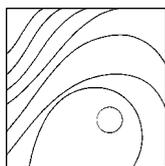


# A Modified Approach in Lip Repositioning Surgery: A Prospective Study in a Twin Population with a 3-Year Follow-up



Reham N. Al Jasser, BDS, MSc, ABP<sup>1</sup>  
 Mohammed A. AlSarhan, BDS, MSc, ABP<sup>1</sup>  
 Dalal H. Alotaibi, BDS, MSc, PhD<sup>1</sup>  
 Monish Bhola, DDS, MSD, ABP<sup>2</sup>

*This study evaluated long-term clinical and patient satisfaction outcomes following a modified lip repositioning technique that utilized periosteal sutures in a twin population. Twin sisters diagnosed with maxillary lip hypermobility were randomly assigned to either the control group (original LipStaT technique) or test group (addition of periosteal sutures). The participants (n = 12; 6 per group) were evaluated at intervals for up to 3 years postoperative. Clinical measurements, digital images, and patient satisfaction surveys were collected. Descriptive statistics were used to assess outcome variables: average lip width at rest (ALW), vertical lip translation (VLT), and average gingival display (AGD). Student t test, one-way analysis of variance, and Spearman rank correlation tests were used to compare mean values of variables at five time points for both groups. The level of significance was  $\alpha = .05$ . In the control group, mean VLT and AGD values showed statistically significant decreases from baseline (14.8 mm and 7.0 mm, respectively) to 2 years (5.7 mm and 2.4 mm, respectively), but a slight increase was seen at 3 years (7.5 mm and 5.0 mm, respectively;  $P < .0001$ ). In the test group, mean VLT and AGD values showed statistically significant decreases from baseline (14.8 mm and 6.9 mm, respectively) to 3 years (5.5 mm and 3.5 mm, respectively;  $P < .0001$ ). A higher participant satisfaction score at 3-year follow-up was observed in the test group. The modified lip repositioning technique in a population of twins resulted in more stable outcomes that lasted up to 3 years postoperatively. Int J Periodontics Restorative Dent 2021;41:e243–e253. doi: 10.11607/prd.4707*

An esthetic smile is increasingly becoming associated with the idea of beauty, motivating people to undergo more corrective and cosmetic procedures.<sup>1</sup> Numerous factors influencing smile esthetics and attractiveness have been assessed.<sup>2–8</sup> Several authors have determined that the amount of gingival display in an attractive smile varies from 1 to 3 mm.<sup>9,10</sup> While different variables contribute to the perception of an attractive smile, excessive gingival display (EGD), also known as a gummy smile (GS), is one of the main concerns associated with an unattractive smile.<sup>11</sup> GS can be defined as gingival display in excess of 2 to 4 mm during a full dynamic smile.<sup>12</sup> This can be more pronounced when lip hypermobility is present.<sup>13</sup>

EGD is associated with several etiologies, including a deficiency in the maxillary lip length, hypermobile upper lip (HUL), bony maxillary excess (particularly bimaxillary protrusion), altered passive eruption, and gingival enlargements.<sup>14</sup> Therefore, the treatment approach should be determined according to the main etiology, or combination of etiologies, observed in each case. During a dynamic smile, a normal upper lip usually has a 4- to 6-mm mobility from rest, and HUL can be diagnosed when the mobility is beyond this range.<sup>15</sup> The diagnosis of HUL can be achieved by clinical

<sup>1</sup>Department of Periodontics and Community Dentistry, College of Dentistry, King Saud University, Riyadh, Saudi Arabia.

<sup>2</sup>Advanced Periodontics Institute, Plymouth, Michigan, USA.

Correspondence to: Dr Reham Al Jasser, Department of Periodontics and Community Dentistry, College of Dentistry, King Saud University, PO Box 60169, Riyadh 11545, Saudi Arabia. Email: raljasser@ksu.edu.sa

Submitted November 4, 2019; Accepted January 27, 2020.

©2021 by Quintessence Publishing Co Inc.

examination of lip translation from the rest position to a maximum smile position.<sup>14</sup> One of the treatment options is lip repositioning surgery,<sup>16–18</sup> also called LipStat.<sup>15</sup>

Lip repositioning surgery involves removing a strip of mucosa from the maxillary vestibule through a partial-thickness incision, thus introducing the lip to a new, lower position during the healing process. Several reports have documented satisfactory results and good esthetic outcomes with this surgical technique.<sup>15,19,20</sup> However, some reports have observed a valid rate of relapse in the 6 months to 1 year following this procedure.<sup>21</sup> The present study therefore aims to evaluate long-term qualitative and quantitative outcomes, related to clinical changes and patient satisfaction, of a modified lip repositioning technique that utilizes periosteal sutures to stabilize the new lip position in the treatment of EGD in a twin population. The hypothesis of the present study is that periosteal sutures can clinically lead to more stable long-term results.

## Materials and Methods

### *Ethical Approval, Study Population, and Design*

The study was registered at the Institutional Committee of Research Ethics at King Saud University (no. E-18-112201) in March 2017 and received approval from the Institutional Review Board. The study was conducted in accordance with the 1975 Declaration of Helsinki, as revised

in 2013. Targeted individuals who desired an improvement in their gummy smile were possible candidates. Inclusion criteria required the participants to be aged  $\geq 18$  years, be seeking treatment at the periodontology clinic situated at the King Saud University Dental Hospital (Riyadh, Saudi Arabia), be identical twins, and indicate a desire for improving their smile. The exclusion criteria were as follows: Individuals diagnosed with bony maxillary excess and skeletal deformity or who had a history of treatment of facial botulinum toxin-A or filler injections; and participants who had altered passive eruption (APE) or a short upper lip. Twelve women (six pairs of twins) were randomly assigned to either the control or test group, and they all provided informed consent.

### *Examination and Diagnosis*

Participants' medical histories and family histories were reviewed. Extra- and intraoral examinations were performed. Facial and skeletal analyses were performed by an orthodontist. Baseline periodontal examinations were conducted to exclude active periodontal disease by recording periodontal pocket depth (PD), clinical attachment level (CAL), Bleeding Index (BI), Plaque Index (PI), and keratinized tissue width (KTW). All participants had  $< 20\%$  of BI and  $< 25\%$  of PI.<sup>22,23</sup> Presence of APE was excluded by measuring maxillary anterior teeth dimensions and the width-to-height ratio, as well as the zenith from the first molar to the first molar in the adjacent

quadrant, ensuring that all teeth fell within normal dimensions according to de Castro et al.<sup>24</sup> Full evaluation of bone level was performed from the first molar to the first molar on the contralateral side, ensuring the distance from the cemento-enamel junction of the teeth to the crestal bone was 1.5 to 2 mm based on new sets of intraoral periapical radiographs. Bone sounding on the same area was performed to confirm the findings. Maxillary lip length was measured at rest to exclude a short lip as an etiology. The amount of gingival display was measured on each tooth from first molar to first molar at three locations for each anterior tooth (mesiofacial, medifacial, and distofacial); the measurement was from the gingival margin to the base of the lip during a full dynamic smile. All measurements were recorded to the nearest millimeter using a Williams periodontal probe (Patterson Dental Supply). The final measurement was the mean of the measurements at the three points.

### *Maxillary Lip Length and Mobility Assessment*

Measurements were assessed using a 15-cm marked ruler, having participants seated in an upright position. Lip length was determined by measuring the distance between the subnasal area and the most inferior portion of the lip at midline and in the resting position. Based on previous observations, measurements of  $< 20$  mm were considered to be a short upper lip.<sup>25,26</sup> Finally, lip mobility was assessed by measuring the

amount of translation of the lip's inferior border from the rest position at maximum smile. Hypermobility lip was diagnosed if the amount of translation exceeded 6 mm.<sup>15</sup> All measurements were taken by the same calibrated periodontist (R.A.).

### *Intraexaminer Reliability*

Before the clinical measurements (which were taken 2 weeks apart), two readings of all variables were taken consecutively in order to calculate Cohen's kappa score for determining intraexaminer reliability. The  $\kappa$  value was 0.95, which indicated a "very good" score.

### *Lip Repositioning Surgery in the Control Group*

All surgeries were performed by the same periodontist (R.A.). The surgical protocol was performed using the LipStaT technique, as described by Bhola et al.<sup>15</sup> Participants were instructed to preoperatively rinse their mouths with 0.12% chlorhexidine for 1 minute (Figs 1a and 1b). Anesthesia was achieved by local infiltration (2% lidocaine with 1:50,000 epinephrine in the buccal vestibule). Borders of the surgical incision area were marked with a surgical marker. The inferior border was located 1 mm coronal to the mucogingival junction and extended bilaterally to the first molar area, based on the horizontal extension of dynamic smile. Height of the superior incision was marked to be 15 mm apical to the mucogingival junction within the

vestibule and, based on a 2:1 ratio of vertical extension, twice the measurement of EGD at a full dynamic smile. Using a no. 15 scalpel blade, superior and inferior incisions were made and joined bilaterally by two vertical incisions. An outlined strip of mucosa was removed by partial-thickness dissection, leaving the underlying connective tissue fascia exposed. All frenal attachments and minor salivary glands were removed when necessary (Figs 1c and 1d). In this group, no sutures were used in the thick connective tissue area, as done for the test group (Figs 1e and 1f). Then, continuous interlocking sutures using polypropylene 4/0 (Ethicon, Johnson & Johnson) were initiated on one side of the incision and ended at the contralateral side, obtaining proper closure of the surgical site. Sutures were used to stabilize the new mucosal margin in its new position (Fig 1g).

### *Surgical Modification Performed for Test Group*

For the test group, the same surgical procedure was performed as for the control group, except a periosteal simple interrupted suture was placed before the continuous interlocking sutures. This vertical simple interrupted suture was introduced into areas of thick connective tissue ( $\geq 0.5$  mm thick) or frenal attachments, starting 2 mm coronal to the base of attachment and then sliding the needle apically, passing the connective tissue attachment up to 6 mm before tying the knot. This suture was intended to move and

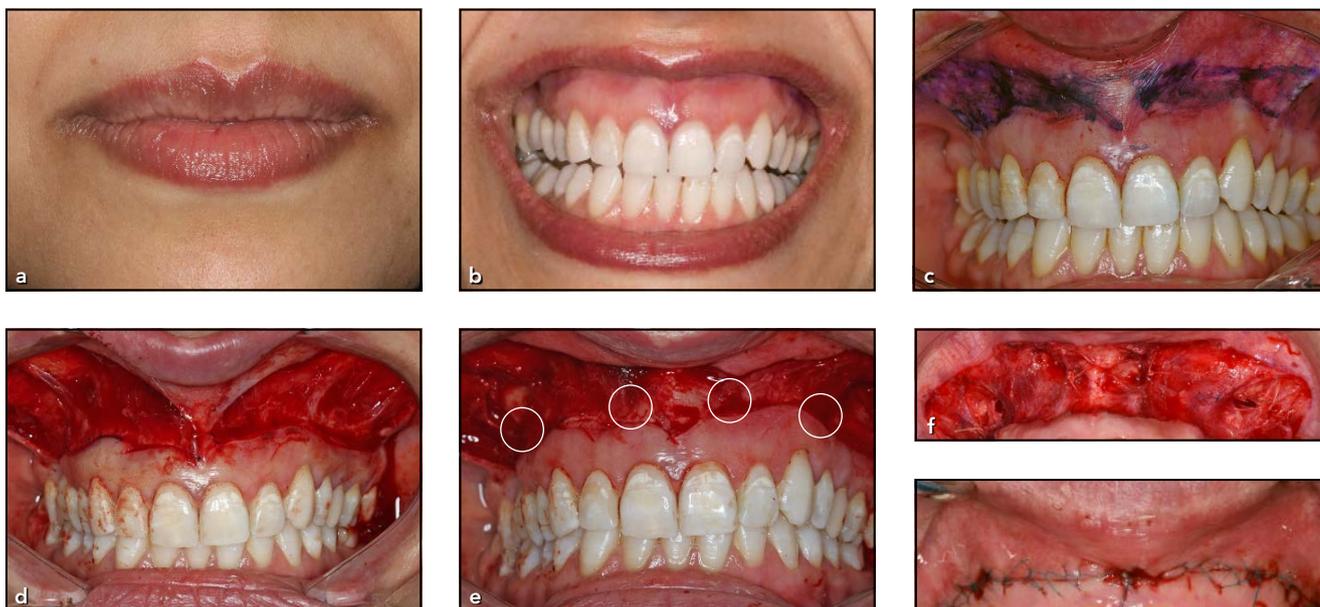
stabilize the thick connective tissue attachments in a more coronal position. All periosteal suturing was carried out using 4-0 Vicryl absorbable sutures (Ethicon). An average of three to four sutures were placed per surgical site (Figs 1e, 1f, and 2).

### *Postsurgery Instructions*

Participants were prescribed analgesics (750 mg acetaminophen/400 mg ibuprofen, alternating dosages every 4 hours) for 2 days and instructed to rinse the mouth with 0.12% chlorhexidine twice daily for 10 days. They were also instructed to apply ice packs, consume only soft foods during the first week, and minimize lip movement when smiling or talking during the first 2 weeks postoperatively.

### *Follow-up Visit*

Postoperative visits occurred weekly for the first 4 weeks, then at 1 month, 6 months, 1 year, 2 years, and 3 years (Figs 1h to 1m). At the 1-week follow-up, sutures were removed because primary closure was observed, and patients resumed regular oral habits. Upon each follow-up visit, professional plaque control was performed, and oral hygiene instructions were revisited. All clinical measurements were obtained by a blinded examiner in the same manner as baseline measurement-taking. Digital photos were taken to help assess further changes in the smile.



**Figs 1a to 1g** Surgical procedure in the test group. (a and b) Presurgical assessment of the average lip width at rest (ALW), vertical lip translation with maximum smile (VLT), and average gingival display (AGD). (c and d) Mucosa (15 mm) was bilaterally removed apical to the mucogingival junction. (e and f) Four periosteal vertical simple interrupted sutures were placed to hold thick connective tissue fibers in a more apical direction. (g) Continuous interlocking sutures obtained proper closure of the surgical site.

### Satisfaction Survey

A prevalidated Likert-type scale, with scores from 1 to 5 (5 being the most positive), was used to measure patient satisfaction regarding their smile at baseline and at the 6-month, 1-year, 2-year, and 3-year follow-up visits (total of five time points). The survey included four questions that addressed participants' satisfaction with their smile, the amount of gingiva displayed, symptoms, the best and worst aspects of the procedure, and whether they would undergo the procedure again.<sup>27</sup>

### Data Analysis

Collected data were analyzed using SPSS version 21.0 (IBM). Descriptive

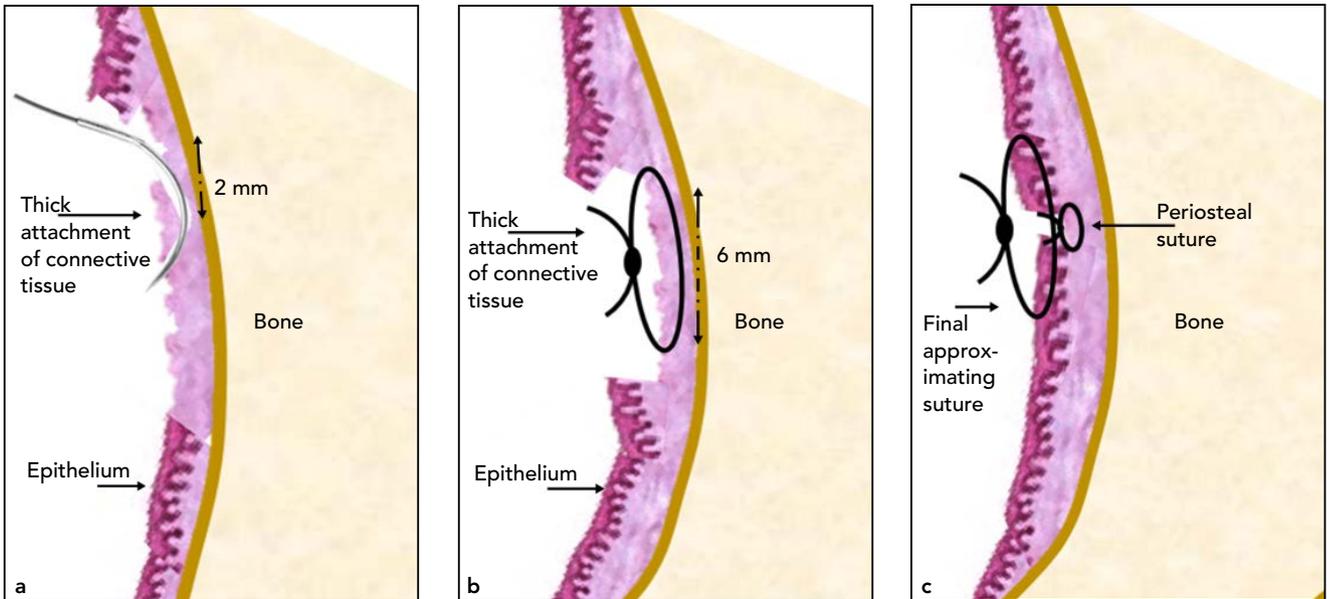
statistics were used to assess the outcome variables, comprising average lip width at rest (ALW), vertical lip translation with maximum smile (VLT), and average gingival display (AGD). Variables were measured at baseline and all of the follow-up appointments in numeric form; thus, the descriptive analysis involved generating means and SDs. Student t test for independent samples was used to compare the mean values of quantitative outcome variables at five time points in each of the control and test groups. Spearman rank correlation test was used

to assess the relationship between VLT and AGD. Descriptive analysis was used to compare the mean scores of the satisfaction assessment between the test and control groups at each study period. For all analyses performed, the significance level was set at  $\alpha = .05$ .

### Results

Twelve participants were included in the present study. Half of the participants ( $n = 6$ ) were in the test group, and the other half were in the control group. During baseline assessments, mean ALW at rest was 23.2 mm (SD: 1.4 mm) for the test group and was 23.0 mm (1.5 mm) for the control group. The difference between the average measurements

**Figs 1h to 1m** (h and i) Follow-up at 1 week postsurgery. (j and k) Follow-up at 6 months postsurgery. (l and m) Follow-up at 3 years postsurgery.



**Fig 2** Schematic drawings portraying the periosteal suturing utilized. (a) The needle is inserted, starting 2 mm coronal to the base of the thick connective tissue attachment or frenal attachment, then the needle is slid apically, passing the attachment. (b) Sliding the needle up to 6 mm and tying a knot creates a simple interrupted suture. (c) The suture is intended to move and stabilize the thick connective tissue attachments in a more coronal position.

**Table 1 Comparison by Time Point of Mean Outcome Variables Between Groups**

Outcome variable	Group		t	P
	Test	Control		
<b>Baseline</b>				
ALW	23.2 (1.4)	23.0 (1.5)	-0.191	.852
VLT	14.8 (2.3)	14.8 (2.3)	0.000	1.000
AGD	6.9 (1.2)	7.0 (1.2)	0.081	.937
<b>6 mo</b>				
ALW	23.2 (1.4)	23.0 (1.5)	-0.191	.852
VLT	4.8 (1.2)	4.8 (1.2)	0.000	1.000
AGD	1.7 (0.4)	1.7 (0.4)	0.000	1.000
<b>1 y</b>				
ALW	23.2 (1.4)	23.0 (1.5)	-0.191	.852
VLT	5.0 (1.3)	5.8 (0.9)	1.274	.231
AGD	2.0 (0.7)	2.4 (0.6)	1.112	.292
<b>2 y</b>				
ALW	23.2 (1.4)	23.0 (1.5)	-0.191	.852
VLT	4.8 (1.3)	5.7 (1.2)	1.135	.283
AGD	2.0 (0.7)	2.4 (0.6)	1.112	.292
<b>3 y</b>				
ALW	23.2 (1.4)	23.0 (1.5)	-0.191	.852
VLT	5.5 (1.6)	7.5 (1.6)	2.108	.061
AGD	3.5 (1.4)	5.0 (1.8)	1.655	.129

ALW = average lip width at rest; VLT = vertical lip translation with maximum smile; AGD = average gingival display. Test and control group data are presented in millimeters as mean (SD).

in both groups was not statistically significant ( $t [5] = -0.191$ ,  $P = .852$ ). VLT was similar in both groups: 14.8 mm (2.3 mm). Mean AGD was 6.9 mm (1.2 mm) in the test group and was 7.0 mm (1.2 mm) in the control group. This difference between the two averages was not statistically significant ( $t [5] = -0.081$ ,  $P = .937$ ; Table 1).

When these measurements were compared at the 6-month follow-up, VLT and AGD had the same mean change in both groups: 4.8 mm (1.2 mm) and 1.7 mm

(0.4 mm), respectively. At the 1-year assessment, VLT was 5.0 mm (1.3 mm) in the test group and 5.8 mm (0.9 mm) in the control group. The difference between both groups was not statistically significant ( $t [5] = 1.274$ ,  $P = .231$ ). A slight difference was seen in AGD between the test group (2.0 mm [0.7 mm]) and control group (2.4 mm [0.6 mm]) but with no statistical significance ( $P = .292$ ).

At the 2-year follow-up, VLT was 4.8 mm (1.3 mm) in the test group and 5.7 mm (1.2 mm) in the control

group. The difference between the two mean values was still statistically insignificant ( $t [5] = 1.135$ ,  $P = .283$ ). AGD in both groups remained similar to the values observed at the 1-year assessment.

When the final, 3-year follow-up was conducted, mean VLT was 5.5 mm (1.6 mm) in the test group and 7.5 mm (1.6 mm) in the control group, showing a marginal statistical difference between the two groups ( $t [5] = 2.108$ ,  $P = .061$ ). Furthermore, AGD decrease was 3.5 mm (1.4 mm) in the test group and was 5.0 mm

**Table 2 Comparison by Group of Mean Outcome Variables Between Groups**

Outcome variable	Time					F	P
	Baseline	6 mo	1 y	2 y	3 y		
<b>Control</b>							
ALW	23 (1.5)	23 (1.5)	23 (1.5)	23 (1.5)	23 (1.5)	0.00	1.00
VLT	14.8 (2.3)	4.8 (1.2)	5.8 (0.9)	5.7 (1.2)	7.5 (1.6)	42.19	< .0001*
AGD	7.0 (1.2)	1.7 (0.4)	2.4 (0.6)	2.4 (0.6)	5.0 (1.8)	28.05	< .0001*
<b>Test</b>							
ALW	23.2 (1.4)	23.2 (1.4)	23.2 (1.4)	23.2 (1.4)	23.2 (1.4)	0.00	1.00
VLT	14.8 (2.3)	4.8 (1.2)	5.0 (1.3)	4.8 (1.3)	5.5 (1.6)	45.12	< .0001*
AGD	6.9 (1.2)	1.7 (0.4)	2.0 (0.7)	2.0 (0.7)	3.5 (1.4)	32.85	< .0001*

ALW = average lip width at rest; VLT = vertical lip translation with maximum smile; AGD = average gingival display. Data are presented in millimeters as mean (SD).

\*Statistically significant.

(1.8 mm) in the control group. This difference was statistically insignificant and indicated that minimal relapse occurred in both groups; however, in the test group, this relapse was minimal compared to baseline readings.

Comparing the mean values of the three outcome variables (ALW, VLT, and AGD) at five time points over the 3-year follow-up period showed a statistically significant difference for VLT and AGD in both groups, but the ALW measurements were the same for both groups at all times during the study. In the control group, the mean VLT and AGD values at 2 years had decreased from baseline, but they showed a slight increase at 3 years ( $F = 42.19$ ,  $P < .0001$ ; and  $F = 28.05$ ,  $P < .0001$ , respectively). In the test group, at the 3-year follow-up, the mean VLT and AGD values had decreased from baseline ( $F = 45.12$ ,  $P < .0001$ ; and  $F = 32.85$ ,  $P < .0001$ , respectively) (Table 2).

In assessing the correlation between VLT and AGD, the results

indicate that the two outcome variables had a negative association in both test and control groups during baseline evaluation ( $n = 6$ ;  $r = -0.696$ ,  $P = .125$ ). At the 6-month evaluation, this correlation was weakly positive in both the test and control groups ( $n = 6$ ;  $r = 0.125$ ,  $P = .813$ ). One year after surgery, the correlation was found to be fairly positive in the test group ( $n = 6$ ;  $r = 0.257$ ,  $P = .623$ ) and weakly positive in the control group ( $n = 6$ ;  $r = 0.127$ ,  $P = .810$ ); it remained the same at the 2-year follow-up in both the test ( $n = 6$ ,  $r = -0.493$ ,  $P = .321$ ) and control groups ( $n = 6$ ;  $r = 0.136$ ,  $P = .797$ ). The 3-year follow-up showed a strong, positive correlation between the two outcome variables in both the test ( $n = 6$ ;  $r = 0.746$ ,  $P = .088$ ) and control groups ( $n = 6$ ;  $r = 0.702$ ,  $P = .120$ ). However, all associations were statistically insignificant (Table 3). It should be noted that the control group had a relapse of nearly 3× between 6 months and 3 years postsurgery vs the 2.2× re-

lapse in the test group, which was statistically significant ( $P < .0001$ ).

In comparing participant satisfaction between groups, responses to all four questions were similar at baseline, with an average score of 1.0 out of a possible 5.0. At the 6-month assessment, an average score of 5.0 out of 5.0 was recorded for all questions for both groups. At 1 year, a slight variation in the average score was observed in responses in both groups to three questions. In the first question, both groups had an average score of 5.0. This score was reduced in the control group to 4.8, 4.8, and 4.7 for the second, third, and fourth questions, respectively. At the 2-year assessment, the average score for the first question was 4.8 for both groups. For the second and third questions, the average score for both was 5.0 in the test group and 4.7 in the control group. For the fourth question, the test group had an average score of 5.0 against the average of 4.5 in the control group. At the 3-year follow-up, the average

**Table 3 Correlation Between Vertical Lip Translation with Maximum Smile (VLT) vs Average Gingival Display (AGD)**

Variable	Time	Test group		Control group	
		<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
VLT vs AGD	Baseline	-0.696	.125	-0.696	.125
	6 mo	0.125	.813	0.125	.813
	1 y	0.257	.623	0.127	.810
	2 y	0.493	.321	0.136	.797
	3 y	0.746	.088	0.702	.120

score for the first question was 4.7 in the test group and 4.5 in the control group. The second and third questions both had an average score of 4.8 in the test group against 4.3 in the control group. Finally, the average score for the fourth question was 5.0 in the test group vs 4.2 in the control group (Table 4 and Figs 3 and 4).

## Discussion

Lip repositioning is proposed in the literature as management of EGD via a simple surgical procedure that limits the retraction of elevator smile muscles. This procedure is reported to be a safe alternative to more invasive procedures (such as orthognathic surgery). It provides a notably quick and robust outcome, with minimal risks or side effects.<sup>21</sup> A recent systematic review<sup>28</sup> presented an overall 3.4-mm improvement in EGD with a median follow-up time of 6 months. As the technique has gained popularity and been utilized by several surgeons over time, the rate of postoperatively reported relapse has ranged from several millimeters to a complete relapse.<sup>21,27</sup>

Dayakar et al<sup>21</sup> explained that some patients expressed esthetic satisfaction immediately after lip repositioning surgery, and this lasted up to 6 months after the procedure. Thereafter, the patients began to experience a gradual relapse within 12 months postsurgery. Thus, this technique was further modified by Miskinyar,<sup>29</sup> using a more invasive approach that included myotomy with partial resection of the levator labii superioris muscle, as well as nerve repositioning before muscle resection. This was thought to eliminate muscle regeneration, thus making the results more permanent. However, such a modification was found to be associated with several postoperative complications (eg, temporary paresthesia) and can be considered aggressive. In addition, the long-term relapse rate in the previous study was not clearly stated. Therefore, establishing a technique that develops almost no relapse remains a challenge.

The modification in the present study involved using deep periosteal sutures to stabilize the thick connective tissue attachment in a more coronal position before final closure.

Periosteal suturing is commonly used in different periodontal procedures for securing and stabilizing either mobilized host tissue or hard and/or soft tissue grafting material, depending on the intended intra-surgical goals.<sup>21,30</sup> The hypothesis was that utilizing deep periosteal sutures to displace and relocate thick connective tissue in a more coronal position could prevent these fibers from returning to their original position during the healing period, thus reducing the rate of postoperative relapse.

When comparing measurements of intended variables during sequential follow-up visits, the outcomes varied slightly, favoring the group with periosteal sutures. However, no single set of outcome variables had a statistically significant difference. This can be explained by the limitation of the small sample size, which may lead to a false assumption to be true. However, comparing identical twins can provide valid information from a strong, controlled design with several cofactors being eliminated. Furthermore, the overall differences between the baseline parameters and the 3-year follow-up parameters were clinically significant to participants, as reported by satisfaction surveys and personal communication. Results favored the group with periosteal sutures, leading to more stable outcomes, especially at the 3-year follow-up.

This study has some limitations, particularly its small sample size (which might have been responsible for the lack of statistical significance in the comparisons of outcome

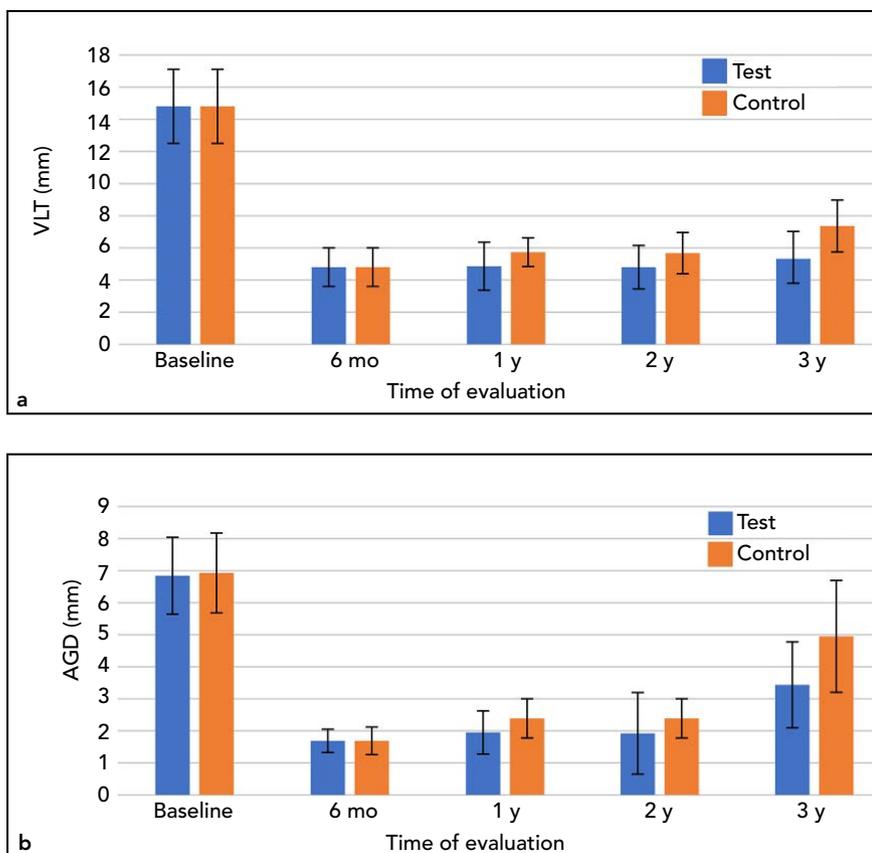
**Table 4 Comparison Between Groups of Mean Satisfaction Assessment Scores at All Time Points**

Assessment of satisfaction	Baseline		6 mo		1 y		2 y		3 y	
	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control
How satisfied are you with your smile?	1.0	1.0	5.0	5.0	5.0	5.0	4.8	4.8	4.7	4.5
How satisfied are you with gum showing in your smile?	1.0	1.0	5.0	5.0	5.0	4.8	5.0	4.7	4.8	4.3
How would you rate the amount of gum showing in your smile?	1.0	1.0	5.0	5.0	5.0	4.8	5.0	4.7	4.8	4.3
Having had the overall experience, would you go through lip repositioning surgery again?	1.0	1.0	5.0	5.0	5.0	4.7	5.0	4.5	5.0	4.2

Prevalidated Likert-type scale. Scores can range from 1 (most negative) to 5 (most positive).

**Fig 3** Case 1. Follow-up photos from baseline to 3 years, comparing control (left) and test (right) groups. (a) Baseline. (b) Six months postsurgery. (c) One year postsurgery. (d) Three years postsurgery.





**Fig 4** Changes in the mean (a) vertical lip translation (VLT) and (b) average gingival display (AGD) between the two groups at all time periods.

variables) and the recruitment of only women. The small sample size and sex limitation were attributable to the difficulty in finding a large population of identical twins who met the inclusion criteria. Notwithstanding, the results of the trial are clinically significant, as they showed patient satisfaction in the test group. Additionally, all cases in the present study had a baseline gingival display > 4 mm; using a criterion of 3 mm as an esthetic amount of postoperative gingival display, this modified lip repositioning technique with periosteal suturing was found to be successful in all cases (98% success rate), with the results maintained up to 3 years. These

promising initial results should motivate the performance of future randomized controlled trials with larger sample sizes, longer follow-up periods, and histologic analyses in order to confirm the present findings.

### Conclusions

A modification to lip repositioning surgery was proposed, adding deep, periosteal, simple interrupted sutures to coronally position the thick connective tissue fibers to reduce reported relapse. The results showed a clinically significant difference in the stability of the outcome

variables. Within the limitations of this study, the findings indicate that the effects of this modification can persist for up to 3 years after the initial surgery.

### Acknowledgments

The authors would like to thank the College of Dentistry Research Center at King Saud University for all of the support provided for this study. This study was registered in the Saudi Clinical Trials Registry (no. 2009-011736-35) in March 2017 and received approval from the Institutional Review Board. This study was conducted in accordance with the Declaration of Helsinki of 1975, as revised in 2013. The authors did not receive any funding from any financial source for this

study. The authors would also like to thank Dr Fahad Abdullatif for providing clinical images of the surgical procedure steps by using his own camera. All authors report no conflicts of interest related to this study.

## References

1. Kaya B, Uyar R. Influence on smile attractiveness of the smile arc in conjunction with gingival display. *Am J Orthod Dentofacial Orthop* 2013;144:541–547.
2. Kerns LL, Silveira AM, Kerns DG, Regennitter FJ. Esthetic preference of the frontal and profile views of the same smile. *J Esthet Dent* 1997;9:76–85.
3. Flores-Mir C, Silva E, Barriga MI, Lagravere MO, Major PW. Lay person's perception of smile aesthetics in dental and facial views. *J Orthod* 2004;31:204–209.
4. Al Jasser R. Proper diagnosis and management of dental smile esthetics from periodontal perspective: Literature review. *Saudi J Oral Dent Res* 2019;4:350–354.
5. Oumeish OY. The cultural and philosophical concepts of cosmetics in beauty and art through the medical history of mankind. *Clin Dermatol* 2001;19:375–386.
6. Ioi H, Nakata S, Counts AL. Influence of gingival display on smile aesthetics in Japanese. *Eur J Orthodont* 2010;32:633–637.
7. Roden-Johnson D, Gallerano R, English J. The effects of buccal corridor spaces and arch form on smile esthetics. *Am J Orthod Dentofacial Orthop* 2005;127:343–350.
8. Pinho S, Ciriaco C, Faber J, Lenza MA. Impact of dental asymmetries on the perception of smile esthetics. *Am J Orthod Dentofacial Orthop* 2007;132:748–753.
9. Geron S, Atalia W. Influence of sex on the perception of oral and smile esthetics with different gingival display and incisal plane inclination. *Angle Orthod* 2005;75:778–784.
10. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: Asymmetric and symmetric situations. *Am J Orthod Dentofacial Orthop* 2006;130:141–151.
11. Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. *J Prosthet Dent* 1984;51:24–28.
12. Robbins JW. Differential diagnosis and treatment of excess gingival display. *Pract Periodontics Aesthet Dent* 1999;11:265–272.
13. Andijani RI, Tatakis DN. Hypermobile upper lip is highly prevalent among patients seeking treatment for gummy smile. *J Periodontol* 2019;90:256–262.
14. Peck S, Peck L, Kataja M. The gingival smile line. *Angle Orthod* 1992;62:91–102.
15. Bhola M, Fairbairn PJ, Kolhatkar S, Chu SJ, Morris T, de Campos M. LipStaT: The lip stabilization technique—Indications and guidelines for case selection and classification of excessive gingival display. *Int J Periodontics Restorative Dent* 2015;35:549–559.
16. Rubinstein AM, Kostianovsky AS. Cosmetic surgery for the malformation of the laugh: Original technique [in Spanish]. *Prensa Med Argent* 1973;60:952.
17. Rosenblatt A, Simon Z. Lip repositioning for reduction of excessive gingival display: A clinical report. *Int J Periodontics Restorative Dent* 2006;26:433–437.
18. Simon Z, Rosenblatt A, Dorfman W. Eliminating a “gummy smile” with surgical lip repositioning. *J Cosmet Dent* 2007;23:102–109.
19. Foudah MA. Lip repositioning: An alternative to invasive surgery a 4-year follow-up case report. *Saudi Dent J* 2019;31(suppl):s78–s84.
20. Humayun N, Kolhatkar S, Souiyas J, Bhola M. Mucosal coronally positioned flap for the management of excessive gingival display in the presence of hypermobility of the upper lip and vertical maxillary excess: A case report. *J Periodontol* 2010;81:1858–1863.
21. Dayakar MM, Gupta S, Shivananda H. Lip repositioning: An alternative cosmetic treatment for gummy smile. *J Indian Soc Periodontol* 2014;18:520–523.
22. Lang NP, Adler R, Joss A, Nyman S. Absence of bleeding on probing: An indicator of periodontal stability. *J Clin Periodontol* 1990;17:714–721.
23. Silness J, Loe H. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand* 1964;22:121–135.
24. de Castro MV, Santos NC, Ricardo LH. Assessment of the “golden proportion” in agreeable smiles. *Quintessence Int* 2006;37:597–604.
25. Ackerman MB, Ackerman JL. Smile analysis and design in the digital era. *J Clin Orthod* 2002;36:221–236.
26. Wu H, Lin J, Zhou L, Bai D. Classification and craniofacial features of gummy smile in adolescents. *J Craniofac Surg* 2010;21:1474–1479.
27. Silva CO, Ribeiro-Júnior NV, Campos TV, Rodrigues JG, Tatakis DN. Excessive gingival display: Treatment by a modified lip repositioning technique. *J Clin Periodontol* 2013;40:260–265.
28. Tawfik OK, Naiem SN, Tawfik LK, et al. Lip repositioning with or without myotomy: A randomized clinical trial. *J Periodontol* 2018;89:815–823.
29. Miskinyar SA. A new method for correcting a gummy smile. *Plast Reconstr Surg* 1983;72:397–400.
30. Urban IA, Lozada JL, Wessing B, Suárez-López del Amo F, Wang HL. Vertical bone grafting and periosteal vertical mattress suture for the fixation of resorbable membranes and stabilization of particulate grafts in horizontal guided bone regeneration to achieve more predictable results: A technical report. *Int J Periodontics Restorative Dent* 2016;36:153–159.