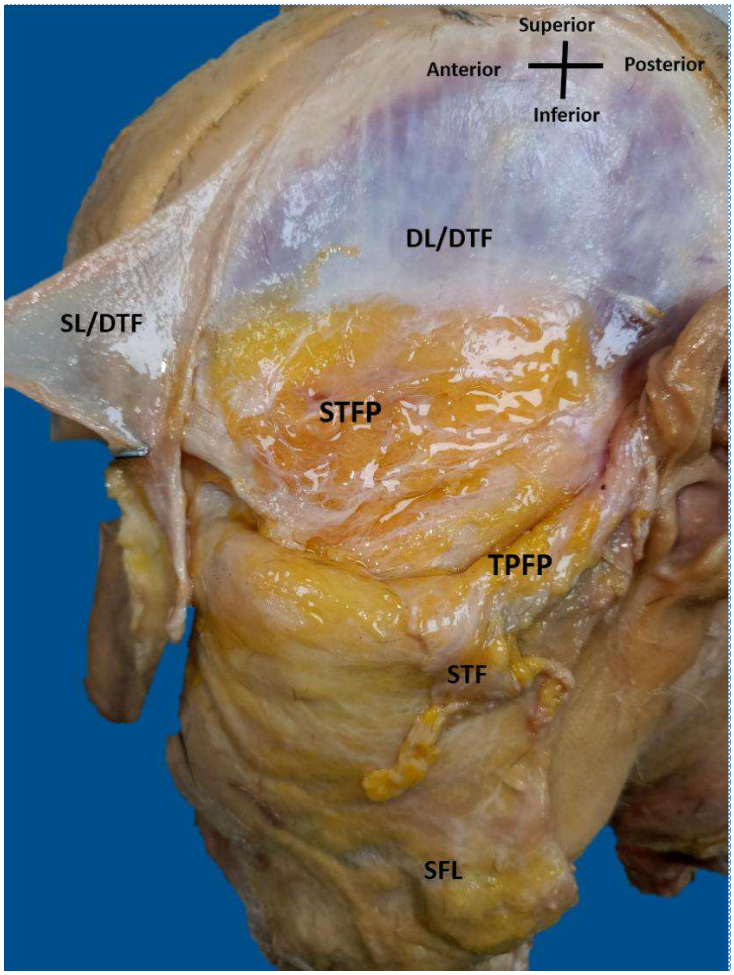


Figure (1): A cadaveric dissection of the left temporal region of fresh frozen adult male human cadaveric head specimen showing the layers of the temporal region. The skin with the underlying superficial fatty layer (SFL) were reflected to show the superficial temporal fascia (STF) with the temporo-parietal fat pad (TPFP) deep to it. The superficial temporal fat pad (STFP) is seen enclosed between the superficial (SL/DTF) and deep (DL/DTF) layers of the deep temporal fascia.

Middle temporal vein anatomy

The middle temporal vein proved to be located within the superficial temporal fat bad, sandwiched between the two layers of the deep temporal fascia.

The middle temporal vein (MTV) began as a continuation of the sentinel vein (SV) in 28 / 36 specimens (77.78%) after piercing the superficial layer of the deep temporal fascia at the superolateral orbital rim (Fig. 2.A). Sentinel vein is formed by union of the superciliary vein (SCV) and the lacrimal vein (LV) to drain the area around the lateral orbital rim (Fig. 2.B). In 7 / 36 specimens (19.44%), the MTV was formed by two transversely oblique veins draining the periorbital region. In 1 / 36 specimens (2.78%), the MTV was found to run vertically and formed by two descending tributaries. The mean distance between the beginning of the MTV and the lateral orbital rim at level of lateral canthus of the eye was 53.61 ± 8.02 mm on the right side and 55.72 ± 7.59 mm on the left side. There was no statistical difference between right and left sides (Fig. 2.C).

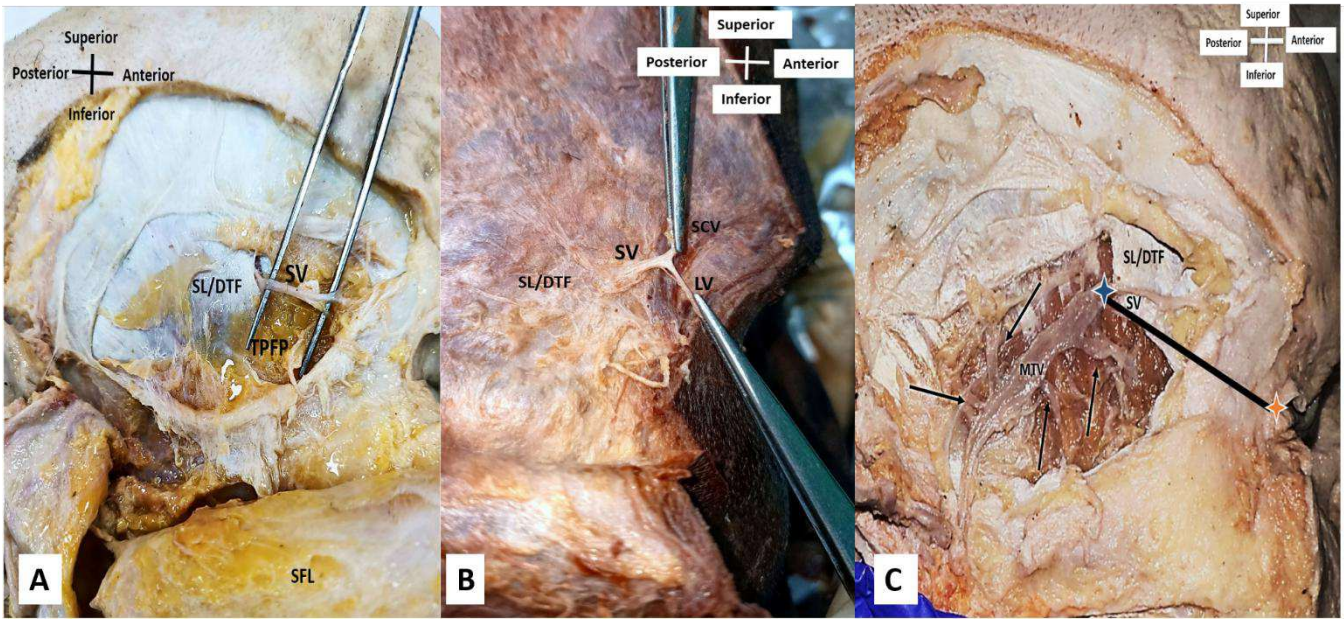


Figure (2): A cadaveric dissection of the right temporal region of adult male human head specimen showing: A:- the sentinel vein (SV) piercing the superficial layer of the deep temporal fascia (SL/DTF) at the superolateral orbital rim. Notice that the superficial fatty layer (SFL) was retracted and the temporo-parietal fat pad (TPFP) is seen superficial to the SL/DTF. B:- showing formation of sentinel vein (SV) by

union of the superciliary vein (SCV) and the lacrimal vein (LV), then it pierces the superficial layer of the deep temporal fascia (SL/DTF) at the superolateral orbital rim. C:- showing the distance (black line) between the lateral orbital rim at level of lateral canthus of the eye (orange star) and the beginning of the middle temporal vein (MTV, the blue star). Notice that the beginning of the MTV as a continuation of sentinel vein (SV) superficial to the superficial layer of the deep temporal fascia (SL/DTF).

Tributaries and morphological patterns

In the superficial temporal fat pad, the middle temporal vein with its main tributaries was observed to exhibit one of five morphological patterns. These patterns were described as follows:

Type 1: One main curved horizontal trunk was observed in 23 / 36 specimens (63.89%, Fig. 3.A).

Type 2: Two large veins converged from the periorbital region to form one curved horizontal trunk observed in 7 / 36 specimens (19.44%, Fig. 3.B).

Type 3: One main curved horizontal trunk receiving one small descending tributary observed in 4 / 36 specimens (11.11%, Fig. 3.C).

Type 4: One main vertical trunk receiving two descending tributaries in 1 / 36 specimens (2.78%, Fig. 3.D).

Type 5: One main curved horizontal trunk receiving two descending tributaries and two smaller ascending tributaries observed in 1 / 36 (2.78%, Fig. 3.E).

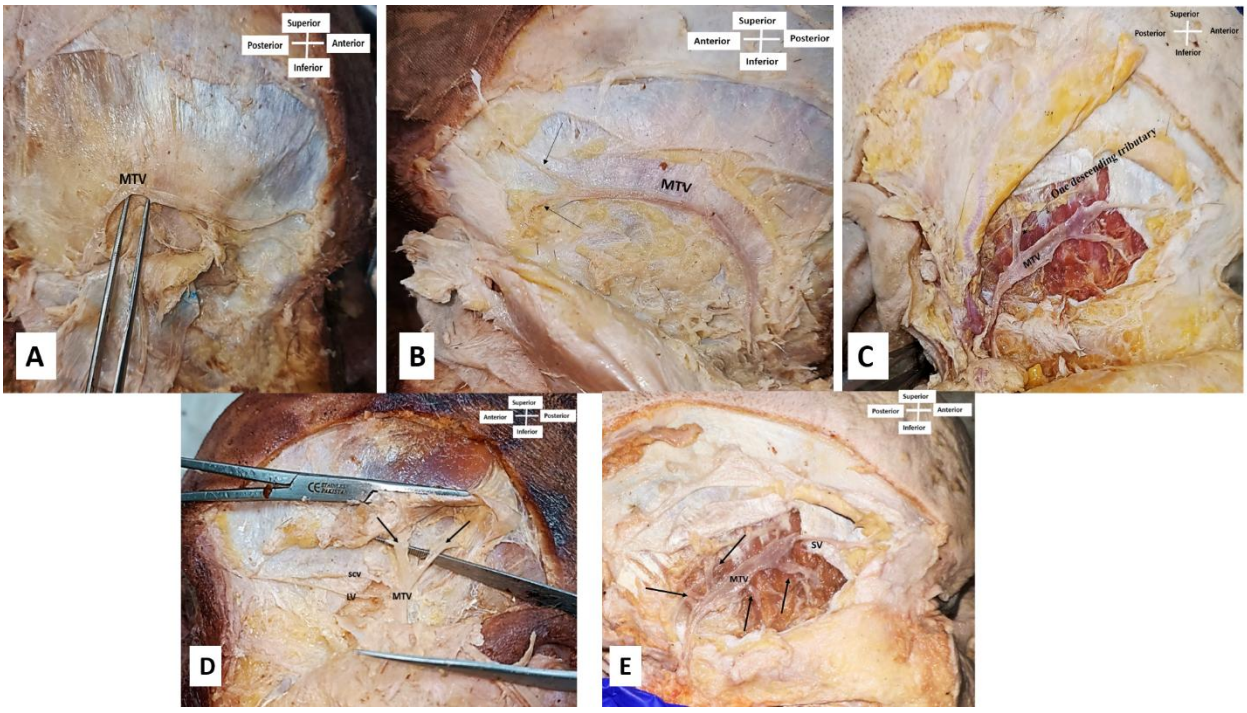


Figure (3): A cadaveric dissection of the temporal region of adult male human head specimen showing: A:- type 1 morphological pattern of the middle temporal vein (MTV) in which it courses as one curved horizontal trunk. B:- type 2 morphological pattern of the middle temporal vein (MTV) and its main tributaries (black arrows) in which there are two large veins converge to form one curved horizontal trunk. C:- type 3 morphological pattern of the middle temporal vein (MTV) in which a main curved horizontal trunk receiving one small descending tributary. D:- type 4 morphological pattern of the middle temporal vein (MTV) with two small descending branches (black arrows) that join the main vertical trunk. Notice the superciliary vein (SCV) together with the lacrimal vein (LV) as they drain in the MTV. E:- type 5 morphological pattern of middle temporal vein (MTV) in which one main curved horizontal trunk courses with two descending tributaries and two smaller ascending tributaries (black arrows).

The mean diameter of the MTV at its termination in the superficial temporal vein (STV) was found to be 2.42 ± 0.65 mm on the right side and 2.69 ± 0.60 mm on the left side. There was no statistical difference between right and left sides (Table 1).

Table (1): The mean diameter of MTV at its junction with the superficial temporal vein among the eighteen dissected cadavers.

Cadaver number	Right (mm)	Left (mm)
1	1.67	1.9
2	2.18	3.35
3	1.89	2.48
4	1.7	3.5
5	3.46	2.19
6	2.89	3.42
7	2.45	1.75
8	3.2	2.56
9	1.45	1.67
10	1.56	3.12
11	2.69	2.9
12	2.36	3.37
13	3.1	2.78
14	2.12	2.89
15	2.35	3.22
16	1.89	2.78
17	3.35	1.88
18	3.19	2.66
Min. – Max	1.45 – 3.46	1.67 – 3.50
Mean ± SD	2.42 ± 0.65	2.69 ± 0.60
t(p)	1.247 (0.229)	

t: Paired t-test

p: p value for comparing between **Right** and **Left**

The mean length of the MTV from its beginning till its termination when it drains into the superficial temporal vein (STV) was found to be 36.33 ± 12.8 mm on the right side and 36.67 ± 12.02 mm on the left side. There was no statistical difference between right and left sides (Fig. 4, Table 2).

Table (2): The mean length of MTV from its beginning till its termination when it drains into the superficial temporal vein (STV) among the eighteen dissected cadavers.

Cadaver number	Right (mm)	Left (mm)
1	55	46
2	24	35
3	30	44
4	48	47
5	50	56
6	18	15
7	58	55
8	32	28
9	27	26
10	35	32
11	52	54
12	43	38
13	28	25
14	15	19
15	39	35
16	23	29
17	36	39
18	41	37

Min. – Max	15.0 – 58.0	15.0 – 56.0
Mean ± SD	36.33 ± 12.8	36.67 ± 12.02
t(p)	0.236 (0.816)	

t: Paired t-test

p: p value for comparing between **Right** and **Left**

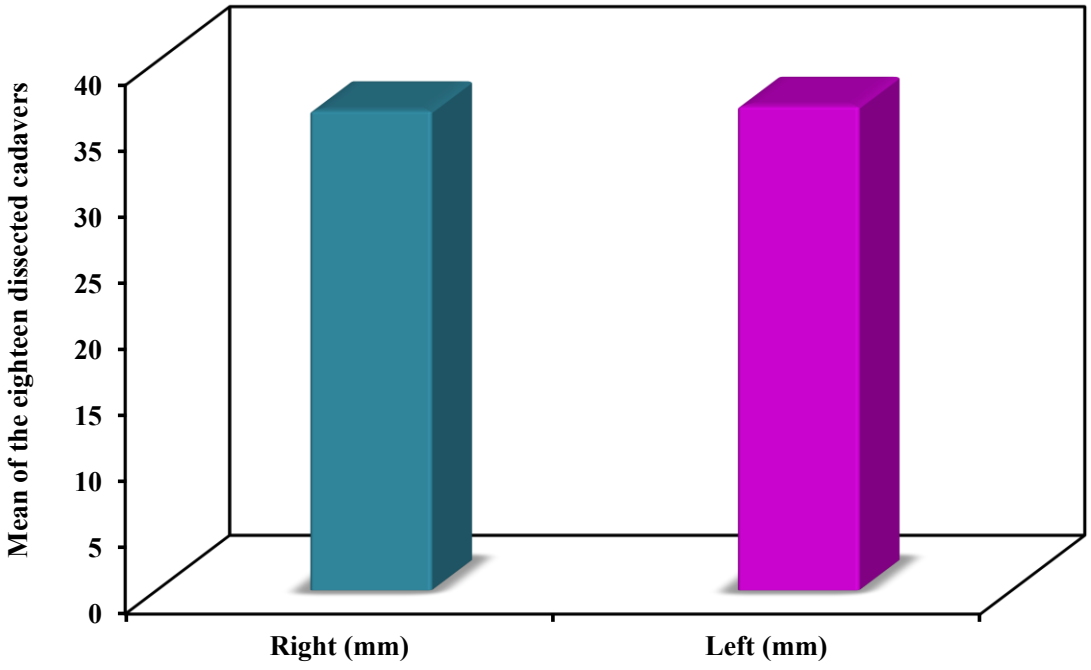


Figure (4): A column chart showing the mean length of MTV from its beginning till its termination when it drains into the superficial temporal vein (STV) in both right and left sides among the eighteen dissected cadavers.

Along the course of MTV, the vertical distance between the most prominent part of the zygomatic arch and the main trunk of middle temporal vein was 22.85 ± 5.32 mm on the right side

and 22.19 ± 5.20 mm on the left side. There was no statistical difference between right and left sides (Fig. 5, Table 3).

Table (3): The mean vertical distance between the most prominent part of the zygomatic arch and the main trunk of MTV among the eighteen dissected cadavers.

Cadaver number	Right (mm)	Left (mm)
1	15.2	18
2	23	22.8
3	19.5	20
4	17.8	15.7
5	24.3	21.2
6	30	28.3
7	16	16.4
8	26.2	25.2
9	31.8	33
10	27	26.8
11	18.3	18
12	29	29.2
13	20	20
14	22.7	19.9
15	16.6	17
16	30.6	29
17	19.5	22
18	23.8	17
Min. – Max	15.20 – 31.80	15.70 – 33.0
Mean ± SD	22.85 ± 5.32	22.19 ± 5.20
t(p)	1.258 (0.225)	

t: Paired t-test

p: p value for comparing between **Right** and **Left**

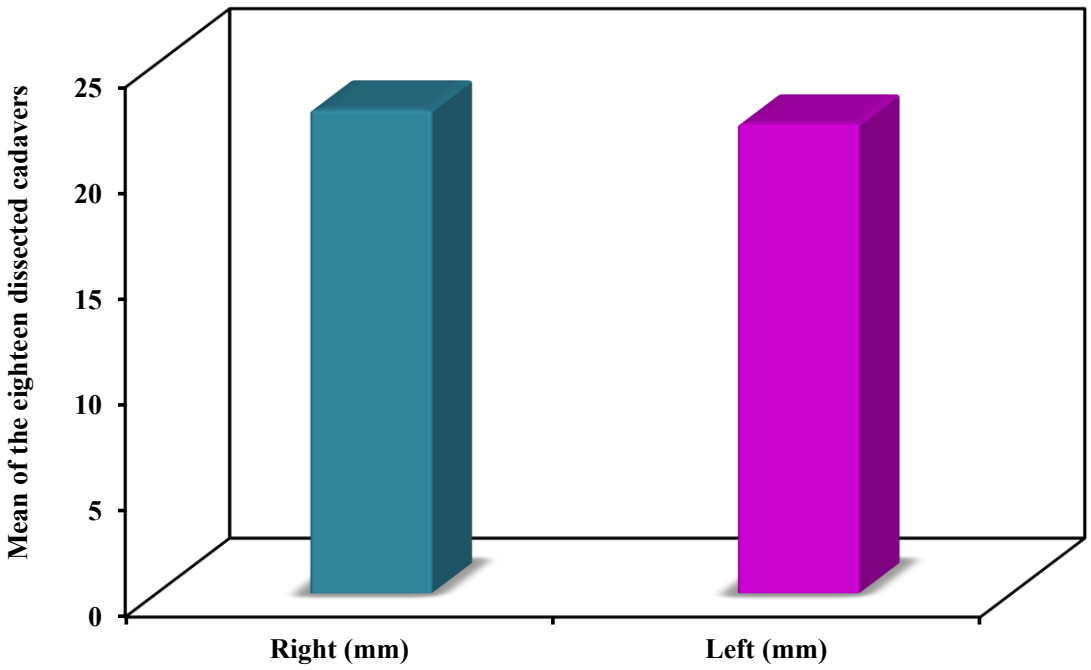


Figure (5): A column chart showing the mean vertical distance between the most prominent part of zygomatic arch and the main trunk of MTV of both right and left sides among the eighteen dissected cadavers.

The middle temporal vein (MTV) proved to have a curved descending course from a horizontal to a vertical segment in front of the ear. Near the pre-auricular point, the MTV drained into the superficial temporal vein after piercing the superficial layer of the deep temporal fascia, temporo-parital fat pad, and superficial temporal fascia (Fig. 6).

The mean distance between the middle of the anterior border of the external auditory meatus and point of meeting between the MTV and the STV was 13.28 ± 5.57 mm on the right side and 13.89 ± 5.44 mm on the left side. There was no statistical difference between right and left sides (Table 4).

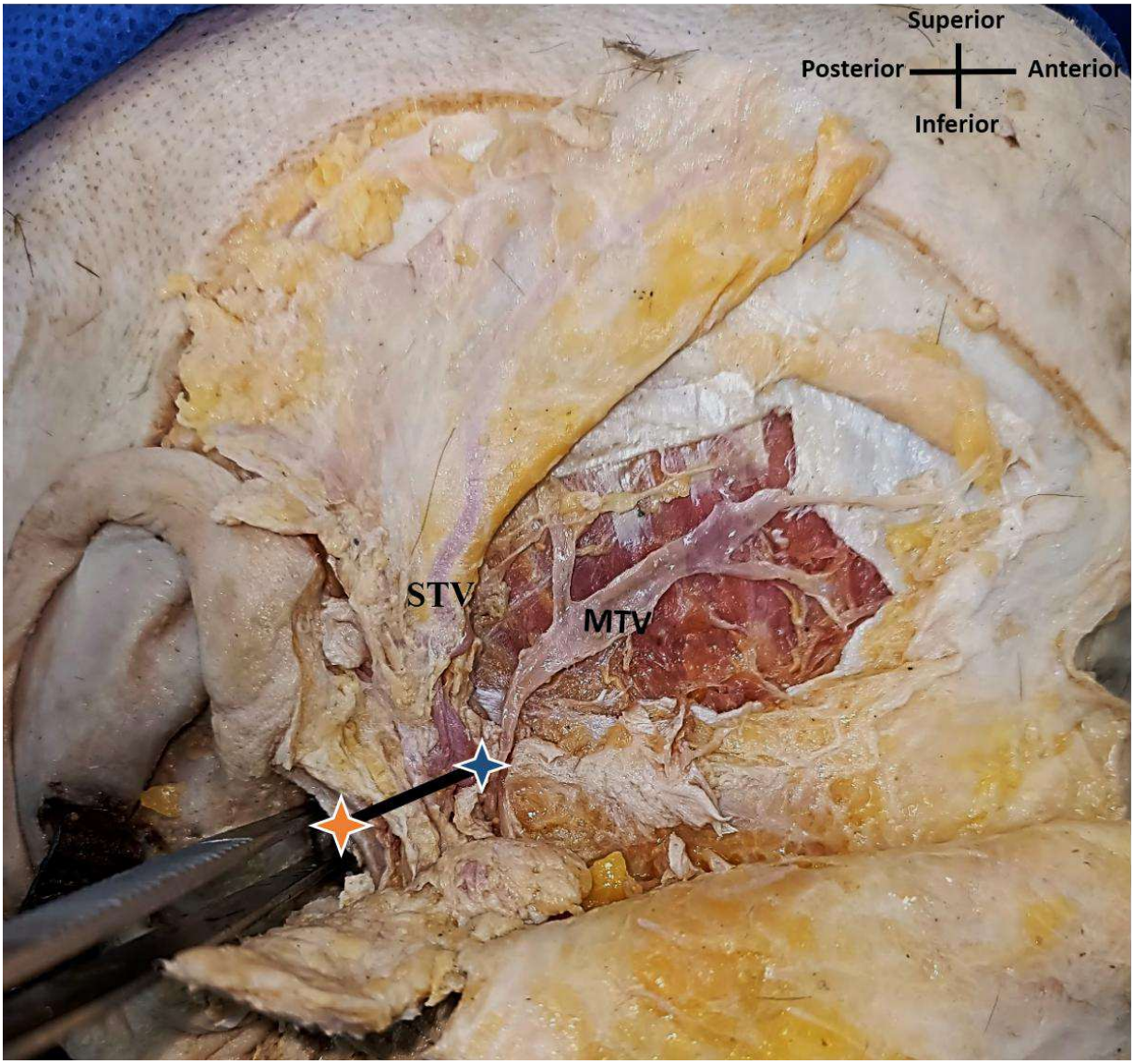


Figure (6): A cadaveric dissection of the right temporal region of fresh frozen adult male human cadaveric specimen showing measuring of the distance (black line) between termination of the middle temporal vein (MTV, blue star), where it drains into the superficial temporal vein (STV), and the middle of the anterior border of the external auditory meatus (EAM, orange star) by using ruler.

Table (4): The mean distance between the middle of the anterior border of the external auditory meatus and point of meeting between the MTV and the STV among the eighteen dissected cadavers.

Cadaver number	Right (mm)	Left (mm)
1	5	6
2	7	10
3	13	15
4	20	18
5	9	8
6	18	10
7	21	19
8	10	14
9	22	21
10	8	7
11	15	16
12	6	5
13	17	20
14	15	19
15	12	11
16	14	12
17	7	22
18	20	17
Min. – Max	5.0 – 22.0	5.0 – 22.0
Mean ± SD	13.28 ± 5.57	13.89 ± 5.44
t(p)	0.560 (0.583)	

t: Paired t-test

p: p value for comparing between **Right** and **Left**

DISCUSSION

The aesthetic significance of the temporal fossa becomes evident when individuals seek aesthetic counsel and intervention to present concerns like soft tissue atrophy, loss of facial volume, and changes in skin texture and color[19].

The complications associated with filler injection are impacted by the physiological and chemical compositions of the product. Additionally, the body's physiological reaction to the filler itself plays a significant role. The proficiency of the doctor performing the procedure and the time of recognizing and management of complications are essential factors[20].

There have been few anatomical studies conducted on the MTV, and even fewer studies have included measurements of the vein. Consequently, some of the findings in the current study have not been reported earlier[10].

The findings during cadaveric dissection of the current study are consistent with previous studies conducted by Cotofana et al[21]. and huang et al.[22]in that the temporal region consists of ten layers starting from superficial to deep as follows: skin, superficial fatty layer, superficial temporal fascia, temporo-parietal fat pad, superficial layer of the deep temporal fascia, superficial temporal fat pad, deep layer of the deep temporal fascia, deep temporal fat pad, temporalis muscle, and periosteum.

The current study identified the presence of temporo-parietal fat pad, superficial temporal fat pad, and deep temporal fat pad. The MTV was observed to be situated within the superficial temporal fat bad.

Beheiry and Abdel-hamid[23] conducted anatomical study using 44 specimens consist of two stillbirths and 20 embalmed cadavers at Faculty of Medicine, Alexandria University. They reported the presence of three temporal pads of fat superficial, intermediate, and deep. The superficial temporal pad of fat referred to as the temporo-parietal fat pad in the present study, the intermediate temporal pad of fat referred to as the superficial temporal fat pad in the present study, and the deep temporal pad of fat referred to as the deep temporal fat pad in the present study. They referred to the MTV as temporal venous sinus, which was found to be embedded within the deep and intermediate temporal pads of fat. This corresponds with the results of the current study.

During dissection in the present study, the lateral orbital rim at level of lateral canthus of the eye, the middle of the anterior border of the external auditory meatus and the most prominent part of zygomatic arch were used as anatomical landmarks.

Yano et al[17] conducted an anatomical study using a total of 60 sides of 30 cadavers; 15 men and 15 women. This study was done at the Tokyo Medical and Dental University. They determined the lateral orbital rim at level of lateral canthus of the eye, the external auditory meatus and the most prominent part of zygomatic arch as anatomical landmarks. The measurements reported by them differ from those reported in the present study, which may be attributed to racial differences.

The current study revealed that the MTV began its course as a continuation of the sentinel vein in 28 / 36 specimens (77.78%) after piercing the superficial layer of the deep temporal fascia at the superolateral orbital rim. It drains the area adjacent to the lateral orbital rim by union of the superciliary vein and the lacrimal vein. This is in agreement with the anatomical studies conducted by Trinei et al[24]and huang et al.[22], who revealed that the sentinel vein was situated lateral to

the lateral orbital rim and traversed from the subcutaneous layer through the temporo-parietal fascia, continuing its course as middle temporal vein.

The current study reported that in 7 / 36 specimens (19.44%), the MTV was found to be formed by two transversely oblique veins draining the periorbital region. In 1 / 36 specimens (2.78%), the MTV was found to run vertically and formed by two descending tributaries. The above-mentioned two patterns of the beginning of the MTV were not reported earlier.

Yang et al[25]. referred in their study to the sentinel vein as medial zygomaticotemporal vein (MZTV). The MZTV receives the periorbital vein then continue to form the MTV. This agrees with the results of the current study which found that the MTV began its course as the sentinel vein.

In the current study, the MTV was found to begin away from the lateral orbital rim at level of lateral canthus of the eye by 53.61 ± 8.02 mm on the right side and 55.72 ± 7.59 mm on the left side.

Tansatit et al[26] revealed that the origin of the MTV typically was at the level of the lateral eyebrow, situated just posterior to the orbital margin and superficial to the lateral orbital thickening. However, they didn`t determine the distance of the beginning of the MTV from the lateral orbital rim.

Yano et al[17] reported that the middle temporal vein originated at a mean distance of 52.0 ± 6.5 mm from the lateral orbital rim at the level of the lateral canthus of the eye. These statistics closely align with the findings of the current study. The range of the distance of the beginning of the MTV ranged from 42 to 65 mm in both studies.

Trinei et al[24] reported that the distance between the beginning of the sentinel vein and lateral canthus of the eye ranged from 20 to 44 mm. However, they didn`t report the distance of the beginning of the MTV from the lateral canthus of the eye.

Longmore and McRae [27]reported that the MTV began from many small periorbital veins and is the continuation of the SV. Furthermore, two to four venous tributaries, emerging from the temporalis muscle and parallel to its muscle fibers, descend toward the trunk of the MTV. This aligns with the findings of the present study, which proved the presence of a few small tributaries originating from the temporalis muscle, descending towards the primary stem of the middle temporal vein.

The current study reported that the middle temporal vein, with its main tributaries within the superficial temporal fat pad, displayed one of five distinct morphological patterns. Type 1: One main curved horizontal trunk was present in 63.89% of the specimens. Type 2: Two large veins converged from the periorbital region to form one curved horizontal trunk in 19.44% of the specimens. Type 3: One main curved horizontal trunk receiving one small descending tributary in 11.11% of the specimens. Type 4: One main vertical trunk receiving two descending tributaries in 2.78% of the specimens. Type 5: One main curved horizontal trunk receiving two descending tributaries and two smaller ascending tributaries in 2.78% of the specimens.

Yano et al[17] reported that within the superficial fat pad, the distribution of the middle temporal vein followed one of four patterns as follows: type 1 had only one major trunk, type 2 had two large trunks that ran in parallel then joined to form one major trunk, type 3 had one major trunk with one small descending tributary, and type 4 one large trunk with two small descending tributaries that confluent together. These four patterns reported by Yano et al[17] may coincide

with the first four patterns reported by the present study; however, type 5 pattern was not reported earlier.

In the present study, the average diameter of the MTV at its termination in the superficial temporal vein (STV) was found to be 2.42 ± 0.65 mm on the right side and 2.69 ± 0.60 mm on the left side.

Wang et al[28]conducted Computed Tomographic Angiography images of 300 MTVs from 150 Asian patients. They reported that the average diameter of MTV was 2.98 ± 0.80 mm. However, they didn`t report the exact site of measuring the diameter of the MTV.

Kagaya et al[29]determined that the average diameter of the MTV in dynamic Computed Tomographic images of 70 MTVs from 35 Japanese patients was 2.94 ± 0.55 mm at the level of the palpebral fissure.

Yano et al[17] reported that the average diameter of MTV in 60 preserved Japanese cadaveric specimens was 1.81 ± 0.56 mm. However, they didn`t report the exact site of measuring the diameter of the MTV, and the variation observed could be attributed to racial differences.

Jung et al.[30] reported that the MTV`s diameter at its thickest point was 5.1 mm in 18 hemifaces from 9 Korean cadavers. This disagrees with the current study findings and with the other mentioned studies[17,28-30] This difference can be attributed to variations in the point of measuring the diameter.

Longmore and McRae[27]dissected the MTV in 11 preserved cadavers and found that it had a diameter ranging from 3 mm to 10 mm.

Certainly, it's important to consider that the observed variation in diameters could be influenced by changes in the point of measuring the diameter.

The mean length of MTV in the present study was found to be 36.33 ± 12.8 mm on the right side and 36.67 ± 12.02 mm on the left side, ranging from 15 to 58 mm. These results agree with Abul-Hassan et al[31], who reported that the MTV`s length ranged from 10 to 60 mm.

In the current study, it was observed that the mean vertical distance between the most prominent part of the zygomatic arch and the MTV was 22.85 ± 5.32 mm on the right side and 22.19 ± 5.20 mm on the left side. Its range was from 15.2 mm to 33 mm. Based on this result, the venous dangerous zone, where filler injection should be avoided, is located within 1.5 - 3.5 cm above the zygomatic arch.

Brennan[32]reported that the dangerous zone in the temporal region lies within 1.5 cm to 3 cm above the zygomatic arch within the interfacial space, and this relatively corresponds with the results of the current study.

Jung et al[30]reported that the MTV was found to be located at 23.5 mm (15.7–33.6 mm) and 18.5 mm (12.5–23.5 mm) above the level of the zygomatic arch at the jugale and the zygion, respectively. So, they stated that the safest area for filler injection in the temporal region is one finger`s width above the zygomatic arch, and this corresponds with the results of the current study.

Wang et al.[28]reported that the vertical distance of the MTV above the jugale and zygion points on the zygomatic arch, based on Computed Tomographic Angiography images of 300 MTVs from 150 Asian patients, was 24.8 ± 4.5 mm, and 24.2 ± 4.6 mm respectively.

The present study proved that the MTV pierced the superficial layer of the deep temporal fascia, the temporo-parietal fat pad, and the superficial temporal fascia before draining into the superficial temporal vein.

Beheiry and Abdel-hamid[23]reported that the MTV during its termination pierced the superficial layer of the deep temporal fascia, the loose areolar fascia, and the superficial temporal fascia to drain into the superficial temporal fascial venous plexus. This corresponds with the results obtained in the present study.

Tansatit et al.[26] reported that the MTV received the superficial temporal vein, which accompanies the temporal branch of the superficial temporal artery, around the preauricular point. This is the last tributary before the formation of the retromandibular vein. This corresponds with the results of the present study.

The current study reported that the point of termination of the MTV into the STV was located at a mean distance of 13.28 ± 5.57 mm on the right side and 13.89 ± 5.44 mm on the left side from the middle of the anterior border of the external auditory meatus. The range was from 5 mm to 22 mm. This corresponds exactly with Yano et al[17]. who revealed that the point of meeting of the MTV with the STV was located at a distance ranged from 5 to 22 mm anterior to the external auditory meatus. This range coincide with the results of the present study. However, they reported the mean and SD of the measurements as 12.0 ± 4.6 mm from the external auditory meatus.

Limitations of the current study:

The main limitation of the current study was the small sample size.

Clinical trial number: not applicable.

Conclusion

There were five morphological patterns for the MTV with its main tributaries; four of which the MTV was curved horizontal, and one pattern was vertical vein. For safe filler injection in the temporal region and to avoid serious complications associated with intravenous filler injection such as NTPE, it is crucial to identify and avoid the venous dangerous zone where the middle temporal vein (MTV) is located as well as the mean diameter and length of the MTV. The range of the diameter of the MTV ranged from 1.45 mm to 3.5 mm and the range of its length ranged from 15mm to 68 mm. The venous dangerous zone was located within 1.5 - 3.5 cm above the zygomatic arch due to the presence of the MTV• The safe areas for filler injection in the inter-fascial space of the temporal region are within 1.5 cm above the zygomatic arch and additionally, from 3.5 cm above the zygomatic arch till the temporal crest.

Abbreviations

MTV: middle temporal vein; SV: sentinel vein; STV: Superficial temporal vein; STFP: superficial temporal pad fat; SCV: superciliary vein; ZA: zygomatic arch; LV: Lacrimal vein; NTPE: non thrombotic pulmonary embolism; MZTV: medial zygomaticotemporal vein.

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Authors' contributions

AIAH, EEBE: Protocol development, dissection of cadavers, data collection, data analysis, and manuscript writing/editing. RRAH, SMMH: Protocol development, dissection of cadavers, data

collection, data analysis, and manuscript writing/editing. The authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This work was done on cadaveric specimens obtained from the dissection room of Anatomy department, Faculty of Medicine, Alexandria University. With no violations to any rights and or ethics. All were for unknown individuals and the Alexandria faculty of medicine is the legally authorized for the cadaveric specimens and the research protocol was approved by the local ethics committee of Faculty of Medicine, Alexandria University (IRB No: 00012098-FWA No: 00018699). Consent to participate was not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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