

True Retaining Ligaments of Face as Surgical Landmarks

Los Verdaderos Ligamentos de Retención de la Cara como Marcadores Quirúrgicos

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SUMMARY: The adherence of the overlying tissues to the underlying structures in the face is maintained by the retaining ligaments. True retaining ligaments named orbital, zygomatic and mandibular ligaments are a series of fibrous bands that run from periosteum to the dermis. The tethering effect of true retaining ligaments must be released for achieving a satisfactory movement of facial skin and Superficial Muscular Aponeurotic System (SMAS) during facial rejuvenation procedures. The aim of this study was to define the location of the true retaining ligaments of the face and to discuss their usability as surgical landmarks. The study was made on ten hemi-faces of formaline-fixed cadavers. Dissections resembling face-lift procedures were applied and ligaments were determined. The distances of the ligaments to lateral canthus, tragus and commissure and to the lines from tragus to lateral canthus and commissure were measured. Correlations were investigated statistically. The distances of the zygomatic and mandibular ligaments from the tragus were 66.50 ± 10.78 mm and 114.80 ± 9.76 mm respectively. The distances of the zygomatic ligament from the commissure and the commissure tragus line were 56.30 ± 8.94 mm and 28.40 ± 5.19 mm respectively. The distances of zygomatic and mandibular ligaments from the tragus were strongly correlated with a ratio of 3/5 and there was a strong correlation between the distances of the zygomatic ligament from the commissure and commissure- tragus line with a ratio of 2. The results of this study elucidated the possibility of the use of the true retaining ligaments as surgical landmarks for facial surgery.

KEY WORDS: Retaining ligaments; Facial ligaments; Face-Lift; Facial rejuvenation; Facial nerve.

INTRODUCTION

The adherence of the overlying tissues to the underlying structures in the face are maintained by condensation of the fibrous connective tissue known as retaining ligaments (Furnas, 1989; LaTrenta, 2004). The retaining ligaments of the face support the soft tissue in normal anatomic position (Ozdemir *et al.*, 2002). Facial soft tissues descend as a result of loosening of these ligaments with aging by the effect of gravity and the stigmata of the aging face develop (Stuzin *et al.*, 1992; Ozdemir *et al.*).

The retaining ligaments of the face can be classified as true and false. True retaining ligaments are a series of fibrous bands that run from the periosteum to the dermis. False retaining ligaments tether the intervening facial tissue layers to each other (Stuzin *et al.*; LaTrenta).

Firstly, two of the true retaining ligaments, zygomatic and mandibular, were defined (Furnas; Stuzin *et al.*). Later, orbital ligament was added to the list as the third one (Knize,

1996). Currently, orbital, zygomatic and mandibular ligaments are accepted as the true retaining ligaments of the face (LaTrenta).

Orbital ligament lies between the superolateral orbital rim and the superficial temporal fascia (Knize).

Zygomatic ligament is the most significant of the retaining ligaments in the midface and originates at or near the inferior margin of the anterior third of the zygomatic arch, just behind the insertion of the zygomatic muscles. A typical grouping is a bundle of white, firm fibers 3 mm in width and 0.5 mm in thickness. Several groupings may be occasionally present (Furnas; LaTrenta).

The mandibular ligament originates from the bone along a line that is about one centimeter above the mandibular margin and extends along the anterior third of the mandibular body (Furnas; LaTrenta). The posterior margin of the

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ligament is usually palpable as a firm, sharp margin (Furnas). These ligaments securely fix the parasymphysial dermis to the underlying mandible (Stuzin *et al.*).

True retaining ligaments must be released during a face-lift to achieve desirable results (LaTrenta; Huettner *et al.*, 2015). Dissection in the face comprises the danger of injury to the facial nerve and estimation of the location of the retaining ligaments is important for avoidance of such injuries. Face has a highly organized and consistent connective tissue framework supporting the overlying skin and soft tissues. The nerves and vessels display constant and predictable relationships with ligamentous attachments. Hence, retaining ligaments are also useful landmarks for the vital neurovascular structures (Moss *et al.*, 2000; Alghoul *et al.*, 2012). However, to our best knowledge practically none of the topographical definitions of safe and danger areas of face includes these ligaments as landmarks (Pitanguy & Ramos, 1966; Ishikawa, 1990; Davies *et al.*, 2012).

The aim of this study was to define the location of the true retaining ligaments of face and discuss their usability as surgical landmarks on the basis of superficial markings, measurements and correlations.

MATERIAL AND METHOD

The study was made on ten hemi-faces of formalin-fixed cadavers. Classical face-lift incision was performed extending inferiorly to the chin below the mandible. Subcutaneous and sub-SMAS dissection was made toward the lateral brow, nasolabial fold and mentolabial fold. Orbital ligament was found on the superior lateral orbital rim, the zygomatic ligament on the malar eminence and the mandibular ligament on the parasymphysial area (Fig. 1a and 1c).

The lateral canthus, posterior end of the tragus and commissure were marked as reference points with 3 pins with colored heads and the center of each ligament over the skin were also marked with 3 pins. A nylon thread was stretched from the tragus to lateral canthus and commissure (Fig. 1b).

Following distances were measured with a pair of compasses in millimeters:

- 1) CT: Lateral canthus to tragus
- 2) ComT: Commissure to tragus
- 3) CT- O: Orbital ligament to the canthus- tragus line
- 4) CT- Z: Zygomatic ligament to the canthus- tragus line
- 5) CT- M: Mandibular ligament to the canthus- tragus line
- 6) ComT- O: Orbital ligament to the commissure- tragus line
- 7) ComT- Z: Zygomatic ligament to the commissure- tragus line
- 8) ComT- M: Mandibular ligament to the commissure- tragus line
- 9) T- O: Orbital ligament to tragus
- 10) T- Z: Zygomatic ligament to tragus
- 11) T- M: Mandibular ligament to tragus
- 12) C- O: Orbital ligament to lateral canthus
- 13) C- Z: Zygomatic ligament to lateral canthus
- 14) C- M: Mandibular ligament to lateral canthus
- 15) Com- O: Orbital ligament to commissure
- 16) Com- Z: Zygomatic ligament to commissure
- 17) Com- M: Mandibular ligament to the commissure

Statistical analysis was done with the SPSS 11.5 program. Mean values and standard deviations were calculated and correlation coefficients were determined by using Pearson correlation analysis. $p < 0.05$ was accepted as statistically significant.



Fig. 1. a) Orbital, zygomatic and mandibular ligaments are seen from cranial to caudal direction, respectively. b) Topographic presentation of three ligaments and a nylon thread stretched from tragus and commissure and lateral canthus. c) The relationship of the zygomatic major muscle and the zygomatic ligament.

RESULTS

The mean values of the measurements, minimum and maximum values and standard deviations are presented in Table I.

The mean distances of the lateral canthus to tragus (CT) and commissure to tragus (ComT) were 81.90 ± 5.24 (73.0–87.0) mm and 105.50 ± 8.30 (96.0–120.0) mm, respectively. There was a very strong and significant correlation between CT and ComT (0.904, $p = 0.000$).

Orbital ligament was located at the superior lateral rim, lateral to the eyebrow and 6.0–23.0 mm from lateral canthus (14.20 ± 5.33 mm). Distance of orbital ligament to lateral canthus was correlated with CT (0.728, $p = 0.017$), CT-O (0.679, $p = 0.031$), CT-M (0.805, $p = 0.005$), ComT-O (0.687, $p = 0.028$), C-M (0.754, $p = 0.012$), Com-O (0.881, $p = 0.001$) and Com-M (0.704, $p = 0.023$).

Zygomatic ligament was located lateral to the origin of the zygomaticus major muscle, at the junction of the zygomatic arch and the body of the zygomatic bone (Fig. 3). The mean distances of the zygomatic ligament from tragus (T-Z), lateral canthus (C-Z) and commissure (Com-Z) reference points were 66.50 ± 10.78 (48.0–80.0) mm, 29.60 ± 6.72 (20.0–39.0) mm and 56.30 ± 8.94 (44.0–70.0) mm, respectively. Distance of zygomatic ligament to tragus was strongly correlated with CT-Z (0.792, $p = 0.006$), T-M (0.713, $p = 0.021$) and C-Z (-0.703 , $p = 0.023$). The mean T-Z was 66.50 ± 10.78 (48.0–80.0) mm and T-M was

114.80 ± 9.76 (102.0–139.0) mm. Distance of zygomatic ligament to commissure was found to be correlated with CT-O (0.713, $p = 0.021$), CT-Z (-0.657 , $p = 0.039$), ComT-O (0.845, $p = 0.002$), ComT-Z (0.648, $p = 0.043$) and Com-O (0.711, $p = 0.021$). Distance of zygomatic ligament to lateral canthus was strongly correlated with only T-Z and it was a reverse correlation (-0.703 , $p = 0.023$).

Mandibular ligament was observed approximately 1 cm above the body of the mandible as fibers parallel to the ground medial to the labiomandibular fold. The mean distances of the mandibular ligament from tragus, lateral canthus and commissure reference points were 114.80 ± 9.76 (102.0–139.0) mm, 99.20 ± 9.52 (83.0–115.0) mm and 32.90 ± 8.08 (20.0–45.0) mm, respectively. Distance of mandibular ligament to tragus was significantly correlated with Com-T (0.696, $p = 0.025$) and T-Z (0.713, $p = 0.021$). Distance of mandibular ligament to lateral canthus was found to be correlated with CT-O (0.0788, $p = 0.007$), CT-M (0.948, $p = 0.000$), ComT-O (0.758, $p = 0.011$), ComT-M (0.689, $p = 0.028$), C-O (0.754, $p = 0.012$) and Com-O (0.903, $p = 0.000$). Distance of mandibular ligament to commissure and C-O were also correlated (0.704, $p = 0.023$).

DISCUSSION

Temporal region is separated into two compartments named upper temporal compartment and lower temporal compartment by inferior temporal septum. Upper margin of the upper temporal compartment is constituted by superior

Table I. The mean values of the measurements, minimum and maximum values and standard deviations (* All measurements are in millimeters).

	Minimum	Maximum	Mean	SD
CT	73.00	87.00	81.90	5.24
ComT	96.00	120.00	105.50	8.30
CT-O	8.00	22.00	12.00	4.08
CT-Z	8.00	29.00	19.50	6.20
CT-M	78.00	119.00	96.70	11.51
ComT-O	50.00	75.00	62.20	8.95
ComT-Z	19.00	36.00	28.40	5.19
ComT-M	20.00	39.00	30.10	6.85
T-O	70.00	84.00	77.40	4.22
T-Z	48.00	80.00	66.50	10.78
T-M	102.00	139.00	114.80	9.76
C-O	6.00	23.00	14.20	5.33
C-Z	20.00	39.00	29.60	6.72
C-M	83.00	115.00	99.20	9.52
Com-O	70.00	103.00	84.40	10.59
Com-Z	44.00	70.00	56.30	8.94
Com-M	20.00	45.00	32.90	8.08

temporal septum. Superior temporal septum takes origin along the superior temporal line of the skull. Inferior temporal septum determines the lower margin of the upper temporal compartment and the upper margin of the lower temporal compartment. The expanded anterior end of the superior temporal septum forms the orbital ligament and orbital ligament forms the anterior boundary of the upper temporal compartment. Inferior temporal septum extends from the lateral corner of the orbital ligament toward the external acoustic meatus. There is no specific structures crossing the upper temporal compartment and it is a safe area for surgical dissection. Lower boundary of the lower temporal compartment is formed by the zygomatic ligaments. Tissue planes are more adhered and there is no clear dissection plane in the lower temporal compartment and this compartment contains temporal branches of the facial nerve, zygomaticotemporal nerve and the sentinel vein. Therefore, lower temporal compartment is a danger area (Moss *et al.*; O'Brien *et al.*, 2013). Orbital ligament confines the anterior margin of the upper temporal compartment and zygomatic ligament confines the lower margin of the lower temporal compartment. Both ligaments are important surgical landmarks. However, to our best knowledge none of the topographical definitions of the danger and safe areas for the temporal branch of facial nerve take into consideration these retaining ligaments (Pitanguy & Ramos; Ishikawa; Davies *et al.*, 2012).

Knize had defined the orbital ligament lied between the superolateral orbital rim and the superficial temporal fascia. Moss *et al.*, had proposed that the orbital ligament inserted the superficial temporal fascia and the galea on the deep surface of the frontalis muscle and the base of the ligament was 10 mm above the orbital rim. Sullivan *et al.* (2006) reported that orbital ligament was extending between the superolateral orbital rim and superficial temporal fascia. In the present study, orbital ligament was determined at the superior lateral rim extending lateral to the eyebrow and approximately 14.20 ± 5.33 (6.0–23.0) mm away from the lateral canthus.

Temporal branch of the facial nerve leaves the superior pole of the parotid gland as 2–4 rami by perforating its capsule (Gosain *et al.*, 1997; Moss *et al.*; Tzaferatta & Terzis, 2010). Temporal branch travels toward the zygomatic arch beneath the parotidomasseteric fascia and crosses the arch at a deep plane. Above the arch, the nerve passes into the innominate fascia first and then undersurface of the temporoparietal fascia (Owsley & Agarwal, 2010). It was determined that temporal branch was within the innominate fascia 1 cm above zygomatic arch and within the temporoparietal fascia 2 cm above it. Temporal branch of the facial nerve travels within the temporoparietal fascia in

the lower temporal compartment (Trussler *et al.*, 2010). Lower temporal compartment is a danger area because of the superficial course of the temporal branch in this region. The mean distance of the upper zygomatic ramus was 4.05 ± 2.25 mm from the zygomatic retaining ligament (Alghoul *et al.*). Zygomatic ligament is an important landmark for both the temporal and the zygomatic nerve.

The zygomatic ligament was determined at the junction of the zygomatic arch and the body of the zygomatic bone. It was 66.50 ± 10.78 (48.0–80.0) mm from the tragus, 29.60 ± 6.72 (20.0–39.0) mm from the lateral canthus and 56.30 ± 8.94 (44.0–70.0) mm from the commissure in the present study. The distance of the zygomatic ligament from the tragus had been reported as 45 mm by Furnas; 42–48 mm in men and 39–45 mm in women by Ozdemir *et al.*; 44.91 ± 9.72 mm by Alghoul *et al.*, and 50 ± 0.336 mm by Rossell-Perry & Paredes-Leandro (Furnas; Ozdemir *et al.*; Alghoul *et al.*; Rossell-Perry & Paredes-Leandro, 2013). We suggest that it may be related to the freshness of the cadavers in the above mentioned studies contrary to our embalmed cadavers and the points selected for measurements on the tragus and the ligament.

The marginal mandibular branch of the facial nerve exits the parotid gland along its anteroinferior aspect (Liebman *et al.*, 1988; Owsley & Agarwal; Davies *et al.*, 2016). The course and the number of the rami of marginal mandibular nerve present great variation according to the different studies. It consists of usually two rami (Dingman & Grab, 1962; Wang *et al.*, 1991), usually three rami (Savary *et al.*, 1997), and at least three or more rami (Nelson & Gingrass, 1979). It runs usually superior to the lower margin of the mandible (Dingman & Grab; Tzaferatta & Terzis; Huettner *et al.*) and almost always below the lower margin of the mandible (Baker & Conley; Davies *et al.*, 2016). Later, major rami of the marginal mandibular branches divide and pass directly to the surface of the mandible to travel beneath the depressor anguli oris and depressor labii inferioris muscles (Dingman & Grab). In the present study, we observed that the mandibular ligament demarcated the transition between the labiomandibular fold and the anterior margin of the jowl area as reported in previous studies (Furnas; Stuzin *et al.*). Mandibular ligament fixes the skin anterior to it and defines the anterior-most margin of the marionette lines (Huettner *et al.*). It was reported that terminal branch of the marginal mandibular nerve was determined approximately 2 cm from the modiolus (Liebman *et al.*). Huettner *et al.*, had determined the terminal branch of marginal mandibular nerve 9.7 ± 1.2 mm cranial to the mandibular ligament. The mean distance of the mandibular ligament was 32.90 ± 8.08 mm from the commissure and this result was consistent with both studies. The release of mandibular

ligaments are not always necessary during facelift procedures and some surgeons prefer not to release them (Huettnner *et al.*). In this area there is an increased tissue adhesiveness and terminal branches of marginal mandibular nerve pass from subplatysmal level to superficial to the platysma (Liebman *et al.*). We suggest that if the surgeon will make an intervention anterior to the labiomandibular fold, mandibular ligaments may be useful surgical landmarks for the estimation of the location of the terminal branches of the marginal mandibular nerve.

The presence of strong and significant correlation (0.904, $p=0.000$) between the distances of canthus to tragus (C-T) and commissure to tragus (Com-T) was implied that Turkish faces were proportional and the ratios provided in the present study might be used for the estimation of the location of an expected structure. The mean distances of C-T and Com-T were 81.90 ± 5.24 (73.0–87.0) mm and 105.50 ± 8.30 (96.0–120.0) mm, respectively and there was a 4/5 ratio between them. There was a strong and significant correlation (0.713, $p=0.021$) between the distances of zygomatic ligament to tragus (T-Z) and mandibular ligament to tragus (T-M) which meant that they were dependent variables. The mean distances of T-Z and T-M were 66.50 ± 10.78 and 114.80 ± 9.76 , respectively. There was a 3/5 ratio between the two measurements. This finding implied that when a surgeon defined the location of one of these ligaments, it might be possible to estimate the location of the other one. The mean distance of zygomatic ligament to commissure (Com-Z) was 56.30 ± 8.94 and zygomatic ligament to commissure- tragus line (ComT-Z) was 28.40 ± 5.19 and they were significantly correlated (0.648, $p=0.043$) with each other with a ratio of 2.

The true retaining ligaments have easily definable superficial markers on the face and they have constant relations with vital structures. Also the ratios we defined in the present study may be useful for surgeon to define the location of the true retaining ligaments. We suggest that new definitions of danger and safe areas based on the location of retaining ligaments are worth to be considered.

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RESUMEN: La adherencia de los tejidos que recubren a las estructuras subyacentes en la cara se mantiene por los ligamentos de retención. Los ligamentos de retención verdaderos llamados ligamentos orbitales, cigomático y mandibular son una serie de bandas fibrosas que se extienden desde el periostio a la dermis. El efecto de la inmovilización de los verdaderos ligamentos de retención debe ser liberado para lograr un movimiento satisfactorio de

la piel del rostro y del SMAS durante los procedimientos de estiramiento facial. El objetivo fue definir la ubicación de los verdaderos ligamentos de retención de la cara para discutir su utilidad como puntos de referencia quirúrgicos. El estudio se realizó sobre diez hemi-caras de cadáveres, fijadas con formalina. Las disecciones se asemejaron a los procedimientos de estiramiento facial, se aplicaron y determinaron los ligamentos. Se midieron las distancias de los ligamentos al canto lateral, trago, comisura y a las líneas de trago a canto lateral y comisura. Las correlaciones fueron analizadas estadísticamente. Las distancias de los ligamentos cigomático y mandibular desde el trago fueron $66,50\pm 10,78$ mm y $114,80\pm 9,76$ mm, respectivamente. Las distancias del ligamento cigomático a la comisura y la línea de comisura al trago fueron $56,30\pm 8,94$ mm y $28,40\pm 5,19$ mm, respectivamente. Las distancias de los ligamentos cigomático y mandibular desde el trago estaban correlacionadas de forma importante con una relación de 3/5 y había una fuerte correlación entre las distancias del ligamento cigomático desde la línea de comisura y el trago - con una relación de 2. Los resultados de este estudio han dilucidado la posibilidad de la utilización de los verdaderos ligamentos de retención como puntos de referencia quirúrgicos para la cirugía facial.

PALABRAS CLAVE: Ligamentos de retención; Ligamentos faciales; Estiramiento facial; Nervio facial.

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