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Lifting vs volumizing—The difference in facial minimally invasive procedures when respecting the line of ligaments

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Abstract

Background: The arrangement of the facial soft tissue layers is different with respect to the line of ligaments: medially oblique and laterally in parallel.

Aims: This split-face study was designed to investigate the effects on midfacial volumization if the same medial vs lateral injection points are targeted in various sequences.

Methods: Twelve patients (3 males, 9 females; 46.67 years ± 4.5) were included in this interventional study. On the right side of the face, lateral injection points were performed first, whereas on the left side, medial injection points were executed first. The infraorbital hollowness score, the upper cheek fullness score, the global aesthetic improvement scale, and the injected volume were assessed.

Results: No side differences were observed after the intervention with $P = 1.00$ for all scores. When the lateral injection points were performed first, the volume injected into the medially located injection points (0.46 ± 0.26 cc vs 0.73 ± 0.31 cc [$P = .037$]), into the lateral injection points (0.79 ± 0.40 cc vs 1.15 ± 0.28 cc [$P = .017$]), and overall (1.26 ± 0.64 cc vs 1.88 ± 0.57 cc [$P = .02$]) was significantly reduced.

Conclusion: The results of the present study emphasize the importance of respecting the layered arrangement of the facial soft tissues when performing minimally invasive soft tissue filler injections. Targeting injection points lateral to the line of ligaments first reduces the volume needed to symmetrically and aesthetically appealing manner and volumizes the infraorbital and upper cheek regions.

KEYWORDS
facial anatomy, facial filling, facial layers, facial volumization, soft tissue filler

1 | INTRODUCTION

Injectable soft tissue fillers have become a popular and widely accepted method to ameliorate the signs of facial aging. According to data from the American Society of Plastic Surgeons, between the years 2000 and 2017, there was a 312% increase in minimally invasive applications of soft tissue fillers.[1] This underscores the considerable demand in today's society for aesthetic enhancement.

Signs of facial aging include volume loss and soft tissue sagging. These phenomena are interrelated and can be attributed to the continuous facial aging process affecting bone, ligaments, muscles, fat, and skin.[2-4] Recent studies have shown that over

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time fat is redistributed from subcutaneous locations such as the superficial and deep facial fat compartments to intra-abdominal or ectopic locations such as the liver or the bone marrow.[5-7] This supports the fatty deflation theory and explains the absolute (not relative) descent of some of the superficial and deep facial fat compartments with aging.[8] Applying soft tissue filler can reflate the targeted facial fat compartments leading to restoration of volume.

Interestingly, a recent study reported on lifting effects of the lower face when the temple was injected.[9] The authors injected into the superficial fat compartments (ie, superficial to the superficial temporal fascia) and relied on the functional anatomy of the superficial fat compartments.[10] In the temple, these superficial fat compartments do not descend when volume is being injected but respond with a lifting effect of the middle and the lower face.[9] In contrast, when volume is injected deep (supraperiosteally) into the central midface, a volumization of the midfacial fat compartments results. This leads to a local restoration of midfacial volume loss.[11]

The concept of the line of ligaments has recently been introduced,[12] where the facial layers are arranged differently medial vs lateral to this functional anatomical landmark. Medially, the facial layers are oriented obliquely to the skin surface (ie, like roof tiles) whereas lateral to this line they are arranged parallel to the skin surface (ie, like onionskin). Placing soft tissue filler in these differently arranged facial layers could potentially result in different effects: injecting medially might result in a volumizing effect, whereas injecting laterally may result in a lifting effect.

To test this hypothesis, we performed and split-face interventional study, whereby the right side of the face was injected in a different sequence than the left side. On the right side of the face, three laterally located (ie, lateral to the line of ligaments) injection points were performed, followed by three injection points medial to the line of ligaments. On the contralateral side of the face, the same injection points were performed but in the opposite sequence, with injection of the three points medial to the line of ligaments followed by the three injection points lateral to the line of ligaments. The primary outcome measure was the symmetric improvement of facial appearance by using the infraorbital hollowness score, the upper cheek fullness score, and the global aesthetic improvement scale (GAIS). The secondary outcome measure was the comparison between the volumes injected into the right vs the left side of the face.

2 | MATERIALS AND METHODS

2.1 | Study sample

We investigated 12 individuals (three males, nine females) in this interventional split-face study (Table 1). The study was conducted between January 2019 and April 2019 at the Ocean Clinic, Marbella, Spain. Written information and verbal explanations about the aims and the scope of the study as well as about the risks of the procedure were provided to participants prior to inclusion. Following the Declaration of Helsinki protocols (1996), written informed consent to participate in this study was obtained from all subjects. This study was conducted in accordance with regional laws and good clinical practice.[13]

2.2 | Study design

Individuals included in this study were patients of the Ocean Clinic, Marbella, Spain being treated for midface volume deficiency. Patients were treated with the same six hyaluronic acid (HA) filler injection points on the right side as the left side of the face (total of 12 injection points) but with a different sequence of injection. In each side of the face, three injection points were located lateral to the line of ligaments, while three injection points were located medial to the line of ligaments (Figure 1). On the right side, injection points lateral to the line of the ligaments were performed first, followed by injection points medial to the line of ligaments (right = lateral then medial). On the left side, injections medial to the line of ligaments were administered first, followed by injection points lateral to the line of ligaments (left = medial then lateral).

Independent of the treatment sequence, an aesthetically appealing and symmetrical result was intended and objectively evaluated by the GAIS,[14] the infraorbital hollowness score,[15] and the upper cheek fullness score.[16]

TABLE 1 Demographic data of the investigated sample including the total injected volume stratified by side and injection location

		Count = 12	
Gender—Count (%)			
Women		9 (75)	
Men		3 (25)	
Mean age (y; mean ± SD) [range]		40.67 ± 4.5; range [32-48]	
Comorbidities—Count (%)		0 (0)	
Allergies—Count (%)		0 (0)	
Total injected volume (sequence) in cc; mean ± SD	**Right Side (Lat-Med)**	**Left Side (Med-Lat)**	***P*-value**
	1.26 ± 0.64	1.88 ± 0.57	.02
Volume per Site (cc; mean ± SD)			
Lateral SOOF	0.28 ± 0.87	0.48 ± 0.04	<.001
Zygomatic arch	0.29 ± 0.22	0.47 ± 0.14	.005
DLCF	0.23 ± 0.11	0.20 ± 0.15	.44
Medial SOOF	0.11 ± 0.11	0.48 ± 0.19	<.001
Palpebromalar groove and tear trough	0.03 ± 0.04	0.07 ± 0.06	.005
DMCF	0.33 ± 0.11	0.18 ± 0.11	<.001

Abbreviations: DLCF, deep lateral cheek fat compartment; DMCF, deep medial cheek fat compartment; SOOF, suborbicularis oculi fat.

2.3 | Injection procedure

Lateral injection points (Figure 2):

- Lateral suborbicularis oculi fat (SOOF) compartment using a 27G 1" needle deep in contact with the bone
- Midportion of the zygomatic arch, 1 cm lateral to the lateral canthus using a 27G 1" needle deep in contact with the bone
- Highest point of the malar eminence (= deep lateral cheek fat compartment) located in the lateral canthal line using a 27G 1" needle deep in contact with the bone

Medial injection points (Figure 3):

- Medial SOOF compartment using a 27G 1" needle deep in contact with the bone
- Deep medial cheek fat compartment using a 27G 1" needle deep in contact with the bone
- Palpebromalar groove and tear trough using a 27G 1" needle deep in contact with the inferior orbital bony rim

Products used for the volumizing procedure were Juvéderm Volbella® (palpebromalar groove and tear trough) and Juvéderm Voluma® (all other facial regions) (Allergan®).

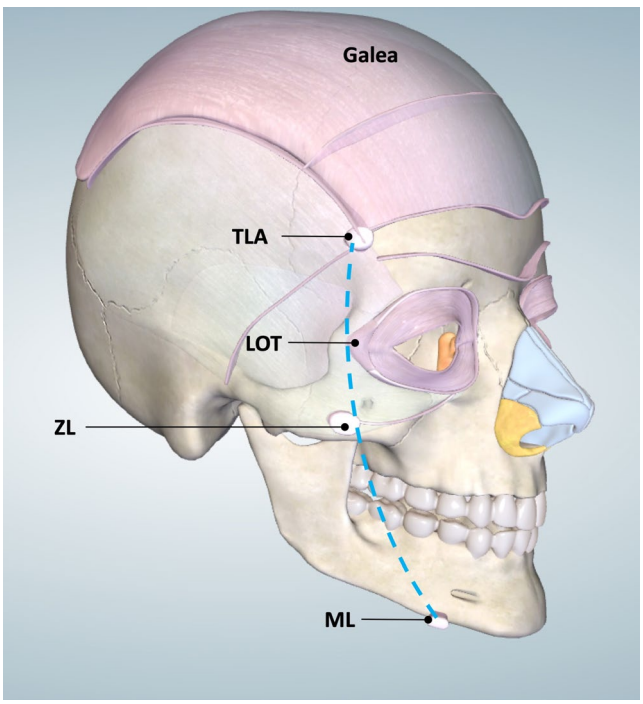


FIGURE 1 Virtual model of the face showing the major facial ligaments. Note how the ligaments can be aligned into one line located immediately lateral to the lateral orbital rim extending from the temporal crest to the mandible, creating the line of ligaments (indicated in blue). LOT, Lateral orbital thickening; ML, Mandibular ligament; TLA, Temporal ligamentous adhesion; ZL, Zygomatic ligament

2.4 | Statistical analyses

Infraorbital hollowness score and the upper cheek fullness score were evaluated by the treating physician (GC) before and after the treatment. The GAIS scale was assessed after the treatment by the treating physician. The volume injected was measured overall and for each individually injected location (3 × lateral and 3 × medial). A paired t test was applied to identify differences in injected volume and assessment scores between the left and the right side of the treated patient. All analyses were performed using SPSS Statistics 25 (IBM, Armonk), and results were considered significant at a probability level of ≤ .05.

3 | RESULTS

3.1 | General description and adverse events

The mean age of the 12 treated patients was 46.67 years ± 4.5 (range of 32-48 years). None of the included patients reported allergies, relevant comorbidities, or previous surgical or minimally invasive interventions of the face (Table 1).

No adverse events were observed immediately after the treatment or reported during the follow-up period of 12 months.

3.2 | Facial assessment

The mean infraorbital hollowness score[15] of the cohort prior to intervention was 2.33 ± 0.78 for the right side and 2.33 ± 0.78 for the left (P = 1.00), while the mean upper cheek fullness score[16] was 1.83 ± 0.72 for the left side and 1.83 ± 0.72 for the right side (P = 1.00). The postinjection infraorbital hollowness score was 0.42 ± 0.52 for the right side and 0.42 ± 0.52 for the left side with P = 1.00 for side differences, whereas the mean upper cheek fullness score[16] was 0.75 ± 0.45 for the left side and 0.75 ± 0.45 for the right side with P = 1.00 for side differences (Tables 2 and 3, Figure 4).

The difference between the pre- and the postinjection infraorbital hollowness scores was 1.91 (P < .001) and 1.08 for the upper cheek fullness score (P < .001).

The GAIS was evaluated to be 1.50 ± 0.52 for the right side and 1.50 ± 0.52 for the left side (P = 1.00).

3.3 | Injected volume

On the right side of the face, lateral injection points were performed first followed by the medial injection points, whereas on the left side of the face, medial injection points were administered prior to the lateral injection points. A total of 0.46 ± 0.26 cc was injected into the medial aspect of the right side while 0.73 ± 0.31 cc was injected into the medial aspect of the left side of the face with P = .037. On the right side of the face, a total of 0.79 ± 0.40 cc was injected into the lateral aspect and 1.15 ± 0.28 cc was injected into the lateral aspect of the left side of the face with P = .017. The overall injected volume was for the right side of the face (lateral followed by medial)

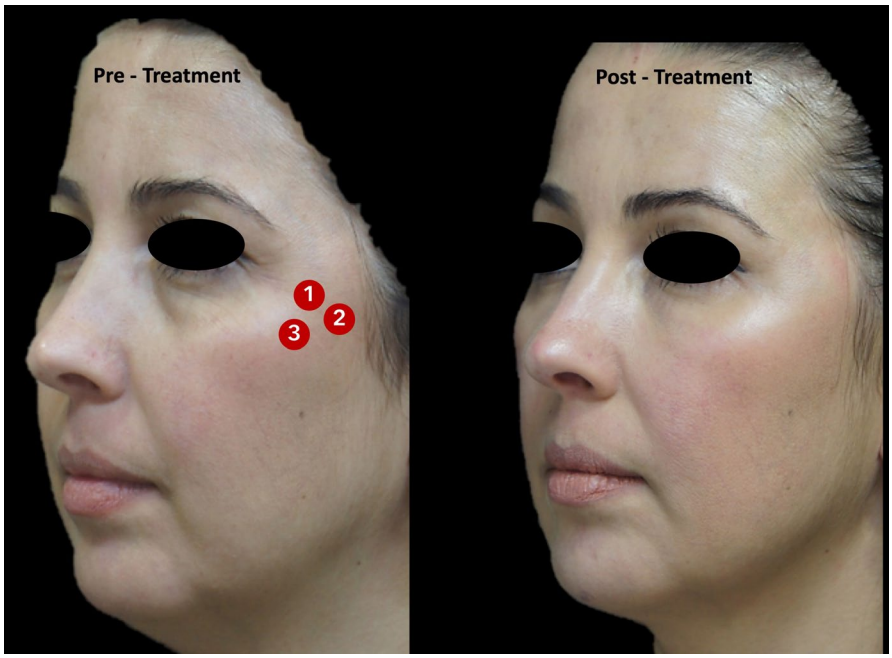


FIGURE 2 Photographs of female patient before (left) and after (right) intervention. The lateral injection points have been indicated: 1 = Lateral suborbicularis oculi fat (SOOF) compartment, 2 = Midportion of the zygomatic arch, 3 = Highest point of the malar eminence (= deep lateral cheek fat compartment)

FIGURE 3 Photographs of a female patient before (left) and after (right) intervention. The medial injection points have been indicated: 1 = Medial suborbicularis oculi fat (SOOF) compartment, 2 = Deep medial cheek fat compartment, 3 = Palpebromalar groove

1.26 ± 0.64 cc and for the left side of the face (medial followed by lateral) 1.88 ± 0.57 cc representing a statistically significant difference in applied volume of $P = .02$ (Table 1, Figure 5).

4 | DISCUSSION

The present study was specifically designed to investigate the effects of soft tissue filler injections on facial anatomy with respect to the line of ligaments. Six discrete injection points per side of the face were performed to restore the infraorbital and upper cheek volume of 12 patients. Three (of six) injection points per side were located medial to the line of ligaments: medial SOOF, deep medial cheek fat compartment and the palpebromalar groove and tear trough and three (of six) injection points were located lateral to the line of ligaments: lateral SOOF, midportion of the zygomatic arch, and the deep lateral cheek fat compartment. On the right side of the face, the lateral injection points were performed first (followed by the medial injection points) whereas on the left side of the face, the injection points were administered medial followed by lateral.

No side differences were observed when the aesthetic outcome was assessed via the infraorbital hollowness or the upper cheek fullness scores: 0.42 ± 0.52 (both left and right side; $P = 1.00$) and 0.75 ± 0.45 (both left and right side; $P = 1.00$), respectively. Likewise,

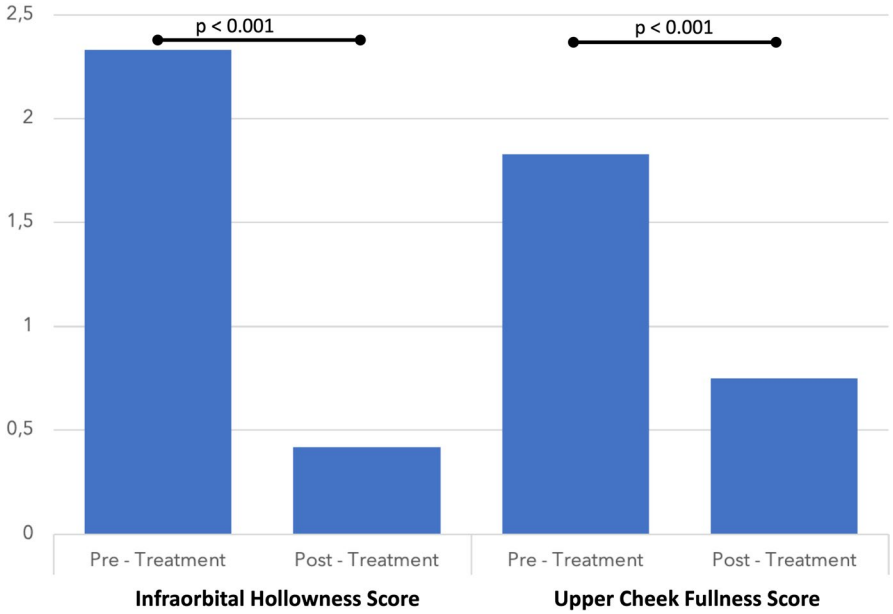
TABLE 2 Table showing side differences in the infraorbital hollowness and the upper cheek fullness scores before vs after the treatment. Differences are indicated by the *P*-value

	Right side	Left side	*P*-value
Infraorbital hollowness score (mean ± SD)			
Pre-injection	2.33 ± 0.78	2.33 ± 0.78	1.00
Postinjection	0.42 ± 0.52	0.42 ± 0.52	1.00
Upper cheek fullness score (mean ± SD)			
Pre-injection	1.83 ± 0.72	1.83 ± 0.72	1.00
Postinjection	0.75 ± 0.45	0.75 ± 0.45	1.00
GAIS (mean ± SD)	1.5 ± 0.52	1.5 ± 0.52	

TABLE 3 Table showing the pre- and post-treatment infraorbital hollowness and the upper cheek fullness scores for the right and left side of the face. Differences are indicated by the *P*-value

	Right side	Left side	*P*-value
Infraorbital hollowness score (mean ± SD)			
Pre-injection	2.33 ± 0.78	0.42 ± 0.52	<.001
Postinjection	2.33 ± 0.78	0.42 ± 0.52	<.001
Upper cheek fullness score (mean ± SD)			
Right side	1.83 ± 0.72	0.75 ± 0.45	<.001
Left side	1.83 ± 0.72	0.75 ± 0.45	

FIGURE 4 Bar graph showing the mean infraorbital hollowness score and the upper cheek fullness score before and after intervention. Note how both scores differ significantly before and after the intervention (*P* < .001)



the GAIS was 1.50 ± 0.52 for the right side and 1.50 ± 0.52 for the left side, with *P* = 1.00 indicating no side differences after the split-face treatment.

The results of the study revealed that if the lateral injection points are performed first, the volume injected into the medially located points to achieve an aesthetically pleasing outcome is significantly less: 0.46 ± 0.26 cc (right) vs 0.73 ± 0.31 cc (left) (*P* = .037). The same phenomenon was observed for the laterally located injection points: 0.79 ± 0.40 cc (right side) vs 1.15 ± 0.28 cc (left side) (*P* = .017). The total injected volume was significantly less when the lateral injection points were performed first 1.26 ± 0.64 cc (right) vs 1.88 ± 0.57 cc (left) *P* = .02.

A strength of the present study is that targeted injection points were based on the specific arrangement of the underlying layered anatomy in combination with a desired aesthetic outcome. Frequently, injection points are chosen based on the aesthetic outcome only, without consideration of the functional anatomy of the treated region. In this study, anatomy was combined with the desired outcome to specifically investigate the influences of the layered arrangement of the face.

A limitation of this study is the small sample size of 12, and all scores were assessed by the treating physician and were not objectively validated by the patient or by an objective observer. As the aesthetic outcome of a treatment is best evaluated by the person identifying the age-related deficits and performing the respective treatment, this could be of advantage. Difference in knowledge (as compared to the patient used for outcome evaluation) or differences in experience (as compared to an objective observer used for outcome evaluation) might create a bias for the assessed outcome scores, which is eliminated if all scores are being evaluated by the treating physician. Another limitation of the study is that the sides of the face are not symmetric as indicated by the results of the presented cores. The results have thus to be understood in the context of the overall appearance of the patient's face and that the side-to-side differences (present prior to treatment) were taken into account when the assessment of the scores was performed.

Before the applied treatment, no side differences were observed when the infraorbital hollowness and the upper cheek fullness score were evaluated (all *P* = 1.00). After the treatment, again no side differences were observed in the assessed scores

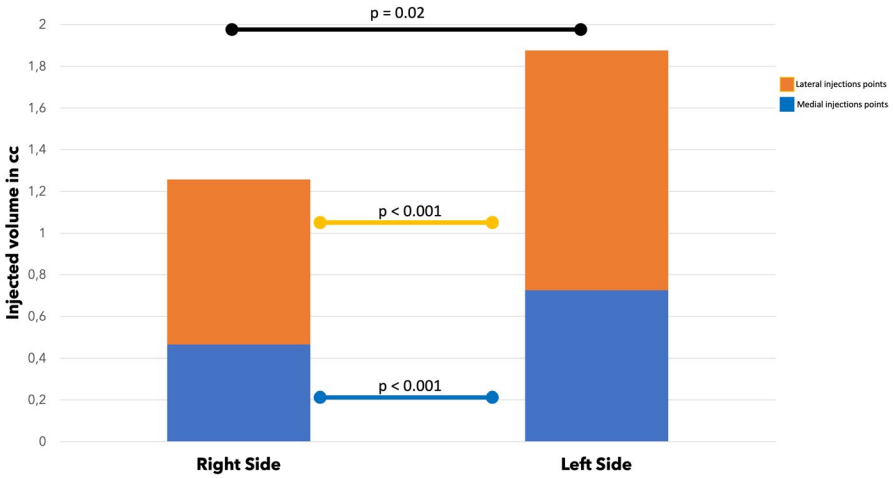


FIGURE 5 Stacked bar graph showing the mean injected volume in cc of the right and left side of the face lateral and medial of the line of ligaments. Note how the volumes for the medial injections ($P < .001$), lateral injections ($P < .001$), and overall ($P = .02$) differed significantly between both sides of the face

and in the global aesthetic improvement scale (all $P = 1.00$). This is of great importance and was thus set as the primary outcome of the study. The injections performed in the present study were conducted in side differences, and the applied volumes were chosen specifically to obtain aesthetically appealing but symmetric results, well knowing that 100% facial symmetry is not given in the face. Based on the presented results, the primary outcome was achieved.

The secondary outcome was the comparison of the injected volumes applied to the right vs the left side of the face. Overall, there was a statistically significant difference of volume injected into the right vs the left side: 1.26 ± 0.64 cc vs 1.88 ± 0.57 cc with $P = .02$. This is interesting and can be related to the underlying anatomy of the facial layers: lateral vs medial to the line of ligaments. The line of ligaments is a vertical line passing from cranial to caudal 1cm lateral to the lateral canthus and connects the major facial ligaments: temporal ligamentous adhesion,[17] lateral orbital thickening,[18] zygomatic ligament (also called McGregor's patch),[19,20] and the mandibular ligament.[19] This connecting line is an anatomical landmark not a real line that can be identified via anatomical dissections. This line also represents the most lateral aspect where the muscles of facial expression originate from the bone. Most of these muscles change their plane during their course before they insert into the skin f.i. of the nasolabial sulcus or insert into other muscles to form muscle complexes f.i. the orbicularis oris muscle complex. When the facial muscles change their plane, they connect facial layers with each other and are arranged oblique to the skin surface (= like roof tiles). This is the layered arrangement medial to the line of ligaments. Lateral to the line of ligament, the layers are arranged parallel to the skin surface (= like onionskin). These layers are (from superficial to deep: skin, superficial fat, superficial musculoaponeurotic system (SMAS), deep fat compartments (here: premasseteric spaces), and deep fascia (here: parotideomasseteric fascia).

A previous study used skin displacement vector analysis to provide evidence for a lifting effect in the middle and the lower face when the temple was injected.[9] Based on a previous analysis of the superficial facial fat compartments by Schenck et al,[10] the temple does not descend when increasing amounts of product are injected. The temple rather reacts with a lifting effect due to the parallel arrangement of the facial layers.

The present study specifically investigated the effects of the parallel layered arrangement. The targeted lateral injection points (lateral to the line of ligaments) were injected first (before the medial injection points) and had the effect that the medially and inferiorly located facial soft tissues were lifted and stretched in a posterolateral direction. This resulted in a reduced injected volume of soft tissue filler needed to achieve an aesthetically appealing and symmetric result (1.26 ± 0.64 cc) when compared to the other facial side of the same patient (1.88 ± 0.57 cc) when the laterally located injection points were performed second. The same effects were observed when the volume of the medial injection points was compared (right side vs left side): 0.46 ± 0.26 cc vs 0.73 ± 0.31 cc ($P = .037$) and when the lateral injection points were compared: 0.79 ± 0.40 cc vs 1.15 ± 0.28 cc ($P = .017$). This provides evidence that when the lateral injection points are targeted first, the volume needed medially, laterally, and overall is less when compared to the contralateral side where the medial injection points were performed first.

An explanatory model could be the following: lateral injections result in a stretching and flattening effect of the midfacial soft tissues. The midfacial fat compartments are being smoothed by the applied stretch of the parallel arrangement of the facial layers. The injected soft tissue filler becomes more apparent on the surface resulting in surface projection. In contrast, if the medial injection points are performed first, no previous stretch is being applied to the midfacial soft tissues. Thus, the volume of the midfacial fat compartments remains unaltered resulting in a reduced surface effect of the injected soft tissue filler.

The results of the present study are of potential clinical relevance. Minimally invasive applications of soft tissue filler can be more efficiently performed if the underlying anatomy is respected. Injections lateral to the line of ligaments could be performed first followed by medially located injection points. Aside of local volumization effects, lateral injection points could also reduce the volume needed to achieve aesthetically appealing effects in medially located facial regions (medial to the line of ligaments).

5 | CONCLUSION

The results of the present study emphasize the importance of respecting the layered arrangement of the facial soft tissues when performing minimally invasive soft tissue filler injections. Targeting injection points lateral to the line of ligaments first reduces the volume needed to symmetrically and aesthetically appealing fashion and volumizes the infraorbital and upper cheek region. Injections lateral to the line of ligaments result in a stretching effect of the midfacial fat compartments. Conversely, injecting into the medial midface medial to the line of ligaments requires an increased amount of product needed to achieve a desired aesthetic outcome if lateral injection points were not targeted first.

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CONFLICT OF INTEREST

None of the other authors listed have any commercial associations or financial disclosures that might pose or create a conflict of interest with the methods applied or the results presented in this article.

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