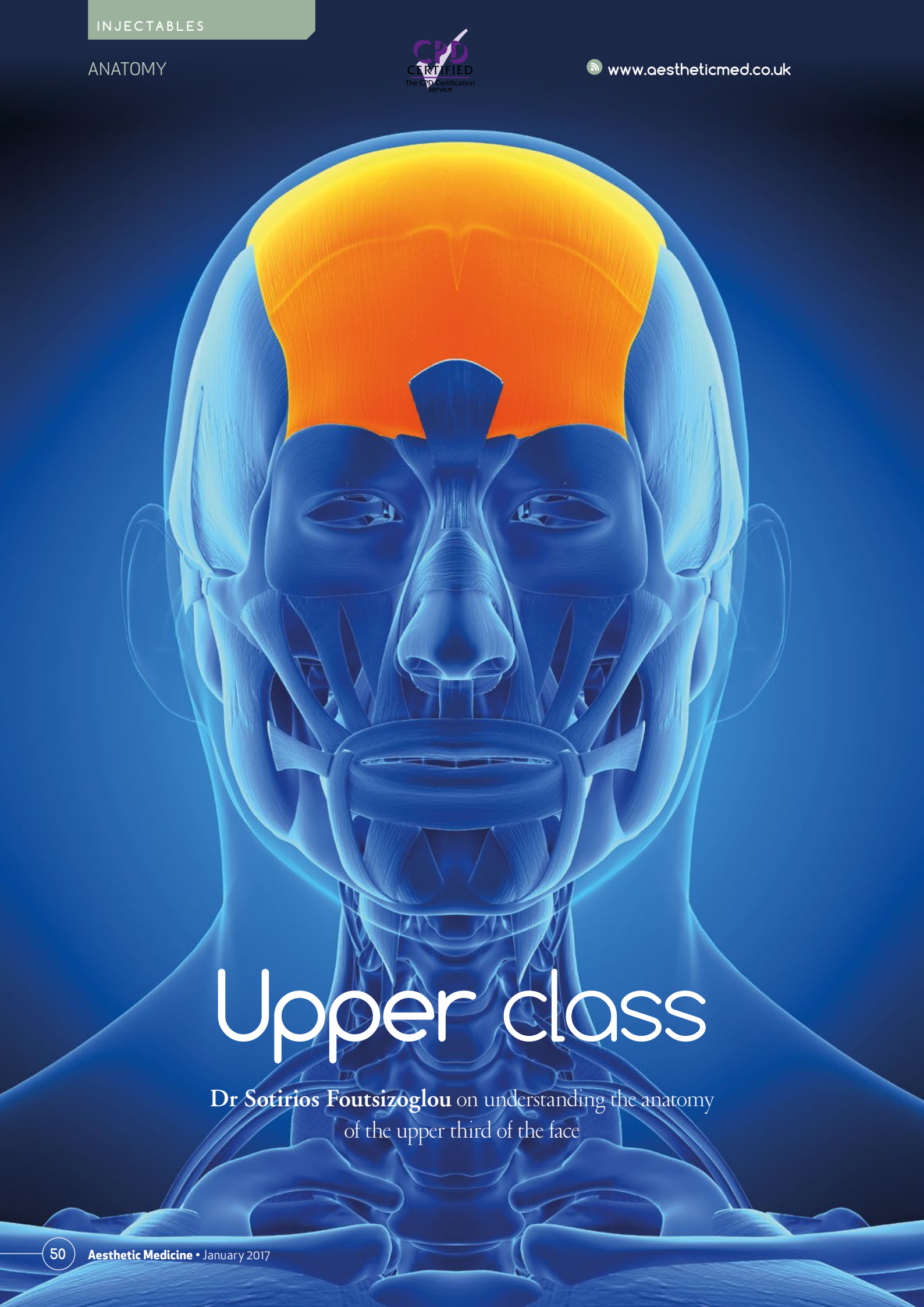


Upper class

Dr Sotirios Foutsizoglou on understanding the anatomy of the upper third of the face

Human embryos include four pairs of well-defined pharyngeal arches forming in a craniocaudal succession between the 22nd and 29th day of gestation. The pharyngeal arches of human embryos initially resemble the gill arches of fish, except they never become perforated to form gill slits. Instead, the external pharyngeal clefts of grooves between the arches remain separated from the apposed, internal pharyngeal pouches by thin pharyngeal membranes[1]. These membranes are initially two-layered, consisting of ectoderm and endoderm; they are later infiltrated by mesenchymal cells. All muscles of facial expression develop from mesenchyme (embryonic connective tissue) of the second pharyngeal arch and are supplied by the 7th cranial nere (CNVII)[2]. They are part of a subcutaneous muscular sheet that spreads over the neck and face during the embryonic development, carrying branches of the facial nerve with it. Functionally the muscular sheet differentiates into muscles that surround the facial orifices, such as the mouth, or covering parts of the skull and inserting into the skin or deep fascia of the face[3].

THE FOREHEAD AND ITS MUSCULATURE

Forehead is delineated laterally by the superior temporal septum, inferiorly by the supra orbital rims, the glabella and frontonasal groove and superiorly by the variable hairline which usually defines the topographic boundary between the forehead and scalp[4]. The superior temporal septum is part of a series of septum-like ligaments perpendicular to fascial layers 3 and 5. It takes origin along the superior temporal line of the skull where the periosteum transitions to the deep temporal fascia, and inserts into the line of junction between the superficial temporal fascia and the galea aponeurotica[5].

The classic description of the scalp layers (layer 1, skin; layer 2, subcutaneous tissue; layer 3, musculoaponeurotic (galea-aponeurotica); layer 4, loose areolar tissue; and layer 5, periosteum) is accurate only over the vertex in the region of the occipito- frontalis muscle with its investing fascia and intervening aponeurosis. Although all five tissue layers continue into the temporal region, the composition of the third, fourth, and fifth layers changes. The galea aponeurotica is replaced by the superficial temporal fascia (layer 3), the loose areolar tissue (layer 4) is structurally different, and the periosteum (layer 5) is replaced by the deep temporal fascia. Over the vertex, layer 3 is termed the "galea aponeurotica." "Epicranial aponeurosis" is a more general term that has been used for layer 3 of the entire scalp, the temporal region and forehead[6,7].

Figure 1: The frontalis muscle

Figure 2. Dynamic forehead lines caused by the contraction of the frontalis muscle

The frontalis muscle is the anterior part (frontal belly) of the scalp muscle – the occipitofrontalis. The occipitofrontalis represents the third layer of SCALP and equates to the superficial musculoaponeurotic system (SMAS) layer in the face. The frontal belly of this muscle arises from the anterior part of the epicranial aponeurosis and is attached to the skin of the eyebrows. It has no bony attachments. Frontalis is a large, vertically oriented, fan-shaped muscle that covers most of the upper third of the face or forehead. Its inferior fibres interdigitate with the procerus and orbicularis occuli muscles. Inferomedially the two halves of the frontalis have a variable relationship, with their fibres interdigitating or even overlapping. Superomedially a variable aponeurosis exists in the space between the two anterior portions of the muscle extending laterally giving it a V-shape appearance. (Fig. 1)

When the frontalis contracts it elevates the eyebrows giving the face a surprised look, and produces transverse wrinkles in the forehead. Horizontal lines are one of the first manifestations of facial wrinkles in the aging face and one of the areas patients are most likely to treat first, particularly women aged 30 to 34 years[8].

Two different types of horizontal lines can occur on the forehead: dynamic lines which are visible during the contraction of the frontalis muscle and static lines that remain visible even at rest. If untreated, dynamic lines will eventually become static. Dynamic forehead lines are generally best treated with BTX-A, whereas static lines usually require the combination of filler and botulinum toxin injections.

NERVE AND VASCULAR SUPPLY TO UPPER FACE

The temporal branch of the CN VII (trigeminal) emerges from the superior border of the parotid gland and crosses the zygomatic arch to supply the auricularis superior and auricularis anterior, the frontal belly of the occipitofrontalis and the superior part of the orbicularis occuli. Interestingly the temporal nerve travels along a line of 0.5cm below the tragus to 1.5cm above the lateral end of eyebrow. Inferior to the zygomatic arch the nerve runs between the superficial and deep layers of the deep temporal fascia in the buccal fat pad. Above this level the nerve becomes more superficial and runs superficially to the superficial temporal fascia[9].

Therefore, superficial injections above the zygomatic arch could damage the temporal nerve.

The frontal nerve, the direct continuation of CN V1, divides within the orbit into two branches: the supratrochlear and supraorbital nerves. The smaller supratrochlear nerve passes superiorly on the medial side of the supraorbital nerve penetrating the frontalis to supply the skin in the middle of the forehead to the hairline[3]. At a distance about 2.7cm from the midline, the supraorbital nerve, the continuation of the frontal nerve, indents the bone into a foramen or notch in the supraorbital margin formed by the frontal bone. The nerve passes superiorly and penetrates the frontalis breaking up into several small branches that supply the subcutaneous tissue and skin of the forehead as far as the vertex of the skull.

Accompanying the nerves, the supratrochlear artery, a terminal branch of the ophthalmic artery, pierces the orbital septum above the medial canthus[10]. Initially the supratrochlear artery passes over the brow above the periosteum, protected by the corrugator muscle. It then travels vertically upwards under the frontalis. At the mid-forehead level (i.e. 15 to 25mm above the supraorbital rim), it passes through the muscle and lies superficial in the subcutaneous tissue (layer 2) as it approaches the hairline.

The supratrochlear artery is found to be relatively constant along the medial canthal vertical line. It rarely deviates more than 5mm lateral or medial from this vertical line. The supratrochlear artery forms anastomoses with the supraorbital artery, the contralateral supratrochlear artery, and the anterior temporal artery of the external carotid.

The supratrochlear artery supplies the skin of the forehead and scalp and the muscles of the forehead. The supraorbital artery, larger and longer than the supratrochlear artery, arises from the ophthalmic artery as it lies medial to the optic nerve. Initially it runs with the supraorbital nerve between the periorbita of the orbital roof and the levator muscle passing through the supraorbital notch or foramen on a vertical line corresponding to the medial limbus of the cornea[11].

It often divides into a superficial branch that penetrates the frontalis running in layer 2 and a deep branch running under the frontalis to supply the skin and the muscles of the forehead respectively. Terminal branches anastomose with the artery from the opposite side, with the supratrochlear artery, and with the anterior temporal artery from the > external carotid. While the supraorbital artery is in the orbit, it sends branches to the superior rectus, superior oblique, and levator muscles and to the periorbita.

The venous drainage of the upper face is provided by the supratrochlear and supraorbital veins that begin in the forehead from a network of veins connected to the frontal tributaries of the superficial and middle temporal veins[12]. The supratrochlear vein descends near the median plane, communicating with its fellow on the other side, and passes to the nose. The supratrochlear vein joins the supraorbital

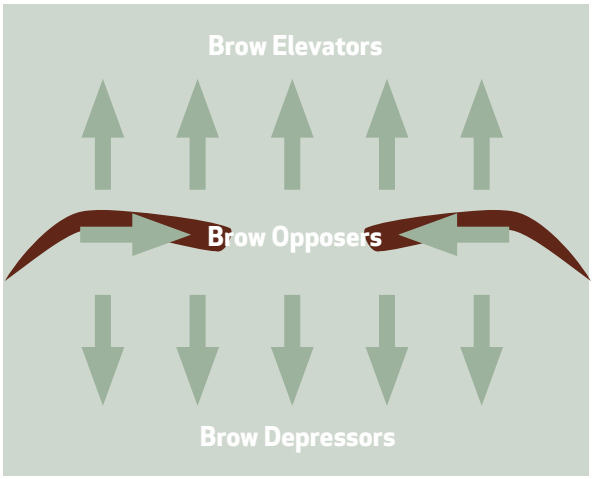


Figure 3. The shape and position of eyebrows are defined by the dynamics of the brow depressors and elevators.

TIP 1

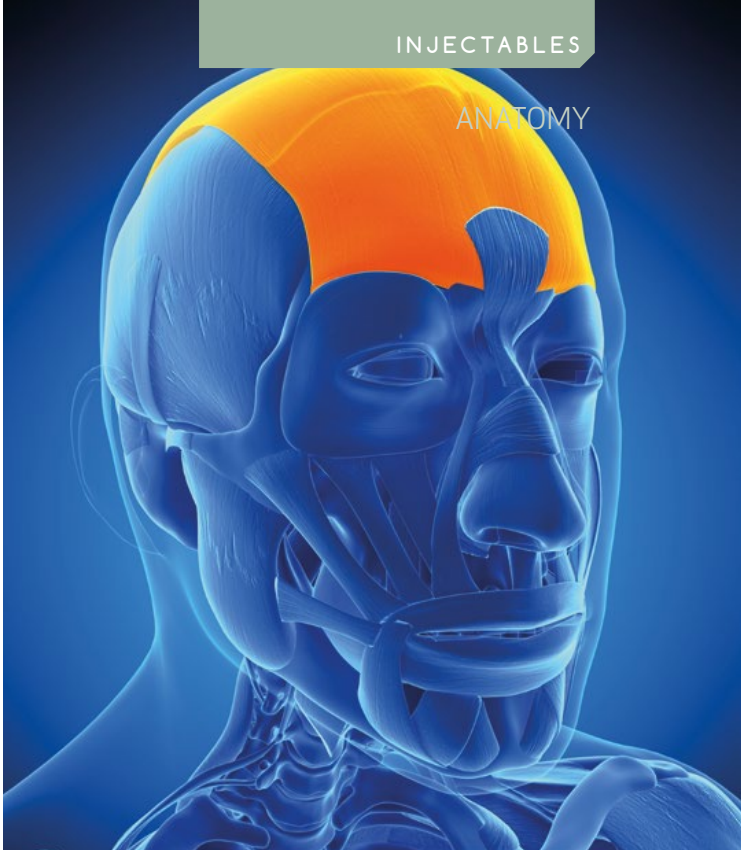
The glabella is a particular danger zone for injection necrosis regardless of the type of filler used, although it is more likely with particulate fillers. Areas most vulnerable are those in which blood supply depends strongly on a single arterial branch (axial pattern blood supply), such as the glabellar region. Necrosis may also occur secondary to local oedema or to occlusion of adjacent vasculature secondary to the hydrophilic properties of the HA product. Glabellar necrosis is a rare but clinically important potential complication caused by interruption of the vascular supply to the area by compression, injury, and/or obstruction of the vessel(s); usually the supratrochlear artery as it courses the glabellar area. Less viscous fillers, aspiration before injection, retrograde placement of the filler, avoiding high injection pressure or large boluses and using a cannula when injecting filler to the glabella are recommended risk reduction strategies.

TIP 2

I use a row of two injection points on either side of the midline halfway between the easily palpable superior orbital rim and the hairline and another row of two or four injection sites halfway between the first row and the hairline. If it is a female patient I try to stick within the two mid-pupillary lines for a desirable accentuation of the lateral eyebrow arch unless they complain of wrinkles on the side of the forehead (outside the mid-pupillary lines) or near the eyebrows. In this case I will use the optional points as shown on figure 4. Administration more inferiorly greatly increases the risk of brow ptosis, in particular superolateral to the tail of the eyebrow (shaded area) (Fig 5). The amount of toxin used for the optional points should be anything between ½ to ¾ of the dose used for the standard points. In male patients with receding temporal hairline or female patients with a large forehead I also use a third row of usually two injection points higher up. Men will typically require a higher overall dose of toxin due to larger and stronger frontalis.

TIP 4

Overtreatment of the medial forehead can have a paradoxical effect on the lateral brow, creating an unnatural elevation of the lateral third of the eyebrow ("Spock" appearance)[13]. This can be very easily corrected by placing a small number of BTX-A units in the lateral forehead 2 cm above the brow.



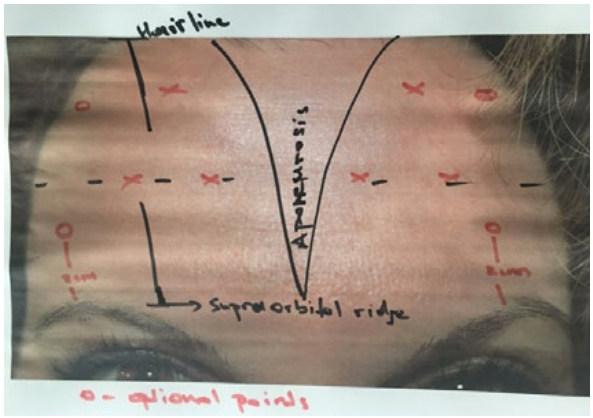


Figure 4. Preferred technique when injecting the frontalis

TIP 3

All patients, in particular elderly, should be examined for potential brow and / or eyelid ptosis as they tend to compensate by using the frontalis to raise the ptotic brow/lid complex. Weakening the frontalis in these individuals may compromise their visual field.

Figure 5. Avoid ptosis by not injecting the shaded area. In the lateral to mid-pupillary line, stay at least 1 finger width above the supra-orbital rim

vein near the medial canthus to form the angular vein, which becomes the facial vein near the inferior border of the orbit.

TREATING THE FRONTALIS WITH BTX-A

The dynamics of the frontalis and the glabellar muscles create a balance forming the brow shape and position. Frontalis is a brow elevator. The lower frontalis muscle fibres (i.e. 2-4cm above the supraorbital ridge) elevate the eyebrows, whereas the glabellar muscles (i.e. procerus, corrugators, and depressor supercilii) and the orbital part of the orbicularis oculi are brow depressors (Fig 3). Therefore, botulinum toxin injection into the lower portion of the frontalis will flatten or inferiorly reposition the eyebrows due to the unopposed action of the brow depressors. Conversely, weakening of the depressor muscles of the upper face can elevate the brow restoring a more youthful brow arch.

CONCLUSION

The key to successfully and safely treating the upper face is sound anatomical knowledge and refined injection techniques. Although the upper face is one of the most common areas for non-surgical treatments, lack of understanding of its complex anatomy can lead to dissatisfied patients or serious complications. This paper is part of a series of didactic articles targeted for the medical aesthetic practitioner who is interested in an in-depth analysis of the dynamic and three-dimensional anatomical structures pertaining to non-surgical treatments. **AM**

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Dr Sotirios Foutsizoglou developed a particular interest in anatomy during his time working in plastic and reconstructive surgery in the NHS. He became heavily involved in teaching anatomy and physiology to medical students and junior doctors and has worked as an anatomy demonstrator for Imperial College. Since 2012, in his role as the lead trainer of KT Medical Aesthetics Group, he has been training practitioners in Facial Anatomy and advanced non-surgical treatments and procedures. He has written and lectured on Facial Anatomy and complications associated with injectables both nationally and internationally.