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The anatomical and functional characteristics of parotid fascia

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Abstract

Parotid superficial and profound fascias are considered to originate from a bifurcation of the profound fascia. Its relations with the facial nerve, the continuity with platysma, temporal and zygomatic fascias suggest it is related to a superficial fascial complex rather with a profound one. The aim of this study is to add clues which sustain the theory of parotid fascia origin from superficial fascia of the face. The study was conducted on 12 cephalic extremities, which were meticulously dissected in the "Ion Iancu" Anatomy Institute of "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi, Romania, and on a group of 10 patients admitted to the Clinic of Maxillofacial Surgery, "St. Spiridon" Emergency Clinical Hospital, Iaşi, patients which were clinically and imagistically diagnosed [computed tomography (CT), magnetic resonance imaging (MRI)] with parotid tumors and underwent surgical interventions for total or partial parotidectomy. On each stage of dissection mesoscopic images were acquired, examined and further processed to remark the regional stratigraphic differences. Surgical interventions have allowed us segmental anatomical studies, providing *in vivo* visualization of the fascial and muscular structures, evaluating the possibilities of dissociating the plans and appreciating their vasculature. The collected specimens were processed by paraffin technique and stained with H special techniques for muscular and connective tissue. The results are clearly showing the belonging of parotid fascia to the superficial fascia of face.

Keywords: superficial muscular aponeurotic system, parotid fascia, facial nerve.

Introduction

The parotid fascia is forming a capsule around the gland, together with the masseteric fascia. It sheaths the parotid gland, its excretory duct and the branches of the facial nerve as well. Commonly is considered that parotid fascia proceeds of the superficial layer of the deep cervical fascia, which splits to cover the gland [1]. It is named parotid fascia because it is related to the lateral side of capsule. The fascia itself is made of two layers: *lamina superficialis* that runs upwards to be continued by the temporal fascia and lateral by the masseteric fascia, *lamina profunda* that covers the stylohyoid, the styloglossus and stylopharyngeus muscles. The superficial layer attaches to the zygomatic arch and to the mandibular body.

The aim of this study is to objectify the origin of the superficial parotid fascia, which is considered to be a duplication of the deep fascia, by analyzing its quantitative and qualitative anatomy. Plastic surgeons [2] consider that the superficial fascias of the mentonian, parotidian and cervical regions are interconnected. The entire connective tissue that makes this connection together with the skeletal muscles attached to it is nowadays considered to form a muscular aponeurotic cervico-facial unit [3]. The importance of our study derives from the practical utility of the superficial muscular aponeurotic system (SMAS) concept, which is continues also at parotidian level. This finding allows surgical techniques to minimize postoperative incidents. The main surgical approach to parotid tumor formations based on the SMAS concept is extracapsular lumpectomy with SMAS flap [4–6].

Basically, by preserving a flap of SMAS in parotid interventions, it can be reduced the risk of parotid Frey syndrome (gustatory sweating), and also minimizes the risk of postoperative infection and allows reconstruction of the parotid lodge [7, 8]. This is possible by maintaining characteristics of the facial SMAS at this level: it forms fascial tunnels for arteries and nerves and continues in neighboring regions. SMAS transmit, distribute and amplify the activity of all facial muscles [9].

The existence of SMAS at this level is not fully recognized by researchers [10, 11]. Indirect has long been used in plastic surgery techniques, but maxillofacial surgery partially adopts this concept and not from long time ago [12, 13]. Our study brings quantitative and qualitative evidence of the existence of SMAS at the parotid level.

Materials and Methods

Our study has highlighted the existence of SMAS at parotid level and the corresponding neurovascular elements. The material used was represented by 12 cephalic extremities, which were meticulously dissected in the "Ion Iancu" Anatomy Institute of "Grigore T. Popa" University of Medicine and Pharmacy, Iaşi, Romania. Each specimen was previously preserved in formaldehyde. Dissections were performed layer by layer and, on each stage of dissection mesoscopic images were captured by using the Kaps SOM 62 operating microscope. The conclusive aspects were acquired, examined and further processed to remark the regional stratigraphic differences.

We collected parotid tissue samples, through a perpendicular incision in the skin, which went deeper until the

level of parotid fascia. Simultaneously, we have conducted a study on a group of 10 patients admitted to the Clinic of Maxillofacial Surgery, "St. Spiridon" Emergency Clinical Hospital, Iaşi. Patients who were clinically and imagistically diagnosed [computed tomography (CT), magnetic resonance imaging (MRI)] with parotid tumors and underwent surgical interventions for total or partial parotidectomy.

Surgical interventions have allowed us segmental anatomical studies, depending on the surgical procedure, providing *in vivo* visualization of the fascial and muscular structures, evaluating the possibilities of dissociating the plans and appreciating their vasculature. The collected specimens were processed by paraffin technique and stained with special techniques for muscular and connective tissue (Szekely).

Results

In parotid region, superficial fascia presents numerous fat lobules and is part of the SMAS of head and neck, together with the mimic muscles, blood vessels and nerves that run across (Figure 1). They are separated by vertical supraSMAS and horizontal subSMAS fibers. The presence of infraSMAS horizontal tract has allowed us to obtain a layer of cleavage and surgical approach between the superficial and deep fascia. Highlighting of vertical tracts allowed us to affirm that it is a common feature with neighboring facial regions. These vertical tracts permit the removal and reattachment of a SMAS flap and, obviously represents the anatomical substrate of a major cosmetic result in parotidectomy techniques based on the existence of SMAS.

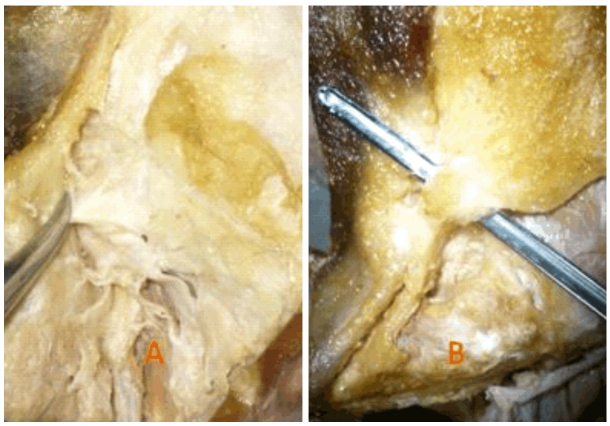

Figure 1 – ***Parotideo-masseteric fascia retaining ligament: the superior region (A) and the inferior region (B). Dissection specimen.***

In the posterior part of the parotid gland, the superficial fascia exhibits a condensation that forms a true hill for the gland. Here, the facial nerve, the facial artery and the external jugular vein enter the parotid gland. After dissecting the superficial and deep parotid fascia, we identified the branches of the facial nerve. They follow the fibrous expansions of the superficial fascia. Thus, we can assert that the superficial fascia forms tunnels for the terminal branches of the facial nerve, which allows us to map and preserve them. Continuing in-depth dissection, we identified the formation of the external jugular vein and the terminal segment of the external carotid artery. Vascularization and innervation of face skin is done directly through the superficial fascia.

Essential constituent of the SMAS is superficial fascia (Figure 2), which continues in all regions of the face, only muscles being different. Blood vessels and terminal branches of the facial nerve, crossing each several regions of the face are closely related to the superficial fascia, which mechanically protects them.

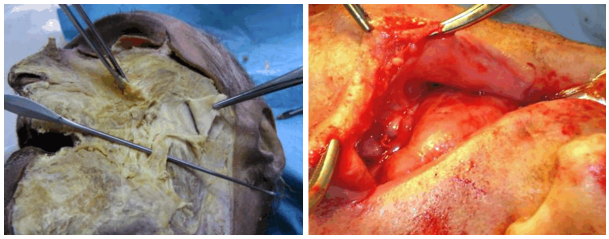

Figure 2 – ***Removing the superficial muscular aponeurotic system and parotid fascia: dissection specimen (left) vs. intraoperative image (right).***

The classical theory regarding origin of parotid fascia as derived from deep facial fascia is invalidated by its anterior continuity with platysma muscle fascia. In upper of the cheek, it makes the transition to the zygomatic region. Morphological, macroscopic and mesoscopic differences between the two regions stand out as a net line, "as a border strip" (Figure 3).

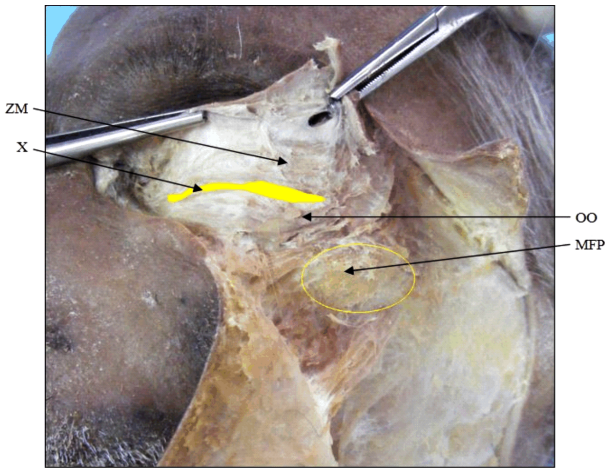

Figure 3 – ***The boundary between the upper and lower face (X) given by the great zygomatic muscle; stratigraphy of infraorbital region – great zygomatic muscle (ZM), inferior fascicle of orbicularis occuli (OO) muscle; molar fat pad (MFP).***

Although SMAS is intimately applied to the surface of the parotid gland, a thin, well-defined parotid fascia is identified between the gland and the SMAS. Superficial fascia facilitates adherence of mimic muscles to the dermis and deep fascia (Figures 4 and 5). This suggests that oral superficial fascia will follow chewing movements of the masseter muscle.

SMAS is well represented, with thick collagen fibers condensations, mostly disposed longitudinally, with dimensionally reduced interstitial spaces (Figures 6), in continuity with the neighboring regional fascias. The blood vessels are found only on the periphery of the lamina and are very small.

Distance to the deep, parotideo-masseteric fascia, is reduced, the fat infraSMAS layer being also reduced

and represented by a very thin lamina of adipose cells, crossed by thin collagen fibers obliquely oriented. Elastic fibers are completely absent.

Figure 4 – ***SMAS adhesions to deep fascia that secures the side of the parotid region. Dissection specimen.***

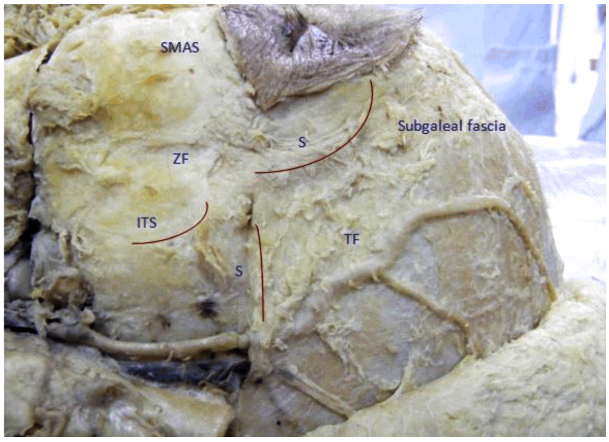

Figure 5 – ***Ligamentary supraorbital (S) adhesion, superior temporal septa (STS) and the inferior one (ITS). SMAS: Superficial muscular aponeurotic system; TF: Temporal fascia; ZF: Zygomatic fascia.***

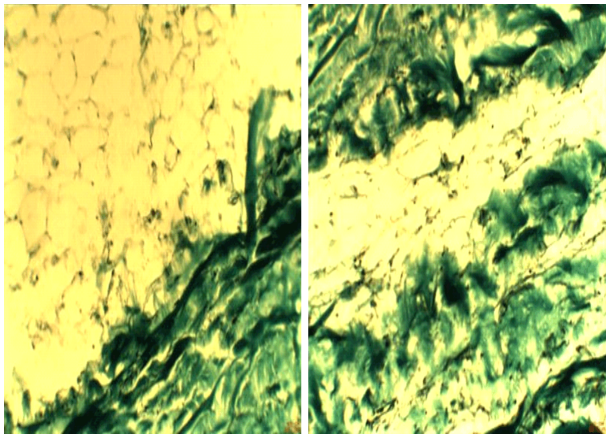

Figure 6 – ***Fibrous-adipose supraSMAS (left image) and infraSMAS (right image) tissue is well represented in the parotid region. Szekely staining, ×200.***

Fibro-adipose superficial layer is well represented with connective fascicles, observing numerous fat lobules separated by connective tracts and almost vertical or slightly oblique in one direction or another. There are predominantly medium-sized collagen fibers and rare elastic fibers.

Our observations support the quantitative data obtained on CT images from the group of patients that underwent surgery. In parotid region, fibroadipose superficial layer has an average thickness by the 4.31±3 mm, and deep fat layer is very thin, 0.34±0.47 mm. SMAS appears as a hyperdense line in the intimate relation to gland, with a thickness of 0.44±0.74 mm. In the parotid region, the superficial layers have different thicknesses: the supraSMAS fibrous tissue is well represented (Figure 7), the SMAS is a structured, dense organized connective tissue, the infra SMAS fat tissue forms a very thin lamina under which lies deep parotid fascia.

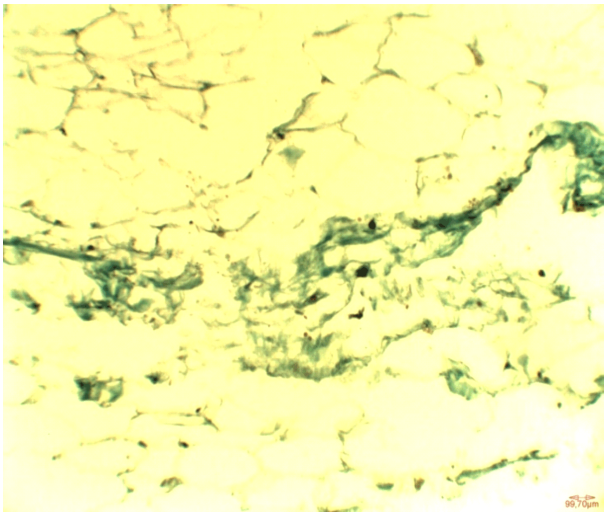

Figure 7 – ***SMAS fibrous layer, well represented in the parotid region. Szekely staining, ×200. SMAS: Superficial muscular aponeurotic system.***

CT investigation shows that the boundary between the two lobes of the gland is considered to be an area of continuity between the superficial and deep fascia (which forms the posterior capsule). Posterolaterally, parotid fascia is continued by a conjunctive part, which interconnects with superficial fascia and sternocleidomastoideus muscle fascia. Anteriomedially, fibrous tissue forms tunnels through which branches of the facial nerve are running (Figure 8).

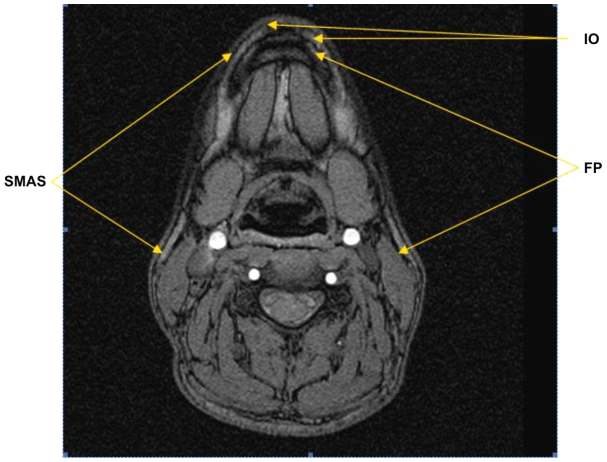

Figure 8 – ***Horizontal section through the lower edge of the mandible; SMAS and deep fascia (FP) between the parotid and mental region; transSMAS insert of the orbicular mouth, inferior fascicle (IO). SMAS: Superficial muscular aponeurotic system.***

Discussion

In the parotid region, the most important neighboring relation of the parotid fascia is that with the branches of the facial nerve and the maxilla. These nerves fibers are accompanied by branches of the external carotid artery. Preserving them is the greatest care of a surgeon who intervenes at this level [14]. Nowadays, by preserving these neurovascular bundles, it is possible to operate a complete face transplant.

Data obtained by imagistic records are consistent with those in the literature – quantitative measurements performed on CT [15] showed regional differences in thickness of the superficial layers of the face.

At the parotid level, the SMAS has individual features and also common morphofunctional characteristics with other facial regions [16]. The common features are that superficial fascia facilitates the adhesion of the mimic muscles from the region to the dermis, forms portvas and portnerve blades and presents an adipose supra and infraSMAS layer. Particular aspects of the parotid region, which we highlighted in this study, refer to the fact that the superficial layers have different thicknesses, the supra SMAS fibrous tissue is well represented, the SMAS is an ordered, dense organized connective tissue, infraSMAS adipose tissue forms a very thin blade under which there is a deep parotid fascia. The latter has a much dense structure, the collagen fibers constituting a dense structure with homogeneous masses in which separated fibers are not individualized. We can affirm they have a lamellar disposal [11, 17].

This reveals that the oral superficial fascia will follow the masticatory movements of the buccinator and masseter muscles, but also those of the great and small zygomatic muscles. These muscles are the infraSMAS layer in parotid region and thus take part in the formation of a unitary complex together with the superficial fascia.

The parotid SMAS continues with that of the adjacent regions, being fixed superiorly by the lower part of peri-orbital septum and zygomatic arch [18]. Medially, it adheres to the maxilla through the fibrous condensation of the nasolabial ditch. Inferiorly it is inserted at the lower edge of the mandible, from where it continues with the surface of the platysma. Laterally, it forms the anterior sheet of the parotid fascia. The great zygomatic muscle adheres to its front face at the superficial fascia.

The latter has a much dense structure, the collagen fibers constituting a dense structure with homogeneous masses in which fibers [19] are not individualized. We can say, they have a lamellar disposal and elastic fibers are thin and fragmented [20]. Therefore, elevation of the SMAS is concomitant with the muscle [21]. Although it is intimately applied to superficial surface of the parotid gland, a weak but distinct parotid fascia is identified between the gland and the SMAS.

The CT examination of patients supports the previous results, showing that, reaching the parotid gland, the superficial fascia gives rise to the anterior capsule of the gland, data that corresponds to literature [22]. The existence of a SMAS layer on the parotid capsule allows the application of techniques that have been used in facial lifting procedures and parotid tumors. This is a novelty in the techniques of maxillofacial surgery and improves the results of interventions at this level.

The identification of the facial nerve in its quadrilateral, its intraparotid dissection, and especially the fascial tunneling of its terminal branches, allows a better preservation of the nerve, in the main patient benefit [23]. The decrease in the incidence of postoperative infections to less than 1% and the higher aesthetic results [24–26] recommend the use of the concept of the single surface layer demonstrated by us in parotid surgery.

Conclusions

In the posterior part of the face, facial nerve branches have a profound situation, finding themselves into a musculo-fascial layer between the superficial and deep fascia (parotideo-masseteric) or intraglandular. Musculo-fascial superficial system is an independent plan that is individualized subcutaneous as a fat layer, just under the posterolateral areas of the face (parotideo-masseteric, oral and frontal), where there is a deep fascial support very well tensed functional.

Conflict of interests

The authors declare that they have no conflict of interests.

References

[1] Tamplen M, Knott PD, Fritz MA, Seth R. Controversies in parotid defect reconstruction. Facial Plast Surg Clin North Am, 2016, 24(3):235–243.
[2] Berry MG, Davies D. Platysma-SMAS plication facelift. J Plast Reconstr Aesthet Surg, 2010, 63(5):793–800.
[3] Khan HA, Bagheri S. Management of the superficial musculo-aponeurotic system (SMAS). Atlas Oral Maxillofac Surg Clin North Am, 2014, 22(1):17–23.
[4] Bonanno PC, Casson PR. Frey's syndrome: a preventable phenomenon. Plast Reconstr Surg, 1992, 89(3):452–456; discussion 457–458.
[5] Giannone N, Lo Muzio L, Politi M. Extracapsular lumpectomy and SMAS flap for benign parotid tumours: an early outcome in a small number of cases on Frey's syndrome and facial nerve dysfunction. J Craniomaxillofac Surg, 2008, 36(4):239–243.
[6] Dell'Aversana Orabona G, Salzano G, Abbate V, Piombino P, Astarita F, Iaconetta G, Califano L. Use of the SMAS flap for reconstruction of the parotid lodge. Acta Otorhinolaryngol Ital, 2015, 35(6):406–411.
[7] Lee CC, Chan RCL, Chan JYW. Predictors for Frey syndrome development after parotidectomy. Ann Plast Surg, 2017, 79(1): 39–41.
[8] Quer M, Vander Poorten V, Takes RP, Silver CE, Boedeker CC, de Bree R, Rinaldo A, Sanabria A, Shaha AR, Pujol A, Zbären P, Ferlito A. Surgical options in benign parotid tumors: a proposal for classification. Eur Arch Otorhinolaryngol, 2017, 274(11):3825–3836.
[9] Owsley JQ Jr. SMAS-platysma facelift. A bidirectional cervico-facial rhytidectomy. Clin Plast Surg, 1983, 10(3):429–440.
[10] Gola R. Chirurgie esthétique et fonctionnelle de la face. Springer-Verlag, Paris, France, 2005.
[11] Gola R, Chossegros C, Carreau P. [Surgical anatomy of the parotid region. Current concepts]. Rev Stomatol Chir Maxillofac, 1994, 95(6):395–410.
[12] Meningaud JP, Bertolus C, Bertrand JC. Parotidectomy: assessment of a surgical technique including facelift incision and SMAS advancement. J Craniomaxillofac Surg, 2006, 34(1):34–37.
[13] Stathopoulos P, Igoumenakis D, Smith WP. Partial superficial, superficial, and total parotidectomy in the management of benign parotid gland tumors: a 10-year prospective study of 205 patients. J Oral Maxillofac Surg, 2018, 76(2):455–459.

[14] Siemionow M, Papay F, Kulahci Y, Djohan R, Hammert W, Hendrickson M, Zins J. Coronal-posterior approach for face/scalp flap harvesting in preparation for face transplantation. J Reconstr Microsurg, 2006, 22(6):399–405.
[15] Macchi V, Tiengo C, Porzionato A, Stecco C, Galli S, Vigato E, Azzena B, Parenti A, De Caro R. Anatomo-radiological study of the superficial musculo-aponeurotic system of the face. Ital J Anat Embryol, 2007, 112(4):247–253.
[16] Zigiotti GL, Liverani MB, Ghibellini D. The relationship between parotid and superfical fasciae. Surg Radiol Anat, 1991, 13(4): 293–300.
[17] Jost G, Levet Y. Parotid fascia and face lifting: a critical evaluation of the SMAS concept. Plast Reconstr Surg, 1984, 74(1):42–51.
[18] Wassef M. Superficial fascial and muscular layers in the face and neck: a histological study. Aesthetic Plast Surg, 1987, 11(1):171–176.
[19] Macchi V, Tiengo C, Porzionato A, Stecco C, Vigato E, Parenti A, Azzena B, Weiglein A, Mazzoleni F, De Caro R. Histotopographic study of the fibroadipose connective cheek system. Cells Tissues Organs, 2010, 191(1):47–56.
[20] Moraru AD, Costuleanu M, Sava A, Costin D, Peptu C, Popa M, Chiseliţă D. Intraocular biodistribution of intravitreal injected chitosan/gelatin nanoparticles. Rom J Morphol Embryol, 2014, 55(3):869–875.
[21] Mendelson BC. Extended sub-SMAS dissection and cheek elevation. Clin Plast Surg, 1995, 22(2):325–339.
[22] Baek SH, Cho IS, Chang YI, Kim MJ. Skeletodental factors affecting chin point deviation in female patients with class III malocclusion and facial asymmetry: a three-dimensional analysis using computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2007, 104(5):628–639.
[23] Ikoma R, Ishitoya J, Sakuma Y, Hirama M, Shiono O, Komatsu M, Oridate N. Temporary facial nerve dysfunction after parotidectomy correlates with tumor location. Auris Nasus Larynx, 2014, 41(5):479–484.
[24] Wong WK, Shetty S. Classification of parotidectomy: a proposed modification to the European Salivary Gland Society classification system. Eur Arch Otorhinolaryngol, 2017, 274(8): 3175–3181.
[25] Scutariu MM, Surdu A, Macovei G. Contributions to recognition of some particularities of the lingual mucosa conditions. Rev Med Chir Soc Med Nat Iasi, 2015, 119(4):1147–1152.
[26] Scutariu MM, Ciurcanu OE, Agop Forna D, Forna NC. Importance of dental maxillofacial aesthetics in dental therapy. Rev Med Chir Soc Med Nat Iasi, 2016, 120(4):926–931.

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