

EFFECTIVENESS OF LIP REPOSITIONING IN THE TREATMENT OF EXCESSIVE GINGIVAL DISPLAY: SYSTEMATIC REVIEW AND META-ANALYSIS

Eficacia del reposicionamiento de labios en el tratamiento de la exposición gingival excesiva: revisión sistemática y metanálisis

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ABSTRACT

Background: The objective of this systematic review and meta-analysis was to answer the questions “Does lip repositioning surgery reduce the amount of gingiva exposed in the smile in individuals with excessive gingival display EGD (excessive gingival display)?” and “Is the reduction of the amount of gingiva exposed when smiling obtained with lip repositioning surgery stable over time?” to evaluate the effectiveness of lip repositioning surgery for correcting EGD on smiling.

Materials and Methods: A systematic structured search was carried out in five databases without data restriction. Studies reporting the degree of reduction in gingival exposure after lip repositioning surgery were included. Study selection, data extraction, and risk of bias assessment were performed in duplicate

Results: One hundred sixty-four references were retrieved and eleven studies met the eligibility criteria. Meta-analysis demonstrated that lip repositioning surgery results in a significant reduction in the amount of exposed gingival tissue (mean difference = -3.03; confidence interval = -3.55; -2.52). In addition, the results remained stable in the evaluated follow-up periods (1, 3, 6 and 12 months). Included studies had a low risk of bias.

Conclusions: Lip repositioning surgery is effective for the treatment of EGD on smiling and exhibits stable results in the evaluated periods. The study was registered (CRD42020184866) in the international prospective register of systematic reviews (PROSPERO).

Keywords: *Lip; Gingiva; Smiling; Lip repositioning; Excessive gingival display; Esthetic periodontal surgery*

RESUMEN

Antecedentes: el objetivo de esta revisión sistemática y metanálisis fue responder a las preguntas “¿La cirugía de reposicionamiento de labios reduce la cantidad de encía expuesta en la sonrisa en personas con exposición gingival excesiva (EGE)?” y “¿La reducción de la cantidad de encía expuesta al sonreír obtenido con cirugía de reposicionamiento de labios estable en el tiempo?” para evaluar la efectividad de la cirugía de reposicionamiento de labios para corregir la EGE al sonreír.

Materiales y Métodos: Se realizó una búsqueda sistemática estructurada en cinco bases de datos sin restricción de datos. Se incluyeron los estudios que informaron el grado de reducción de la exposición gingival después de la cirugía de reposición de labios. La selección de estudios, la extracción de datos y la evaluación del riesgo de sesgo se realizaron por duplicado.

Resultados: Se recuperaron ciento sesenta y cuatro referencias y once estudios cumplieron con los criterios de elegibilidad. El metanálisis demostró que la cirugía de reposicionamiento de labios da como resultado una reducción significativa en la cantidad de tejido gingival expuesto (diferencia de medias = -3,03; intervalo de confianza = -3,55; -2,52). Además, los resultados se mantuvieron estables en los periodos de seguimiento evaluados (1, 3, 6 y 12 meses). Los estudios incluidos tenían un bajo riesgo de sesgo.

Conclusión: La cirugía de reposicionamiento de labios es efectiva para el tratamiento de la EGE al sonreír y presenta resultados estables en los períodos evaluados. El estudio fue registrado (CRD42020184866) en el registro prospectivo internacional de revisiones sistemáticas (PROSPERO).

Palabras Clave: *Encía; Labio; Sonrisa; Reposicionamiento labial; Exposición gingival excesiva; Cirugía periodontal estética.*

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INTRODUCTION

EGD is a commonplace condition associated with a high degree of dissatisfaction with the smile, characterized by exposure of the upper gingiva greater than 3 mm during spontaneous smile.¹ Different etiological factors, such as excessive vertical growth, short upper lip, hyperactivity of the upper lip, altered passive eruption and small-sized teeth are associated with EGD.²⁻⁵ In many cases, multiple factors might be in place. Treatment plan is drawn up after a careful analysis of determinant factors. Thus, several therapeutic possibilities to address EGD are available.⁶

A viable alternative treatment for EGD due to a hyperactive upper lip is the application of botulinum toxin, which reduces muscle activity and reduces the elevation of the upper lip by means of the inhibition of the release of acetylcholine.⁷ However, the mechanism of action of botulinum toxin is temporary and EGD relapses.^{8,9} Lip repositioning surgery is another therapeutic alternative for EGD cases resulting from the hyperfunction of the upper lip lifter muscle. In this technique, the removal of a portion of mucosa from the maxillary buccal vestibule with two partial incisions and suture of the lip mucosa in a more coronal position, at the level of the mucogingival junction, is performed. This procedure results in a shallow vestibular depth and in less gingival exposure.¹⁰ Reports on the successful management of EGD with lip repositioning surgery have been described in the literature. However, the stability of the results has been questioned.¹¹⁻¹³ The identification of the percentage of reduction of gingival exposure that can be achieved with this technique and

the assessment of the stability of the results on the long term are essential to the clinician during the decision making process.¹⁴

Therefore, the current systematic review and meta-analysis aimed to assess the effectiveness of lip repositioning surgery for the treatment of EGD and evaluate the stability of the surgical procedure in longer follow-up.

MATERIALS AND METHODS

Registration of a protocol

This systematic review and meta-analysis was carried out according to the recommendations made in PRISMA.¹⁵ The study was registered in the database for registration of systematic reviews - PROSPERO (CRD42020184866).

Eligibility criteria

Focused questions: This systematic review and meta-analysis has two clinical questions (PICO):

1. Does lip repositioning surgery reduce the amount of gingiva exposed in the smile in individuals with EGD.
2. Is the reduction of the amount of gingiva exposed when smiling obtained with lip repositioning surgery stable over time.

Patients: Individuals with EGD when smiling;
Intervention: Lip repositioning surgery;
Comparison: No treatment; **Outcome:** Reduction and stability of gingival display while smiling.

Intervention studies, in which the degree of reduction (in millimeters) of EGD after lip repositioning surgery was evaluated.

Literature reviews, letters to the editor, expert opinions, meeting abstracts, observational

studies, and intervention studies, in which EGD when smiling had a multifactorial etiology and was treated with a technique other than lip repositioning surgery without available data on the results of the different techniques separately were excluded.

Sources of information and search strategy

The literature search was conducted in July 2021 by two reviewers (JCS and RPEL) in the electronic databases: PubMed, Scopus, Ovid, Lilacs, and Web of Science. The following search strategy was employed: ((lip repositioning) AND (gummy smile OR excessive gingival display)). No restrictions were imposed on the year of publication. The grey literature was consulted in OpenGrey. A search in Google Scholar was also performed. The searches in OpenGrey and Google Scholar were restricted to the first 200 hits. Finally, a manual search of the reference list of the included studies was carried out as well.

Selection of studies

The selection of studies was carried out in two phases. Initially, the analysis of titles and abstracts obtained from the electronic databases and the other sources of information (Phase 1) was carried out independently by two researchers (JCS and RPEL). The full texts of references that appeared to meet the eligibility criteria after assessment of titles and abstracts were evaluated. The analysis of the full text of the selected references (Phase 2) was carried out by the two independent reviewers (JCS and RPEL) to confirm the inclusion of studies in this systematic review and meta-analysis. Disagreements between reviewers during studies' selection were resolved by discussion and consensus.

Data extraction

The following information was extracted from the included articles: year of publication, author (s), sample size, age of participants, sex of participants, follow-up period, and measurement of EGD before and after lip repositioning surgery.

Assessment of methodological quality (risk of bias) of studies

The evaluation of the methodological quality (risk of bias) of the included studies was carried out independently by two reviewers (JCS and RPEL). Disagreements between reviewers were resolved by discussion and consensus. The Joanna Briggs Institute Critical Appraisal instruments for case series and for case report were used.^{16,17} The former contains 10 items and the latter has eight items. In general, the items evaluate issues regarding participants' demographic characteristics, inclusion of participants, assessment of the condition and outcomes, and statistical analysis deployed. For each item, there are the following answer options: yes (low risk of bias), no (high risk of bias), uncertain (uncertain risk of bias) and not applicable.

Measures used in studies to report results

The measures used to report the data on EGD on smiling before and after lip repositioning were the mean and standard deviation.

Synthesis of the results

The results of homogeneous studies were aggregated into meta-analysis. The meta-analysis was carried out with Review Manager 5.3 [Review Manager (RevMan)].

Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014]. The I² statistics was used to assess statistical heterogeneity.¹⁴

RESULTS

Selection of studies

One hundred sixty-four studies were identified in the electronic search and no study was identified manually. No reference was identified in *OpenGrey* and *Google Scholar*. After the removal of 93 duplicate hits, the title and

abstract of the remaining 71 references were evaluated in Phase 1.

Thirty-two references were excluded straight away because the titles and abstracts did not fulfill the eligibility criteria. The full texts of 39 references were assessed in Phase 2 and eleven studies were included in this systematic review and meta-analysis.

The list of studies excluded after the evaluation of the full texts and the reasons for exclusion are available in Appendices A. A flowchart depicting the steps for the selection of the studies of this systematic review and meta-analysis is provided in Figure 1.

Figure 1. Flowchart of the systematic review and meta-analysis depicting the search and the selection of the included articles.

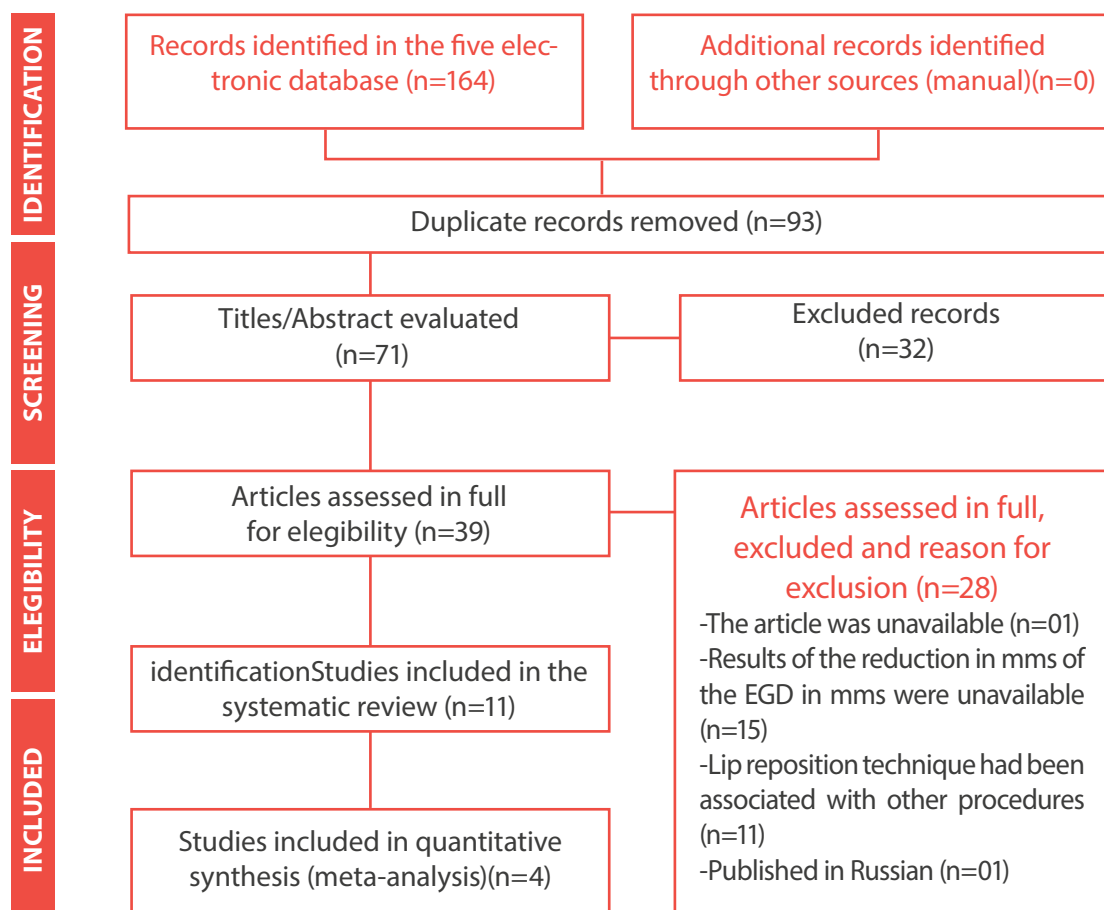


Table 1. Characteristics of the included studies and measurement of excessive gingival display (EGD) before and after surgery.

Authors	Country	Sample size (n)	Age (mean)	Sex	Etiology of EGD	Follow up time	EGD before surgery in mm (mean)	Results surgery (EGD after in mm mean and Standard Deviation)
Alammar et al. 2018	Syria	11 individuals	---	---	Short upper lip and Hypermobility upper lip	1, 3 and 6 months	5.8	1 month: 2.2 ± 0.8 mm (p<0.01) 3 months: 2.6 ± 0.9 mm (p<0.01) 6 months: 3.3 ± 0.8 mm (p<0.01)
Bouguezzi et al. 2020	Tunisia	1 individual	24	Male	Vertical maxillary excess	3 and 6 months	7-8	3 months: 3.0 mm 6 months: 3.0 mm
Dayakar et al. 2014 ¹⁷	India	1 individual	22	Female	Vertical maxillary excess	3, 6 and 12 months	5-6	3 months: 3 mm 6 months: 3 mm 12 months: almost complete relapse
Jacobs et al. 2013 ²	USA	7 individuals	---	Female	Hypermobility upper lip	1 month to 3 years	5.3	1 month to 3 years: 1.1 ± 2.5 mm (value not reported)
Jananni et al. 2014 ²⁰	India	1 individual	18	Female	Vertical maxillary excess and hypermobility upper lip	18 months	6	2 mm
Mateo et al. 2021	Dominica Republic	4 individuals	18-35	Female	Hypermobility upper lip and vertical maxillary excess	3.3 years	7.3	2.25 mm
Ozturan et al. 2014 ¹⁸	Turkey	10 individuals	27.8	Female	Hypermobility upper lip	6 and 12 months	4.3	6 months: 1.1 ± 1.0 mm (p < 0.01) 12 months: 1.2 ± 1.5 mm (p < 0.01)
Rao et al. 2015 ²¹	India	1 individual	23	Male	Hypermobility upper lip	1 week and 1 month	6	1 week: <1 mm After 1 month: 1 mm
Ribeiro-Junior et al. 2013 ¹⁰	Brazil	1 individual	22	Female	Hypermobility upper lip	6 months	7	1 mm
Silva et al. 2013 ¹⁶	Brazil	13 individuals	28.7	11 Female and 2 male	Hypermobility upper lip	3 and 6 months	5.8	3 months: 1.4 ± 1.0 mm (p<0.01) 6 months: 1.3 ± 1.6 mm (p<0.01)
Tawfik et al. 2018 ¹⁹	Egypt	10 individuals	---	---	Vertical maxillary excess	3, 6, and 12 months	4.3	3 months: 1.7 ± 0.9 mm (p<0.05) 6 months: 2.2 ± 1.0 mm (p<0.05)

Table 2. Meta-analysis comparing gingival display before and after lip repositioning surgery

Study or Subgroup	AFTER SUGERY			BEFORE SUGERY			Weight	MEAN DIFFERENCE IV, Random, 95% CI	MEAN DIFFERENCE IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total			
1.1.1 ONE MONTH AFTER SUGERY									
Alamman et al., (2018)	2.18	0.75	11	5.82	0.87	11	12.7%	-3.64 [-4.32, -2.96]	
Subtotal (95% CI)			11			11	12.7%	-3.64 [-4.32, -2.96]	
Heterogeneity: Not applicable Test for overall effect: Z=10.51 (p<0.00001)									
1.1.2 THREE MONTHS AFTER SURGERY									
Alamman et al., (2018)	2.55	0.93	11	5.82	0.87	11	12.1%	-3.27 [-4.02, -2.52]	
Silva et al., (2013)	1.4	1	13	5.8	2.1	13	8.2%	-4.40 [-5.66, -3.14]	
Tawfik et al., (2018)	1.65	0.9	10	4.31	1.12	10	10.9%	-2.66 [-3.55, -1.77]	
Subtotal (95% CI)			34			34	31.2%	-3.34 [-4.19, -2.49]	
Heterogeneity: Tau ² =0.33; Chi ² =4.87, df=2 (p=0.09); I ² =59% Test for overall effect: Z=7.69 (p<0.00001)									
1.1.3 SIX MONTHS AFTER SURGERY									
Alamman et al., (2018)	3.27	0.79	11	5.82	0.87	11	12.5%	-2.55 [-3.24, -1.86]	
Silva et al., (2013)	1.1	1	10	4.3	1.8	10	8.1%	-3.20 [-4.48, -1.92]	
Tawfik et al., (2018)	1.3	1.6	13	5.8	2.1	13	7.2%	-4.50 [-5.94, -3.06]	
Subtotal (95% CI)			44			44	38.5%	-2.94 [-3.80, -2.07]	
Heterogeneity: Tau ² =0.49; Chi ² =8.38, df=3 (p=0.04); I ² =64% Test for overall effect: Z=10.51 (p<0.00001)									
1.1.4 TWELVE MONTHS AFTER SURGERY									
Ozturan et al., (2014)	1.2	1.1	10	4.3	1.8	10	107.9%	-3.10 [-4.41, -1.79]	
Tawfik et al., 2018	2.73	128	10	4.31	1.12	10	9.7%	-1.58 [-2.63, -0.53]	
Subtotal (95% CI)			20			20	17.6%	-2.29 [-3.77, -0.80]	
Heterogeneity: Tau ² =0.79; Chi ² =3.15, df=1 (p=0.08); I ² =68% Test for overall effect: Z=3.02 (p<0.003)									
Total (95% CI)			109			109	100.0%	-3.03 [-3.55, -2.52]	
Heterogeneity: Tau ² =0.43; Chi ² =25.67, df=9 (p=0.02); I ² =65% Test for overall effect: Z=11.53 (p<0.00001) Test for subgroup differences: Chi ² = 3.40, df= 3 (p=0.33), I ² =11.9%									

Characteristics of the studies

The characteristics of the eleven included studies¹⁸⁻²⁸ are described in Table 1. All included studies were published in English and were conducted in eight different countries. In the eleven studies, 60 individuals had undergone lip repositioning surgery for the treatment of EGD. The number of participants in each study ranged from one to 13 individuals. The participants were followed up for 1 week to 7 years after lip repositioning surgery. Four studies^{19,20,25,27}

had a follow-up of at least 6 months, three studies^{21,23,26} had a follow-up of 12 months, while in one study,¹⁸ the follow-up period was 3 years. One study²⁸ had a follow-up of up to 7 years, with an average of 3.3 years. In one study,²² the follow-up was 18 months and in another study,²⁴ the follow-up was 1 month. In all articles, information on the criteria of EGD used for the selection of participants was available.

Lip repositioning surgery and clinical parameters

All eleven studies demonstrated that lip repositioning surgery contributed to a significant improvement in EGD on smiling, significantly reducing the exposure in mm. In the studies, the mean EGD before lip repositioning surgery among the participants ranged from 4.3 mm to 8.0 mm. The mean after lip repositioning surgery ranged from 1.0 mm to 3.3 mm. Satisfactory stability of the results of lip repositioning surgery at 6 months was observed in six studies.^{19,20,21,23,25,26} In these studies, the mean of gingival exposure before the surgical procedure was 5.36 mm and after 6 months, the mean was 1.98 mm. In four studies^{22,23,26,28} data of lip repositioning surgery for 12 months or more were reported. In these studies, the mean of gingival exposure before the surgical procedure was 5.46 mm and after 12 months, the mean was 2.04 mm.

Evaluation of the methodological quality of the included studies

The six case series^{18,20,23,25,26,28} included had a low risk of bias for inclusion of participants, measurement of the condition, methods used to identify the condition, and the reporting of results on follow-up (Supplementary file 1). The five case reports^{19,21,22,24,27} included had a low risk of bias for the reporting of the patient's demographic characteristics, clinical condition of the patient, intervention(s) or treatment procedures, clinical condition post-intervention, identification of adverse events, and takeaway lessons (Supplementary file 2).

Synthesis of the results

Four studies^{20,23,25,26} evaluating the mean gingival display before and after the repositioning surgery were incorporated into the meta-analysis.

The meta-analysis showed a significant reduction in the EGD when smiling after lip repositioning (Mean difference = -3.03, confidence interval = -3.55; -2.52). The reductions were also significant for the subgroups: 1 month (Mean difference = -3.64, confidence interval = -4.32; -2.96), 3 months (Mean difference = -3.34, confidence interval = -4.19; -2.49), 6 months (Mean difference = -2.94, confidence interval = -3.80; -2.07), and 12 months (Mean difference = -2.29, confidence interval = -3.77; -0.80), after surgery (Figure 2).

DISCUSSION

EGD on smiling is a prevalent condition associated with different etiological factors, including hypermobility of the upper lip.^{10,29} Application of botulinum toxin and lip repositioning surgery have been indicated for the treatment of EGD caused by hyperactive upper lip.^{20,30-33}

The objective of this systematic review and meta-analysis was to evaluate the effectiveness of lip repositioning surgery for the correction of EGD. Few studies have evaluated the results of lip repositioning surgery in the treatment of EGD and the stability of the results over the long-term. In this systematic review and meta-analysis, a comprehensive search and strict eligibility criteria to identify all the pertinent literature on the issue were employed. Our results reportedly demonstrated a significant reduction in gingival exposure after lip

repositioning surgery. The results were also significant in the subgroup analyses considering the period of 1, 3, 6 and 12 months after lip repositioning surgery.

In the studies included, the mean gingival exposure before surgery ranged from 4.3 to 8.0mm, while after lip repositioning surgery, the variation was between 1.0 and 3.3mm. Most studies had a follow-up time of six months or more.^{18-23,25-27}

EGD has a multifactorial etiology, which may be the result of dental, skeletal, labial, periodontal and muscle alterations. External factors related to conditions that cause gingival enlargement, including dental biofilm and specific medications have also been described in the literature.² The combination of several factors is often observed in cases of EGD.^{20,34}

The determination of the etiological factor associated with EGD is essential for the proper development of the treatment plan and prognosis. Depending on the etiological factor, several treatments may be indicated, including gingivectomy, apical repositioned flap with or without bone resection, and orthognathic surgery.^{2,6,35} Lip repositioning surgery can be indicated for the treatment of EGD associated with less severe cases of vertical excess of the maxilla or with hyperactivity of the upper lip.^{2,36}

The blockade of the muscles involved in the lifting of the upper lip by the action of botulinum toxin results in less exposure of the gingival tissue. However, toxin applications must be renewed often between 4 to 8 months.⁸ The effect of botulinum

toxin restricted to the short-term has been pointed out as a limitation in the treatment of EGD. Complications, such as pain, edema, inflammation, hemorrhage, paresthesia and asymmetry have also been reported.³⁷ In this sense, lip repositioning surgery appears as a therapeutic alternative to botulinum toxin. lip repositioning surgery has the advantage of being a simple procedure, with adequate tissue healing, improved results, minimized side effects and low morbidity.¹¹ The combination of botulinum toxin and lip repositioning surgery has also been reported.³⁸

Results of our meta-analysis with follow-up studies of 6 and 12 months after lip repositioning surgery demonstrated a significant reduction in the amount of gingival tissue exposed when smiling. Among the studies included in this systematic review, six reported results of a 2-month follow-up or longer.^{18,21-23,26,28} Five of these studies^{18,22,23,26,28} demonstrated that the results remained stable over a period of 12 months or beyond. Two of these studies^{18,22} are case reports and, therefore, refer to the result of the surgery in a single patient. However, another case report²¹ demonstrated the almost complete remission of the amount of exposed gingiva after 12 months and a significant reduction in the amount of gingival tissue exposed at 3 and 6 months.

The purpose of lip repositioning surgery is to minimize gingival exposure restricting the retraction of the elevator muscles. Postoperatively, tension in the upper lip when speaking and smiling and discomfort in the first week were the complications most frequently reported in the studies

included.¹⁹⁻²⁵ Bleeding, paraesthesia, ecchymosis, edema, and mucocele are also complications associated with LRS.^{2,10,19,20,25}

The limited number of patients in the included studies is a shortcoming of this review. Four of the included studies are case reports. In addition, few studies showcase results on a follow-up longer than six months. Additional studies on the effectiveness of lip repositioning surgery should include larger samples and longer follow-ups.

CONCLUSION

The present systematic review and meta-analysis demonstrated that lip repositioning surgery is effective in the treatment of EGD, allowing for a significant reduction in the amount of exposed gingiva and stable results up to or over 12 months.

CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

ETHICS APPROVAL

Not applicable.

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AUTHORS' CONTRIBUTIONS

Silva JC, Freire B and Esteves-Lima R: Conceived the ideas.

Silva JC and Esteves-Lima R: Collected the data.

Silva JC, Freire B, Esteves-Lima R, Abreu L and Cunha F: Analysed the data.

Abreu L and Esteves-Lima R: Did the meta-analysis data and all authors all authors wrote and approved the article.

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PEER REVIEW

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ANNEXES

Supplementary file A.1 – Risk of bias assessment for case series

	Alammar et al. 2018	Jacobs et al. 2013	Mateo et al. 2021	Ozturan et al. 2014	Silva et al. 2013	Tawfik et al. 2018
Were there clear criteria for inclusion in the case series?	Yes	Yes	Yes	Yes	Yes	Yes
Was the condition measured in a standard, reliable way for all participants included in the case series?	Yes	Yes	Yes	Yes	Yes	Yes
Were valid methods used for identification of the condition for all participants included in the case series?	Yes	Yes	Yes	Yes	Yes	Yes
Did the case series have consecutive inclusion of participants?	Yes	Yes	No	No	No	No
Did the case series have complete inclusion of participants?	Yes	Yes	No	No	No	No
Was there clear reporting of the demographics of the participants in the study?	No	Yes	Yes	No	Yes	Yes
Was there clear reporting of clinical information of the participants?	Yes	Yes	Yes	Yes	Yes	No
Were the outcomes or follow up results of cases clearly reported?	Yes	Yes	Yes	Yes	Yes	Yes
Was there clear reporting of the presenting site(s)/clinic(s) demographic information?	No	No	No	No	No	No
Was statistical analysis appropriate?	Yes	No	No	Yes	Yes	Yes

Supplementary file A.2 – Risk of bias assessment of the case reports

	Bouguezzi et al. 2020	Dayakar et al. 2013	Jananni et al. 2014	Rao et al. 2015	Ribeiro- Junior et al. 2013
Were the patient's demographic characteristics clearly described?	Yes	Yes	Yes	Yes	Yes
Was the patient's history clearly described and resented as a timeline?	No	No	No	No	No
Was the current clinical condition of the patient on presentation clearly described?	Yes	Yes	Yes	Yes	Yes
Were diagnostic tests or assessment methods and the results clearly described?	Yes	No	No	Yes	Yes
Was the intervention(s) or treatment procedure(s) clearly described?	Yes	Yes	Yes	Yes	Yes
Was the post-intervention clinical condition clearly described?	Yes	Yes	Yes	Yes	Yes
Were adverse events (harms) or unanticipated events identified and described?	Yes	Yes	Yes	Yes	Yes
Does the case report provide takeaway lessons?	Yes	Yes	Yes	Yes	Yes