Aesthetic surgical treatment in anterior maxilla: Comparison between Lip repositioning versus Crown lengthening. Literature Review.

Universidade Fernando Pessoa

Faculdade de Ciências da Saúde Porto, 2021

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(Marco Catalano)

Abstract

The aim of this article is to address the Gummy smile in a number of aspects including the psychosocial limitations it brings to an individual, the parameters of an aesthetic smile, and the aetiologies that can cause the excessive gingival display. The final scope will hinge on discussions surrounding two minimally invasive surgeries - Lip repositions and Aesthetic Crown lengthening. Indications and Contra-indications of both these surgeries will be considered and compared with reference to the amount of Excessive Gingival display that may be reduced from baseline to Post op follow ups.

The number of articles used for the elaboration of this bibliographic review is of 45 articles, with the exclusion criteria being publications whose content would not be relevant for the completion of the work.

Keywords: Gummy smile; Gingival smile; Excessive gingival display; Lip repositioning surgery; Aesthetic crown lengthening; Altered passive eruption; Hyperactive upper lip.

Resumo

O objetivo deste artigo é abordar o sorriso gengival em uma série de aspectos, incluindo as limitações psicossociais que ele traz ao indivíduo, os parâmetros de um sorriso estético e as etiologias que podem causar a exposição gengival excessiva. O escopo final dependerá de discussões em torno de duas cirurgias minimamente invasivas – Reposicionamento labial e alongamento estético da coroa. As Indicações e Contra-indicações de ambas as cirurgias serão consideradas e comparadas com referência à quantidade de exposição gengival excessiva que pode ser reduzida desde a consulta inicial até os acompanhamentos pós-operatórios.

O número de artigos utilizados para a elaboração desta revisão bibliográfica é de 45 artigos, sendo os critérios de exclusão publicações cujo conteúdo não seria relevante para a conclusão do trabalho.

Palavras-Chave: Sorriso Gengival; Exibição gengival excessiva; Reposicionamento labial; Alongamento estético da coroa; Erupção passiva alterada; Lábio superior hipermóvel.

Dedicated

I dedicate this work first and foremost to my parents, Vincenzo Catalano and Monica Catalano, that with their unconditional love and strength made me achieve something so important in my life. Without you all of this wouldn't have been possible.

I also dedicate this dissertation to my brother Giuseppe Catalano, and all of my friends who were always there rooting for me.

To my mentors in life who inspired me to become the best version of myself, Vincenzo Catalano and Doctor James Galea.

And at last, I dedicate this to my girlfriend, Ènaam, who resisted so many years of long distance.

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To my girlfriend Ènaam for the constant support and patience she had with me in these years of long distance.

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Abbreviation Index

ABC- Alveolar Bone Crest

ACL- Aesthetic Crown Lengthening

APE- Altered Passive Eruption

CEJ- Cementoenamel Junction

EGD- Excessive Gingival Display

GD- Gingival Display

GS- Gummy Smile

LRS-Lip Repositioning Surgery

MGJ- Mucogingival Junction

NSAIDS- Non steroidal anti-inflammatory drugs

SCI- Superior Central Incisors

VAS- Visual aesthetic score

VME- Vertical Maxillary Excess

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I. Introduction

Achieving a "perfect smile" has become a primary aim for many people nowadays. With the oral cavity becoming the main focus of conversation, the smile plays a major role in speech and presentation. While the teeth are absorbing most of the attention of dental practitioners, the lips, the state of the oral tissues, and the gingival contours are all factors that affect the final aesthetic of a smile. Creating the right smile is a challenge nowadays, as rehabilitation now needs a multidisciplinary approach and careful treatment planning (Tawfik et al., 2017).

When the gingival display in a full smile is 1-3 mm between the vermilion of the upper lip and the gingival zenith of the superior anterior incisors, a “normal” smile is seen. Many patients have a natural and attractive smile when these parameters are encountered. However, the diagnosis of Excess Gingival Display (EGD), also known as Gummy Smile (GS), is given when there is 4 mm or more of gingiva visible. This gummy smile is considered unattractive by dentists and laypeople. According to the severity of the gingival exposure, GS can be classified into three groups, Type I 2-4mm; Type II 4-6mm; Type III more than 6mm (Chacón Martínez et al., 2011; Jacobs and Jacobs, 2013; Alammar and Heshmeh, 2018)

Excessive gingival display affects 10% of the population, mainly women, in the range of 20 and 30 years old. As time passes, there is a decrease in the incidence rate of this condition due to the dropping of the upper and lower lips. This translates to a reduction in the exposure of the maxillary incisors giving more visibility to the mandibular. Individuals that have a gummy smile might suffer psychosocial effects. They feel unattractive and might be more introverted. Although not pathological, the consequences of this gummy smile can be detrimental in some patients. These patients, whose smile is compromised, may become self-conscious and thereby resist social contact. The psychosocial effects of a gummy smile are similar to an individual whose anterior dentition is compromised or otherwise considered unattractive. (Silberberg, Goldstein and Smidt 2009; Jacobs and Jacobs, 2013)

Being viewed as anaesthetic, EGD has led many patients to seek treatment to address the issue. In order to choose the treatment, the clinician must carry out a methodical diagnosis in order to establish the aetiology responsible for EGD (Simon, Rosenblatt and Dorfman, 2007; Dym and Pierre, 2020).

In this literature review, articles related to the use of Crown Lengthening and Lip Repositioning were analysed in order to see if these two surgical techniques can be adopted as an alternative to other methods when an EGD is present, with the aim of reducing a gummy smile.

1.Materials and Methods

For the execution of this narrative literature review, online search engines were used, such as; Pubmed, b-on, Scielo, Science Direct and ResearchGate. The bibliographic research was carried out between November 2020 and June 2021. The keywords used were: “Gummy Smile”, “Gingival Smile”, “Excessive Gingival Display”, “Lip Repositioning Surgery”, “Aesthetic Crown Lengthening”, “Altered Passive Eruption” and “Hyperactive Upper Lip”. The number of articles used for the elaboration of this bibliographic review is 45 articles, with the exclusion criteria being publications whose content would not be relevant for the completion of the work. There were no time limits when searching for studies or articles.

II. Development

2.Diagnosis of the EGD

The dentist must assess the patient's EGD complaint when he or she is speaking or smiling actively and naturally. Various aetiologies are associated with EGD. It is imperative that prior to treatment the clinician has the knowledge to evaluate the essentials of a patient's smile to diagnose a gummy smile. In order to determine the aetiologies of a gummy smile a well- defined diagnostic process is carried out, this is done through the analyzation of a series of elements (Rosenblatt and Simon, 2006; Pereira et al., 2013; Pavone, Ghassemian and Verardi, 2016).

After a thorough diagnosis, the various aetiology must be determined before any surgical treatment in order to guide the clinician, elaborate the correct treatment plan for the patient, including all risk and benefits (Bynum, 2016).

i. Patient Medical History

When arriving at a diagnosis, having a detailed medical history is of great importance. Key elements include the age and general health of the patient. The patient’s age may reflect the dentition's eruptive stage, and the overall health can reveal any contributing factors to the condition of the patient to the clinician (Dym and Pierre, 2020).

ii. Facial Examination

(Pavone, Ghassemian and Verardi, 2016) Claims that evaluating the facial profile of the patients can provide useful information to help identify the cause of the gummy smile. Assessment of the facial symmetry and proportion in the frontal and lateral view is carried out through the interpupillary line. This horizontal line together with other Accessory horizontal lines (ophriac line and the commissure line) divide the face into equal halves. When these two accessory lines are parallel to the interpupillary line then there will be an overall facial harmony. These lines not only give us the perception of facial harmony but can also be used as a reference with regards to the occlusal plane, incisal plane and gingival couture. This isn't the only parameter that should be analysed; if we divide the face into thirds, we can assess Face Height. The ones to be taken into consideration are the middle and lower third; they are the most involved in the patient's aesthetic. The middle and lower third should be of equal height when measured in repose position. Furthermore, the lower third can be subdivided into upper one third and lower two thirds by means of the stomion (Jorgensen and Nowzari, 2001;Ahmad, 2005).

iii. Upper lip length

The upper lip length has a well-defined measurement for it to be considered normal. When at rest, the average lip length is 20 to 24 mm for a young male as for a young female the average length is 20 to 22mm. The measurement is taken from the sub nasal to the lower border of the upper lip. The altered length of this reference can be one of the etiological factors contributing to EGD, GS. If an individual presents a measurement inferior to those stated before, they will have a diagnosis of a short lip, leading to incompetent lips and, therefore, a gummy smile. The evaluation of the upper lip should also be done in a dynamic position in order to determine the muscular contribution, causing the EGD. The dynamic evaluation of the upper lip is done by verifying the hypermobility of the levator labii superior muscle; the hyperactivity of this muscle will reflect in an increase of exposure of the teeth and Gingival smile, resulting in a higher position of the lip. Therefore, an upper lip examination to determine the EGD should be conducted in both static and dynamic positions when it comes to the lips. The cause of the gummy smile can either be lip length, lip hypermobility, or both. With age, this distance tends to increase. (Image 1) (Jorgensen and Nowzari, 2001; Pavone, Ghassemian and Verardi, 2016; Dym and Pierre, 2020)

iv. Display of maxillary central incisors at rest

Another aspect to consider and analyse to diagnose a gingival smile and confirm the aetiology is the display of the upper central incisors. On average, a young woman exhibits 3-4mm. On the other hand, a young male would usually be in the range of 2mm. This display tends to decrease with age due to wearing of the incisal edge and upper lip length dropping. (Vig and Brundo, 1978)

v. Smile line

During a full and natural smile, the upper lip should rest in correspondence to the midfacial gingival margins of the maxillary anterior teeth. The smile line is a term used during a full and natural smile to identify the position of the upper lip in conjunction with the maxillary incisors and gingiva. Peck and Peck, in 1995 stated that the smile line can be divided into three different types, high, average and low. The high smile line is the one that can be diagnosed as an EGD as it reveals a large amount of gingiva and the entire crown height. The average would demonstrate 75%-100% of the crown and interproximal gingiva, and at last, a low smile line would reveal 75% of the crown. This data was obtained through a study that was carried out by Tjan and colleagues, and it was observed that a low smile line is a predominant male characteristic, and as for the high smile line, it is a dominant female characteristic (Peck, Peck and Kataja, 1992; Peck and Peck, 1995).

vi. Gingival margin outline

Another important aspect to analyse in order to diagnose GS should be the gingival margin outline. In patients with EGD any disharmony in the marginal outline can cause further aesthetics problems. There should be a parallelism between gingival margin, incisal edge and curvature of the lower lip. The gingival margin should be located more apical in the maxillary central incisors and maxillary canines, whereas for the laterals, it should be slightly more coronal, ranging from 0.5-2.0 mm from the central incisors and the canines. This gingival harmony should be present more in the anterior sector (midline) rather than in the lateral sectors, where a certain amount of asymmetry is permitted. As for Fradeani, 2008 harmony should coexist in the anterior and posterior segment. (Image 2) (Chiche and Alain Pinault, 1994; Fradeani, 2008).

vii. Anatomy and proportions of the teeth

Width and length are important parameters that should be proportional to each other when looking at the dimensions of individual teeth. The superior central incisors (SCI) width has to be 80% of its length as described by the gold standard of aesthetics proportion but can range around 65% to 85%. As for length, the SCI should measure around 10,6 mm in males and 9,8mm in females. All these parameters can be clinically evaluated by a Chu probe proportion gauge. (Image 3) (Sabri, 2005; Silberberg, Goldstein and Smidt, 2009; Silva et al., 2013; Rossi et al., 2014).

3.Aetiology of excessive gingival display

Understanding and identifying the aetiology of EGD through a proper diagnosis is of utmost importance for the clinician to establish a correct treatment plan. EGD can be a result of single or multiple aetiologies and it is important for the clinician to understand how many of them are present thus leading him to the correct treatment modality in order to re-establish harmony within hard and soft tissues. It's common that EGD is the result of multi-aetiological factors. EGD aetiologies can be classified into two categories, Dentoalveolar discrepancies or Non-dentoalveolar discrepancies. Dentoalveolar discrepancies embrace; short clinical crowns, altered passive eruption (APE), gingival hypertrophy/hyperplasia and anterior dentoalveolar extrusion. Non-dentoalveolar discrepancies include; hyperactive upper lip, short upper lip and vertical maxillary excess (VME). (Chart 1). (Jananni, Sivaramakrishnan and Libby, 2014; Tawfik et al., 2017; Dym and Pierre, 2020).

i. Plaque/Drug-induced gingival hyperplasia

Dental plaque or medication can cause gingival hyperplasia, which in some cases will result in the covering of the clinical crown, which will lead to an unesthetic appearance. Dental plaque and inflammation are the major causes of gingival hyperplasia. Still sometimes, the importance of a systemic evaluation could rule out certain medications such as Phenytoin (anticonvulsant), cyclosporin (Immunosuppressor) and calcium channel blockers (Anti-hypertensive) who are also responsible for gingival hyperplasia. Patient motivation for optimal oral hygiene should be of utmost importance to treat this condition, but in situations where oral hygiene isn’t enough, periodontal surgery to eliminate pseudo pockets should be adopted. (Jorgensen and Nowzari, 2001; Lindhe, Lang and Karring, 2008).

ii. Anterior dentoalveolar extrusion

EGD may also be caused by overeruption of the maxillary central incisors. This coronal migration of the teeth leads to a shifting of all the dento-gingival complex, thus leading to a more coronal position of the gingival margins and an EGD. If the clinical findings of incisal tooth wear are present, then compensatory incisor over-eruption would be the cause of the GS. Orthodontic intrusion of the extruded teeth is the ideal treatment for this aetiology to reposition the gingival margin apically, re-establishing harmony within the smile. According to Iqbal, Nandakumar and Padmakumar, 2015, anterior dentoalveolar extrusion can also be due to Class 2 malocclusion with anterior deep bite (Garber and Salama, 1996; Chan, 2015; Iqbal, Nandakumar and Padmakumar, 2015).

iii. Altered Passive Eruption

Teeth eruption is divided into two stages: active and passive. The physical displacement of the tooth out of the alveolar bone and into place on the occlusal/incisal plane is known as active eruption, whilst the apical migration of the gingival tissues at the level of the Cemento-enamel junction (CEJ) exposing the clinical crown of the tooth is called passive eruption process. There are four stages in the apical migration of the gingival margin during the passive process of tooth eruption: In an initial stage after the teeth have reached the occlusal plane, the junctional epithelium is located on the enamel. In the secondary stage, the junctional epithelium moves apically towards the CEJ, resting partially on enamel and partially on the radicular cementum; in this stage the base of the gingival sulcus is still on enamel. In the third stage, the apical migration of the junctional epithelium persists, thus making it lay totally on cementum, and the base of the sulcus is now situated at the CEJ. As for the last stage, the junctional epithelium and the base of the sulcus are completely on the cementum. (Silberberg, Goldstein and Smidt, 2009; Chan, 2015; Dym and Pierre, 2020). In a healthy dento-gingival complex, the alveolar crest would lay 1-2 mm apically to the CEJ; this can be determined through periapical radiographs, where the alveolar bone crest (ABC) interproximal level can be evaluated and bone sounding (transgingival probing) will help determine the localisation of the CEJ and ABC. Altered passive eruption (APE) is when the gingival margins fail to migrate apically to the level of the CEJ, thus remaining coronally to the CEJ, giving the teeth a short and square like shape. This alteration can occur in multiple teeth or to a single tooth. APE has a prevalence rate of approximately 12%, and a classification of APE was developed by Coslet et al. where he

divided APE into 2 Types and 2 Subgroups. The 2 types, Type 1 and Type 2 of APE are the relation of the gingiva and to the crown, whilst the 2 subgroups A and B classifies the relation between ABC and the CEJ. The clinician must recognize the different clinical presentations of APE in order to diagnose and treat the GS. APE is treated through Aesthetic crown lengthening surgery by means of gingivectomy or apically positioned flap with or without osteoplasty/osteotomy. The classification system developed by Coslet et al. serves a guideline to develop a treatment plan for GS caused by APE. (Chart 2) (Levine and McGuire, 1997; Silberberg, Goldstein and Smidt, 2009; Silva et al., 2015; Mele et al., 2018). Type 1A APE is characterised by a wide band of keratinized gingival tissue, with the ABC 1-2mm from the CEJ (normal Relationship) thus making gingivectomy the ideal treatment option. In Type 2A APE, traditional gingivectomy can't be adopted as the ideal treatment as it would remove too much of the keratinized tissue leaving the gingival margin in close contact with the alveolar mucosa. Adequate treatment of Type 2A would consist of an apically repositioned flap. More complex treatment is carried out when Type 1B and Type 2B APE is diagnosed. In these two types, the osseous crest is at the same level as the CEJ, and so osteoplasty and osteotomy surgery must be performed to re-establish the biological width and treat the GS. As previously stated by Dym and Pierre, the patient's age may reflect the dentition's eruptive stage. It is not clear yet at what age APE can be diagnosed due to the fact that it is difficult to determine when the physiological process of passive eruption ends. Coslet, Vanarsdall and Weisgold in 1977 state that, at 18-20 years of age most of the individuals would have a fully developed dentogingival complex, as for Robbins, APE should be diagnosed when the individual has completely developed but without specifying age (Coslet, Vanarsdall and Weisgold, 1977; Levine and McGuire, 1997; Robbins, 1999; Dym and Pierre, 2020).

iv. Short or Hyperactive upper lip

GS may be caused by a short upper lip. The upper lip length of an adult male usually varies from 22-24mm whilst in adult women 20-22mm, and when in repose 3-4mm of the maxillary central incisors are displayed. After running through the diagnostic parameters mentioned before, a patient that presents a measurement from the subnasale to the lower border of the upper lip that is inferior to 15mm, a short upper lip can be attributed as the aetiological factor of EGD. (Robbins, 1999; Ahmad, 2005; Luthra, Grover and Gupta, 2014)

A Hyperactive upper lip on the other hand is the increased activity of the superior labii muscles during a smile. If the cause of the GS is a hyperactive lip, then all the diagnostic parameters like face height, gingival levels, lip length, and central incisors length should be all within the norm. During a full smile, 10 to 11mm of the clinical crown of the maxillary central incisors is exposed and, the upper lip should have a repose to smile transition of roughly 6 to 8mm, but if this transition is of 10mm then we are in front of a hyper-mobile lip scenario. The authors of Bhola et al, 2015 classified the GS into subclasses depending on the amount of movement of the Upper lip in order to guide the surgeon in the vertical placement of the incision depending on the amount of EGD. Similar treatments are adopted to reduce GS when these two aetiologies are present. Lip-repositioning which was first described by Rubinstein and Kostianovsky in 1973, is a minimally invasive surgical technique that can be used to reduce EGD. Some authors have suggested a non-surgical treatment with the use of Botulinum toxin injections, but this technique had a short-term effect which reverted after 3-6 months (Robbins, 1999; Silberberg, Goldstein and Smidt, 2009; Bhola et al., 2015; Chan, 2015; Ramesh et al., 2019).

According to Peck, Peck and Kataja in 1992, the musculature of the elevator muscles are more developed and more efficient in patients with a high lip line (EGD), the upper lip is raised 1mm more in comparison to those with an average lip line and no EGD (Peck, Peck and Kataja, 1992).

v. Vertical Maxillary Excess

After having evaluated the previously mentioned parameters, VME can be an aetiology for GS. VME as described by Silberberg et al., is the excessive vertical growth of the maxilla, which is usually correlated with Dolichofacial faces, where the lower third of the face is usually longer than the midface, and harmony between the anterior and posterior sector of the occlusal plane is found. In comparison, discrepancy in the occlusal plane between the anterior and posterior segments occur when EGD is caused by compensatory over eruption of the anterior maxillary incisors. Clinically the clinician might notice that the lower lip covers the incisal edges of the maxillary canines and premolars, this is due to the fact that the occlusal plane in individuals with VME is lower than normal, and that the length of the upper lip is normal, even though it might seem clinically short, and so VME may me be the aetiology of EGD, Gummy smile (Robbins, 1999; Silberberg, Goldstein and Smidt, 2009).

Authors have proposed other methods to clinically diagnose VME; this is done by viewing the position of the maxillary canines in regards to the upper lip in repose. If the tip of the maxillary canine is displayed 2mm or more with the upper lip in repose, then a diagnosis of VME can be confirmed, on the other hand, if the tip of the maxillary canine is at the same level of the upper lip in repose, then the EGD is not caused by VME. In order to confirm these clinical findings, the clinician should carry out a cephalometric radiograph, and the distance between the palatal plane and the incisal edge of the maxillary central incisors would be 2mm higher in individuals with GS due to VME in comparison with individuals that don't have a GS (Silberberg, Goldstein and Smidt, 2009; Chan, 2015).

The treatment for VME, introduced by Garber and Salama in 1996, depends on its degree of EGD. Most authors state that the gold standard treatment is Orthognathic surgery associated with orthodontic treatment, which will restore inter jaw relationship and reduce the EGD. Hospitalization is required for this kind of surgery and has significant side effects for the patient. In cases where the VME is type I and II of Garber and Salama, lip-repositioning surgery can be a less invasive treatment. (Chart 3) (Rosenblatt and Simon, 2006; Silberberg, Goldstein and Smidt, 2009; Gupta, Shivananda and Dayakar, 2014).

4.Aesthetic Crown Lengthening

It becomes a common cause of concern among patients when they experience EGD, and the cause of it is APE. APE is typically treated by Aesthetic Crown lengthening surgery (ACL). Aesthetic Crown lengthening surgery is a procedure whose aim is to re-establish the biological width between junctional epithelium and ABC apically while exposing the full clinical crown. This procedure can be adopted in patients who are unwilling to go through a complicated surgery, such as orthognathic surgery, that would involve hospitalisation but still want their GS to be altered. Although there are no clear Diagnostic methods for APE, Authors have suggested clinical and radiographic investigations to be the methods to diagnose APE. CBCT has been suggested as an alternative method to diagnose APE and plan out a surgical guide for a more precise and predictable outcome for crown lengthening surgery.
(Image 4) (Narayan, Narayan and Jacob, 2011; Mele et al., 2018; Alhumaidan, Alqahtani and al-Qarni, 2020).

The most common type of APE in nature is Type 1B as established by Coslet's classification, this type of APE requires a crown lengthening surgery with osseous resection, where the distance between ABC and CEJ is re-established to 2,5 to 3,0 mm, in order to achieve

physiological biological width. Crown-lengthening surgery with osseous resection is indicated when patients have a high smile line (gummy smile) > 4mm, and the aetiology is APE Type 1B, but it is contraindicated when, 1) there is a substantial crown-root ratio difference, 2) when it is expected that insufficient amount of supporting bone remains after surgery, 3) Areas where formation of black triangles is expected due to soft tissue recession (Silberberg, Goldstein and Smidt, 2009; Majzoub, 2014; Chambrone, 2015; Chan, 2015).

i. Pre-Op Protocol

Prior to the surgical treatment, a few important factors need to be taken into consideration in order to establish an accurate assessment of the conditions which the patient presents, height and symmetry of the face, length and lip activity, smile line, conditions and dimensions of teeth, width of keratinized gingiva, gingival biotype, buccal thickness of alveolar bone and Crown/Root ratio (Narayan, Narayan and Jacob, 2011).

ii. Aesthetic Crown lengthening Surgical Protocol

Pre-operatively, patients are asked to rinse with 0.12% chlorhexidine solution, and local anaesthesia is obtained with 2% lidocaine 1:100,000 epinephrine through an infiltration technique. After marking the CEJ position mid-buccally, an internal bevel incision using a 15C blade following the CEJ anatomy is carried out on every tooth. A secondary intrasulcular incision is made, and the gingival collar is removed, thus exposing the new gingival margin and zenith. A full-thickness mucoperiosteal flap is raised until the Mucogingival Junction, and the distance as previously planned between CEJ and ABC is marked. Osteotomy is done using a high-speed carbide bur in order to re-establish the biological width and to allow the connective tissue fibres and the junctional epithelium to reconnect to the radicular cementum, and osteoplasty is carried out to give the bone a positive shape and reduce the buccal exostosis, which would limit the lip pull and eversion whilst smiling. The flap is then repositioned with an internal vertical mattress technique by means of non-resorbable monofilament sutures. (Image 5) (Silva et al., 2015; Alhumaidan, Alqahtani and al-Qarni, 2020).

iii. Post-Op protocol

Non-steroidal anti-inflammatory drugs (NSAID) 600mg of ibuprofen three times a day for seven days for analgesia and inflammation control are prescribed, and 0,12% chlorhexidine twice a day for one week for antiseptic control, patients are also asked to refrain from any type of plaque control for one week and to apply ice for the first day (Silva et al., 2015).

iv. Complications

Patients need to be informed that there can be complications after having ACL performed on them, such as Root sensitivity, Black triangles, Root resorption and Temporary mobility of teeth (Narayan, Narayan and Jacob, 2011).

5.Lip Repositioning Surgery

Lip repositioning was described initially by Rubinstein and Kastianovsky in 1973 as a conservative surgical technique used to treat EGD. The surgery consists of limiting the superior elevator muscle pull (Zygomatic minor, levator anguli, orbicularis orris and superior levator labii) thus reducing the upper vestibule depth through an elliptic incision. Since then, the procedure has undergone many modifications and was related as a dental procedure by Rosenblatt et al in 2006 (Tawfik et al., 2017).

Lip repositioning surgery is indicated when there is a mild VME I or II, or when the aetiology of the EGD is caused by a short or hyperactive upper lip. On the other hand, the surgical technique is contraindicated when 1) individuals have severe VME (>8mm of gingival display), 2) patients who don't have enough keratinized gingiva (<3mm) in the anterior maxillary sextant, which could cause difficulty in the flap design and suturing and 3) patients who have active smoking habits and uncontrolled systemic diseases (Peres et al., 2014; Alammar and Heshmeh, 2018; Dym and Pierre, 2020).

i. Pre-Op Protocol

Preoperatively, gingival display is measured by placing a periodontal probe parallel to the long axis of the teeth in a full smile, in the anterior and posterior sectors. This measurement is taken from the vermillion of the upper lip to the gingival margin of the maxillary teeth and depending on the amount of EGD, the quantity of the mucosa to be removed is established, which should be double, as described by Bhola et al, 2015. Pre-op photos in a full smile are taken in order to compare with post-op results. (Chart 4) (Bhola et al., 2015; Alammar and Heshmeh, 2018).

ii. Lip repositioning Surgical Protocol

After having rinsed with 0.12% chlorhexidine for one minute preoperatively, local anaesthesia is obtained through infiltrative technique in the vestibular mucosa with 2% lidocaine 1:100,000

epinephrine. The area of interest is then dried and the incision outlines marked with a sterile surgical pen. To start off, a partial thickness horizontal incision is made 1mm coronally to the Mucogingival Junction and is extended laterally depending on the smile extension, and a second horizontal incision is made depending on the amount of EGD measured, this incision will be double the measurement of the EGD prolonging into the labial mucosa, by means of a 15c blade. The two incisions are then connected in an elliptic outline. The remaining mucosa strip is then removed by means of a partial-thickness dissection. Bleeding can be controlled with electrocoagulation or local anaesthesia if needed, and the exposed connective tissue is then sutured. (Image 6) (Chambrone, 2015).

iii. Post-Op protocol

Postoperatively, pain is managed with NSAID ibuprofen 600mg or Diclofenac sodium 50mg three times a day for three days or paracetamol 1000mg, and antibiotics are prescribed. Patients are instructed to apply ice packs on the upper lip for some hours, and to carry out antiseptic control with 0.12% chlorohexidine mouth rinse. Patients should refrain from brushing the surgical site for two weeks and minimise lip movement for the first two weeks. The sutures are then removed after two weeks. (Silva et al., 2013)

iv. Complications

The patient must be aware of the post-op complications that can manifest after undergoing LRS and that relapse may occur. Complications include pain, bruising, edema and mucocele formation. Relapse may be caused due to, 1) removing the keratinized gingiva and not having any left, and 2) not taking into consideration cases with high muscle pull and 3) not taking into consideration the “twice the gingival display rule”. (Foudah, 2019; Dym and Pierre, 2020)

III. Discussion

As stated earlier by the literature EGD or GS is considered an unaesthetic parameter by many individuals, and for this reason many exhibits try to seek for help in order to enhance their quality of life. The demand of patients for an attractive smile increases when >4mm of gingival display (GD) is visible during a full smile. The first step in choosing the best treatment regimen for EGD is to correctly diagnose the aetiological factors. However, research comparing the GD results before and after surgical treatment of Excessive Gingival Display using surgical

procedures such as Aesthetic Crown Lengthening and Lip Repositioning are lacking in the literature. (Alammar and Heshmeh, 2018; Silva et al., 2021)

In a prospective study conducted by Silva et al. in 2013, 13 patients with the main complaint of EGD were treated with a modified lip repositioning technique. All patients presented the aetiology of Hyperactive upper lip (>8mm lip mobility) and a GD of >4mm. The studies aim was to report the outcomes for the treatment of EGD after the surgical technique, from baseline, three months and six months, and a survey was given to the patients 2.5 years post-op with open questions, which addressed the satisfaction with the smile and amount of GD.

Baseline EGD was 5.8±2.1mm and changed significantly post operatively at three months 1.4±1.0mm and at six months 1.3±1.6mm thus translating to an obtained reduction of 4.7 mm at three months and 4.5mm at six months. 90% of the patients were not happy with the amount of EGD preoperatively in comparison with the 70% that considered their GD to be just right post operatively. Post-op healing wasn't complicated; 92% of the patients felt tension while talking and smiling, only during the first week and at 2.5 years post op, 85% never felt tension and the remaining 15% rarely did. After 2.5 years, 70% of the patients remained satisfied with the amount of GD reduction. The results showed that the Baseline EGD was successfully reduced with the LRS, with very low morbidity (Silva et al., 2013). Tawfik and colleagues concluded in a systematic analysis were just four studies out of 22 with a total of 33 patients were analysed, that LRS has an overall average improvement of 3.4 mm (95% confidence interval), indicating that the procedure could be used effectively in the treatment of EGD with a mean follow up of 6 months. However, further studies are needed to determine this outcome and reach more definitive conclusions on stability due to the limited number of studies, insufficient follow-up, and insufficient data available. Only one study of Dayakar et al. out of the 22 had a complete relapse reported at 12 months post-op but without any reason reported (Tawfik et al., 2017).

Silva et al., in 2015 carried out another study on 22 patients, which consisted of a prospective interventional clinical trial, whose objective was to evaluate the clinical postoperative results of aesthetic crown lengthening (ACL) caused by APE, from baseline to six months and patient satisfaction by means of a survey with open-ended questions, addressing satisfaction with smile and GD. All patients complained about quadratic anterior teeth and too much gingiva covering the anterior teeth (EGD). Baseline Average GD was significantly reduced from 2.6mm to 1.1mm at six months. 64% of the patients were not happy with the amount of EGD pre

operatively in comparison with the 82% that considered their GD to be just right postoperatively when talking and smiling. The surgery also enhanced the smile with the exposure of the six anterior teeth, which were covered by the gums, altering the pre-operative rating of 96% “too small” to a post-op 77% “about right”. With regards to post-op healing, only four (18%) patients complained about pain in the first week, and no other experience of pain was reported in the future visits (six months). In the first postoperative week the patients complained about swelling (64%), light bleeding (32%), suture discomfort (23%), numbness in the surgical area (9%) and sensitive teeth (5%). In a previous study conducted by Ribeiro et al. in 2012, a modified ACL was adopted and demonstrated that when a modified ACL is carried out in indicated cases, this will result in a greater reduction of the GS due to the excessive osteoplasty of the buccal plate, leading to an upper lip dropping, when compared to routine ACL. The results showed that ACL resulted in a substantial exposure of the maxillary anterior sextant's previously hidden crowns, as well as a decrease in postoperative gingival display during smile (Silva et al., 2015).

In a prospective study carried out by Aroni et al, in 2019, six female patients who had been diagnosed with APE type 1B, underwent ACL surgery to be able to reduce their main complaint that was their gummy smile. The studies aim was to evaluate the outcomes for the treatment of EGD with a follow up of 1 year. EGD can be the cause of multiple aetiologies in some cases, like for example the combination of APE and a Hyperactive upper lip, and for this reason two surgical techniques can be adopted in order to reach the goal which is reducing the EGD. One of the patient, after undergoing ACL surgery, was not happy with the amount of gingiva visible. This patient had multiple aetiologies present at the same time and LRS and ACL surgery was indicated and performed in order to reduce the remaining EGD, thus showing that the two surgeries can be adopted on the same patient depending on the aetiologies and the amount of EGD still present after the first surgery (Aroni et al., 2019). There aren’t enough studies that analyse the same results in order to allow a comparison between LRS and ACL. As a postoperative result, many of the studies simply reported a subjective improvement without an exact measurement, and for this reason, there are no comparable or comparative studies to allow analysis. Silva et al. in 2021 published a study whose objective was to assess the smile attractiveness before and after ACL for APE or LRS for HUL were carried out. One hundred raters with different social backgrounds (dental students, general dentist, periodontist and laypersons) evaluated through a Visual Aesthetic Score (VAS) pre-op and post-op six months full smile photos of ACL or LRS, which were obtained though studies of Silva et al. 2013 and

Silva et al. 2015. The VAS score ranged from zero hardly attractive, five attractive and ten very attractive, and after the photos were flashed for 30 seconds in front of the raters, the score was given. The results showed that for ACL cases VAS score was 3.8±2.0 pre-op and 6.2±1.9 post-op whereas for LRS cases, the VAS score was 4.8±2.0 pre-op and 6.4±1.9 post-op. Attractiveness score significantly increased in both ACL and LRS after treatment, and a strong interaction was met between baseline EGD and treatment effect, indicating that both ACL and LRS enhanced smile attractiveness and also reduce GD when performed (Silva et al., 2021).

IV. Conclusion

From the results ascertained through the available literature, it can be determined that Lip repositioning surgery and Aesthetic crown lengthening are two minimally invasive surgical techniques that can be adopted in order to reduce a Gummy Smile with minimal postoperative complications. LRS compared to ACL, delivered a more significant gingival display reduction, but this is due to the fact that there are more quantitative studies for LRS. Nonetheless, the knowledge of aesthetic smile parameters and a correct diagnosis of the Aetiological factors becomes of utmost importance when treating patients with Excessive Gingival Display. Apart from the aetiologies, knowledge of the limits for the surgical techniques is also valuable. ACL surgery takes into consideration the crown height and the location of the CEJ whilst LRS takes into consideration the amount of EGD and double the measurement, meaning that it can be carried out up to ≥7mm of EGD present.

In conclusion, ACL and LRS both deliver significant positive changes in smile attractiveness in the eyes of laypeople and dental professionals alike – implying that patients who undergo either of these procedures can expect significant postoperative improvements in their smile attractiveness. However, there is a need for more studies in order to reach a more significant result regarding outcome and stability of both ACL and LRS.

V. Bibliography

- Ahmad, I. (2005). Anterior Dental aesthetics: Dentofacial Perspective. *British Dental Journal*, 199(1), pp.15–21.
- Alammar, A. and Heshmeh, O. (2018). Lip repositioning with a myotomy of the elevator muscles for the management of a gummy smile. *Dental and Medical Problems*, 55(3), pp.241–246.
- Alhumaidan, A., Alqahtani, A. and al-Qarni, F. (2020). 3D-Printed Surgical Guide for Crown Lengthening Based on Cone Beam Computed Tomography Measurements: A Clinical Report with 6 Months Follow Up. *Applied Sciences*, 10(16), p.5697.
- Aroni, M.A.T., Pigossi, S.C., Pichotano, E.C., de Oliveira, G.J.P.L. and Marcantonio, R.A.C. (2019). Esthetic crown lengthening in the treatment of gummy smile. *The International Journal of Esthetic Dentistry*, 14(4), pp.370–382.
- Batista, E.L., Moreira, C.C., Batista, F.C., de Oliveira, R.R. and Pereira, K.K.Y. (2012). Altered passive eruption diagnosis and treatment: a cone beam computed tomography-based reappraisal of the condition. *Journal of Clinical Periodontology*, 39(11), pp.1089–1096.
- Bhola, M., Fairbairn, P., Kolhatkar, S., Chu, S., Morris, T. and de Campos, M. (2015). LipStaT: The Lip Stabilization Technique— Indications and Guidelines for Case Selection and Classification of Excessive Gingival Display. *The International Journal of Periodontics & Restorative Dentistry*, 35(4), pp.549–559.
- Bynum, J. (2016). Treatment of a "Gummy Smile": Understanding Etiology is Key to Success. *Compendium of Continuing Education in Dentistry (Jamesburg, N.J.: 1995)*, 37(2), pp.114–122.
- Chacón Martínez, H., Castro Govea, Y., Pérez Porras, S., Vázquez Costilla, O., González Cárdenas, H.R. and Mendoza Adam, G. (2011). Simplificando el tratamiento quirúrgico de la sonrisa gingival. *Cirugía Plástica Ibero-Latinoamericana*, 37(1), pp.43–49.
- Chambrone, L. (2015). *Evidence-Based Periodontal and Peri-Implant Plastic Surgery*. Cham Springer International Publishing
- Chan, D.K. ed., (2015). *Predictable Treatment for "Gummy Smiles" Due to Altered Passive Eruption*.
- Chandrashekar, K., Mishra, R., Tripathi, V., Sthapak, U. and Kataria, S. (2015). Management of excessive gingival display: Lip repositioning technique. *Journal of the International Clinical Dental Research Organization*, 7(2), p.151.

- Chiche, G.J. and Alain Pinault (1994). *Esthetics of anterior fixed prosthodontics*. Chicago: Quintessence Pub. Co.
- Coslet, J.G., Vanarsdall, R. and Weisgold, A. (1977). Diagnosis and classification of delayed passive eruption of the dentogingival junction in the adult. *The Alpha Omegan*, 70(3), pp.24–28.
- Dym, H. and Pierre, R. (2020). Diagnosis and Treatment Approaches to a "Gummy Smile." *Dental Clinics of North America*, 64(2), pp.341–349.
- Foudah, M. (2019). Lip repositioning: An alternative to invasive surgery a 4 year follow up case report. *The Saudi Dental Journal*, 31(31), pp.78–84.
- Fradeani, M. (2008). *Esthetic rehabilitation in fixed prosthodontics.* Chicago: Quintessence.
- Garber, D.A. and Salama, M.A. (1996). The aesthetic smile: diagnosis and treatment. *Periodontology 2000*, 11(1), pp.18–28.
- Gupta, S., Shivananda, H. and Dayakar, M. (2014). Lip repositioning: An alternative cosmetic treatment for gummy smile. *Journal of Indian Society of Periodontology*, 18(4), p.520.
- Iqbal, C., Nandakumar, K. and Padmakumar, T. (2015). Laser assisted treatment of excessive gingival display along with modified lip re-positioning. *Journal of Dental and Medical Sciences*, 14(7), pp.28–33.
- Jacobs, P.J. and Jacobs, B.P. (2013). Lip repositioning with reversible trial for the management of excessive gingival display: a case series. *The International Journal of Periodontics & Restorative Dentistry*, 33(2), pp.169–175.
- Jananni, M., Sivaramakrishnan, M. and Libby, T.J. (2014). Surgical correction of excessive gingival display in class I vertical maxillary excess: Mucosal strip technique. *Journal of Natural Science, Biology, and Medicine*, 5(2), pp.494–498.
- Jorgensen, M.G. and Nowzari, H. (2001). Aesthetic crown lengthening. *Periodontology 2000*, 27(1), pp.45–58.
- Levine, R.A. and McGuire, M. (1997). The diagnosis and treatment of the gummy smile.
- Lindhe, J., Lang, N.P. and Karring, T. (2008). Clinical Periodontology and Implant Dentistry, 2 Volumes - 5Th Edition, pp.405–410.
- Luthra, S., Grover, H. and Gupta, A. (2014). Lip repositioning surgery: A pioneering technique for perio-esthetics. *Contemporary Clinical Dentistry*, 5(1), p.142.
- Majzoub, Z.A.K. (2014). Crown lengthening procedures: A literature review. Seminars in Orthodontics, 20(3), pp.188–207.

- Mele, M., Felice, P., Sharma, P., Mazzotti, C., Bellone, P. and Zucchelli, G. (2018). Esthetic treatment of altered passive eruption. *Periodontology 2000*, 77(1), pp.65–83.
- Narayan, S., Narayan, T.V. and Jacob, P.C. (2011). Correction of gummy smile: A report of two cases. *Journal of Indian Society of Periodontology*, 15(4), pp.421–424.
- Pavone, A.F., Ghassemian, M. and Verardi, S. (2016). Gummy Smile and Short Tooth Syndrome--Part 1: Etiopathogenesis, Classification, and Diagnostic Guidelines.
- *Compendium of Continuing Education in Dentistry (Jamesburg, N.J.: 1995)*, 37(2), pp.102–107.
- Peck, S. and Peck, L. (1995). Selected aspects of the art and science of facial esthetics. *Seminars in Orthodontics*, 1(2), pp.105–126.
- Peck, S., Peck, L. and Kataja, M. (1992). The gingival smile line. *The Angle Orthodontist*, 62(2), pp.91–100.
- Pereira, J., Furtado, A., Ghizoni, J., Molina, G. and Oliveira, M. (2013). Gummy smile: A contemporary and multidisciplinary overview. *Dental Hypotheses*, 4(2), p.55.
- Peres, M.F.S., Peres, R., Lopes, E.G.B., Ramos, S.P., Correa, M.G., Ribeiro, F.V. and Chaves, E. (2014). Does Lip-Repositioning Surgery Improve Long-Term Smile Outcome and Dental Esthetics in Patients With Excessive Gingival Display? A Review of the Current Literature. *Clinical Advances in Periodontics*, 4(4), pp.280–287.
- Ramesh, A., Vellayappan, R., Ravi, S. and Gurumoorthy, K. (2019). Esthetic lip repositioning: A cosmetic approach for correction of gummy smile – A case series. *Journal of Indian Society of Periodontology*, 23(3), p.290.
- Robbins, J.W. (1999). Differential diagnosis and treatment of excess gingival display. *Practical periodontics and aesthetic dentistry: PPAD*, 11(2), pp.265–272.
- Rosenblatt, A. and Simon, Z. (2006). Lip repositioning for reduction of excessive gingival display: a clinical report. *The International Journal of Periodontics & Restorative Dentistry*, 26(5), pp.433–437.
- Rossi, R., Brunelli, G., Piras, V. and Pilloni, A. (2014). Altered Passive Eruption and Familial Trait: A Preliminary Investigation. *International Journal of Dentistry*, 2014.
- Sabri, R. (2005). The eight components of a balanced smile. *Journal of clinical orthodontics: JCO*, 39(3), pp.155–167.
- Seixas, M.R., Costa-Pinto, R.A. and Araújo, T.M. de (2011). Checklist dos aspectos estéticos a serem considerados no diagnóstico e tratamento do sorriso gengival. *Dental Press Journal of Orthodontics*, 16(2), pp.131–157.

- Seixas, M.R., Costa-Pinto, R.A. and Araújo, T.M. de (2012). Gingival esthetics: an orthodontic and periodontal approach. *Dental Press Journal of Orthodontics*, 17(5), pp.190–201.
- Silberberg, N., Goldstein, M. and Smidt, A. (2009). Excessive gingival display--etiology, diagnosis, and treatment modalities. *Quintessence International (Berlin, Germany: 1985)*, 40(10), pp.809–818.
- Silva, C.O., Rezende, R.I., Mazuquini, A.C., Leal, V.C., Amaral, G.S.A., Guo, X. and Tatakis, D.N. (2021). Aesthetic crown lengthening and lip repositioning surgery: Pre- and post-operative assessment of smile attractiveness. *Journal of Clinical Periodontology*.
- Silva, C.O., Ribeiro-Júnior, N.V., Campos, T.V.S., Rodrigues, J.G. and Tatakis, D.N. (2013). Excessive gingival display: treatment by a modified lip repositioning technique. *Journal of Clinical Periodontology*, 40(3), pp.260–265.
- Silva, C.O., Soumaille, J.M.S., Marson, F.C., Progiante, P.S. and Tatakis, D.N. (2015). Aesthetic crown lengthening: periodontal and patient-centred outcomes. *Journal of Clinical Periodontology*, 42(12), pp.1126–1134.
- Simon, Z., Rosenblatt, A. and Dorfman, W. (2007). Eliminating a Gummy Smile with Surgical Lip Repositioning.
- Tawfik, O.K., El-Nahass, H.E., Shipman, P., Looney, S.W., Cutler, C.W. and Brunner, M. (2017). Lip repositioning for the treatment of excess gingival display: A systematic review. *Journal of Esthetic and Restorative Dentistry*, 30(2), pp.101–112.
- Vig, R.G. and Brundo, G.C. (1978). The kinetics of anterior tooth display. *The Journal of Prosthetic Dentistry*, 39(5), pp.502–504.

VI. Appendices

Image appendices:

Image 1- Measurement of the upper lip length: between the subnasal and upper lip vermilion (Robbins 1999).

Image 2- Ideal gingival margin outline, demonstrating lateral incisor 0.5-2mm more coronal from the centrals and canines (Seixas, Costa-Pinto and Araújo, 2012).

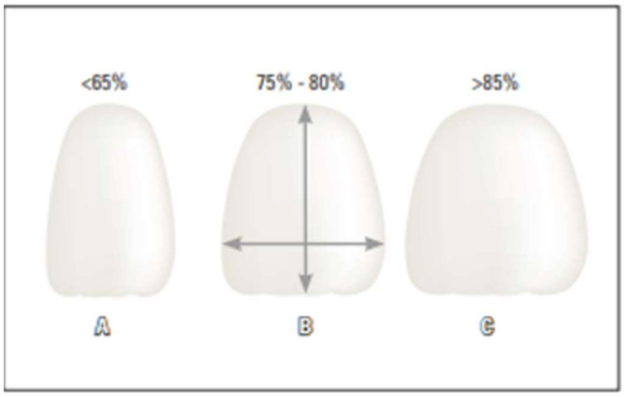

Image 3- Ideal proportions of the Superior Central Incisor; Width is 80% of its length but can range around 65% to 85%. (Seixas, Costa-Pinto and Araújo, 2011).

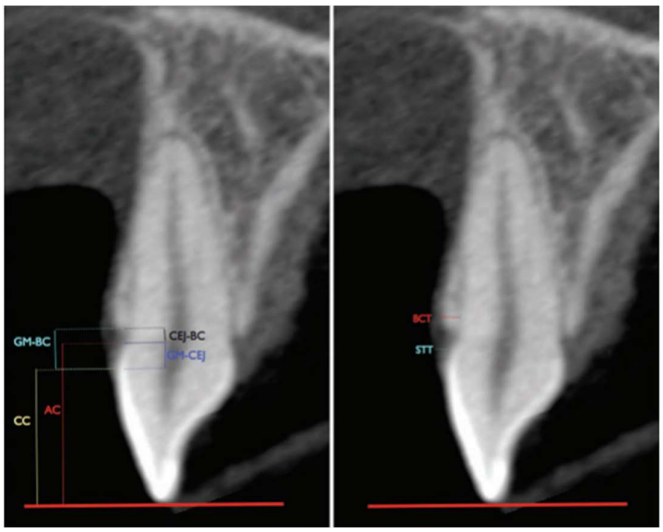

Image 4- CBCT for Altered passive eruption diagnostic and aesthetic crown lengthening treatment plan (Batista et al., 2012)

CC: Clinical crown length from incisal edge to the gingival margin

AC: Anatomic crown length from incisal edge to the cemento enamel junction

CEJ-BC: Distance from the cemento enamel junction to the bone crest

GM-BC: Distance from the gingival margin to the Bone crest

GM-CEJ: Distance from the gingival margin to the cemento enamel junction

BCT: Bone crest thickness

STT: Soft tissue thickness

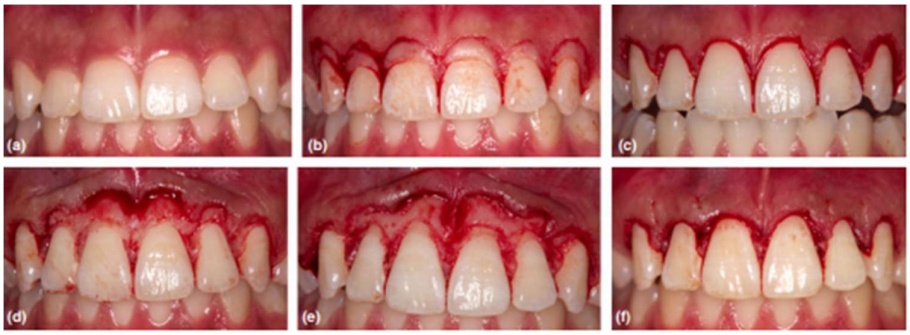

Image 5: Aesthetic crown lengthening surgery procedure (Silva et al., 2015)

A) Pre op of patient with altered passive eruption

B) Internal bevel incision on Cemento enamel junction

C) Removal of gingival collar

D) Elevation of Mucoperiosteal flap

E) Osteotomy and osteoplasty

F) Repositioned and sutured flap

Image 6: Lip repositioning surgery procedure (Aroni et al., 2019)

A-C: Measurement of EGD

D-E: Demarking of incision lines with respect to the amount of EGD

F-I: Partial thickness incision

J-K: Final suturing

Chart appendices:

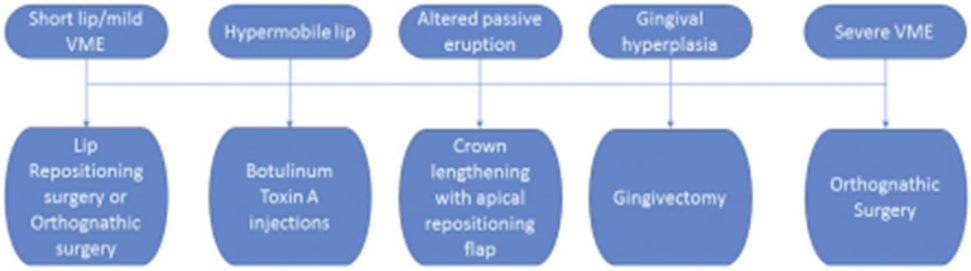

Chart 1- Different Aetiologies of Excessive gingival display with corresponding treatment (Dym and Pierre, 2020).

Type	Description	Treatment
1A	Osseous crest apical to cementoenamel junction Adequate amount of attached gingival Gingival margin incisal to CEJ	Gingivectomy
1B	Osseous crest at CEJ Adequate amount of attached gingival Gingival margin incisal to CEJ	Gingivectomy and osseous surgery
2A	Osseous crest at CEJ Inadequate amount of attached gingival Gingival margin incisal to CEJ	Apically positioned flap
2B	Osseous crest at CEJ Inadequate amount of attached gingival Gingival margin incisal to CEJ	Apically positioned flap and osseous surgery

Chart 2- Coslet et al, Altered passive eruption classification and treatment modalities (Chandrashekar et al.,2015).

GRAU	EXPOSIÇÃO GENGIVAL	TRATAMENTO
I	2 a 4 mm	• Ortodôntico (intrusão ortodôntica) • Periodontal e Ortodôntico • Periodontal e Restaurador
II	4 a 8 mm	• Periodontal e Restaurador • Cirurgia Ortognática
III	Superior a 8 mm	• Cirurgia Ortognática com ou sem tratamento periodontal e restaurador

Chart 3- Degree of EGD due to vertical maxillary excess, to aid in surgical treatment (Garber and Salama, 1996).

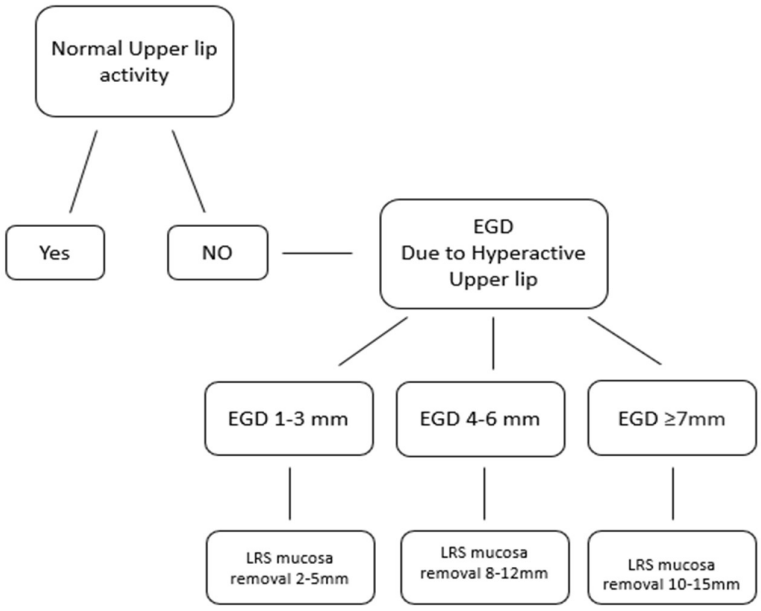

Chart 4- Guideline to aid in the mucosa removal of LRS depending on amount of EGD (Bhola et al, 2015).