

Major Considerations on the Lingual Orthodontics: A Systematic Review

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Abstract

In recent years, there has been a significant increase in the demand for orthodontic treatment for adult patients. For primarily aesthetic characteristic, the tongue device is an excellent alternative to meet the requirements of patients who value dental esthetics, since it allows the patient has a beautiful smile not just after, but also during the treatment. This study discusses the development of the lingual technique, its basic principles, advantages and disadvantages and point out differences with respect to the conventional technique, aiming to give a broad overview of the concepts of Lingual Orthodontics and confirm this technique as a safe option for correction and alignment of teeth.

Keywords: Aesthetic orthodontics; Lingual orthodontics; Lingual technique

Introduction

Facial appearance plays an important role in judging personal attractiveness and also in developing self-esteem [1]. The perception of the appearance, mainly of the face, affects the mental health and the social behavior of the individual, causing significant implications in the areas of education and professional, as well as effective life [2,3]. In the last years, the increase in the demand for orthodontic treatment among adults has been observed [4-10] and the current treatment of orthodontics has been paying special attention to the treatment for them [11].

There are two key factors that have a significant influence on the decision of adults to undergo orthodontic treatment: extended treatment time and unsightly brackets [12,13]. Thus, many adult patients who require orthodontic treatment, either for aesthetic or functional reasons, are discouraged from using orthodontic appliances due to the contrast between the metal brackets and the dental surface [14]. This fact justifies the increase in patients' requests for the correction of malocclusion with a more aesthetic treatment alternative [14,15].

For socio-cultural reasons, aesthetics play an important role for adult patients when considering orthodontic treatment [15,16]. Hamdan [17] conducted a study with a sample of 100 patients to evaluate the reasons for orthodontic treatment. Aesthetics were indicated as the main reason for 93 patients, and only 7 justified the search for orthodontic treatment due to masticatory problems. Still, of the 93 who sought aesthetics, 18 presented the second reason, being 11 for masticatory problems and atm, and 7 for problems of diction. This study makes clear how much patients value and prioritize the aesthetics of the smile and seek to achieve it through orthodontic treatment.

In order to achieve the objective of improving the aesthetics of the smile, it is necessary to undergo orthodontic treatments considered unsightly [18]. Although the social constraint caused by the fixed orthodontic appliance is variable and subjective, it is very common for adult patients to refuse treatment because of the aesthetic impairment, claiming that they are no longer of age to use these appliances, which are so common in adolescents and children [19].

The materials industry has sought to offer alternatives for aesthetic treatments, developing technologies and specific treatment techniques, such as lingual orthodontics, a totally invisible orthodontic treatment due to lingual support [20-22].

People who are concerned about the aesthetics of their smile may be reluctant to spend months or years on orthodontic treatment that will alter the aesthetics of their teeth [23]. In contemporary orthodontics, several types of brackets are available. Although aesthetic brackets may serve to mask the visual presence of the orthodontic appliance, it persists as an aesthetic problem for many patients [14]. In this context, the use of lingual brackets becomes a feasible possibility for these patients, supplying the requirement of aesthetic treatment [24,25]. Therefore, the present study aimed to describe the applicability of the lingual appliance for orthodontic treatment with the function of contributing to the correction and alignment of teeth, as well as to report a broad view of the concepts of lingual orthodontics and to review through literature the development of lingual technique, its basic principles, its advantages and disadvantages.

Methodology

Study design

Following the criteria of literary search with the use of the Mesh Terms that were cited in the item below on "Search strategies", a total of 75 papers were checked that were submitted to the eligibility analysis and, after that, 62 studies were selected, following the rules of systematic review-PRISMA (Transparent reporting of systematic reviews and meta-analyzes-<http://www.prisma-statement.org/>).

Search strategy

In general, as an example, the search strategy in MEDLINE/ Pubmed, Web of Science, ScienceDirect Journals (Elsevier), Scopus (Elsevier), OneFile (Gale) followed the following steps: - search for mesh terms (Aesthetic Orthodontic, Lingual Orthodontics, Lingual

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Technique.), - use of the bouleanos “and” between mesh terms and “or” among historical findings (Figure 1).

Literature Review

In 1726, Pierre Fauchard was the first to suggest the possibility of using appliances on the lingual faces of the teeth [26]. In 1841, Pierre Joachim Lefoulon created the first lingual arch for expansion and alignment of teeth. But it was not until 1970 that lingual orthodontics (as we understand it today - complete lingual multibracket) actually began [12,13].

The first lingual appliance was not a consequence of aesthetic requirements but was developed by Kinja Fujita in Japan to protect soft tissues (lips and cheeks) from possible impact on braces to meet the need for patients practicing martial arts [10,21-23]. In 1967, Fujita presented his concepts on lingual multibracket technique using the mushroom bow. He began his research in 1971 and published the Fujita Method in 1978, which treated Class I and Class II malocclusions with four premolar extractions. The Fujita bracket had three slots: occlusal, horizontal and vertical [26].

The 1970s were intense for Lingual Orthodontics in the United States, as the straight wire appliance was created, which increased the

demand for treatments, especially in adults. Due to the intense search for aesthetics, clear plastic brackets were created, but they presented significant problems because of stains [10]. It was Craven Kurz who introduced the concept of Lingual Orthodontics in the USA, noting that he had many adult patients, among them, were public figures with great aesthetic concern. One patient, in particular, asked for a non-visible orthodontic treatment, refusing to use vestibular devices, thus stimulating Kurz’s interest in the lingual apparatus [20-23].

With the creation of the lingual appliance, a new approach to orthodontic treatment was conceived, which motivated the commercial interest for the development of such. In California, the Ormco company created teams for the development of the lingual apparatus. The first team consisted of engineers Craig Andreiko and Frank Miller and the orthodontist Jim Wildman, who resulted in one [12].

To manage his research, develop and perfect a commercially viable lingual device and test cases with lingual treatment, Ormco founded a task force called Task Force, consisting of Craven Kurz (Beverly Hills, CA), Jack Gorman (Marion, IN), Bob Smith (Stanford, FL), Wick Alexander and Moody Alexander (Dallas, TX), James Hilgers (Mission Viejo, CA) and Bob Scholz (Alameda, CA) along with Managers Floyd Pickrel, Ernie Strauch and Michael Swartz 1998).

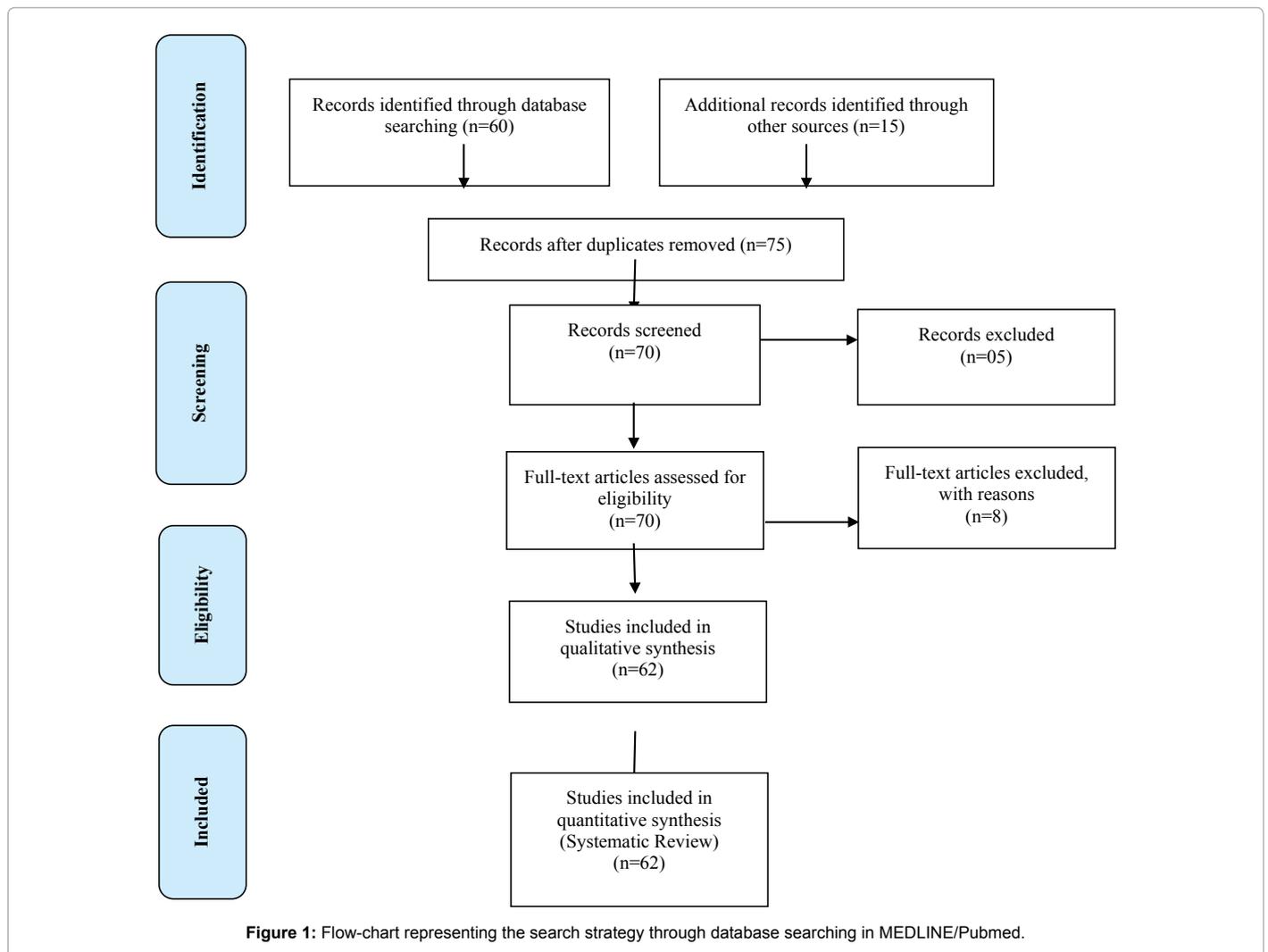


Figure 1: Flow-chart representing the search strategy through database searching in MEDLINE/Pubmed.

In 1981, in Japan, Dr. Fujita published in the American Journal of Orthodontics an article on lingual therapy. And in Newport, California, the Task Force held regular seminars. Thus, the commercial interest in the lingual technique increased and companies like American Orthodontics, Forestodont, and Unitek that started to invest in the lingual apparatus [22].

In 1982, Vince Kelly used Unitek lingual appliances. Steve Paige used Begg brackets and light strands on the lingual surface of the teeth [22,26]. Creekmore developed a complete technique with lingual notch vertical supports with a laboratory system, called Slot Machine [22,26,27].

The interest in lingual orthodontics was growing, and so several societies around the world were created, such as ALOA in 1987 - The American Lingual Orthodontics Association, SFOL - Société Française d'Orthodontic Lingual, BLOS - British Society of Lingual Orthodontics, ESLO in 1992 - The European Society of Lingual Orthodontics and WLOS - World Society of Lingual Orthodontics. In 1996 the Lingual Study Group was founded by Craven Kurz, Willian Laughlin, Thomas Creekmore, Jim Wildman, Giuseppe Scuzzo, Didier Fillion and Pabli Echarri [26].

In 1987, ALOA held its Annual Meeting in Montreal, Canada, where Dr. Kurz discussed lingual orthodontic therapy. At that time, many orthodontists were looking for solutions because they could not give their treated cases the same success obtained through the conventional vestibular technique. There seemed to be widespread problems with the placement of the device through the technique of direct bonding of brackets. Also, in this event was launched as an alternative aesthetic that would solve the finalization of those cases that presented problems, Starfire - a clear esthetic vestibular bracket resistant to staining [10].

After this very promising initial period, in the 90's began a time of frustration regarding the lingual technique, due to treatment failures and failure cases. The interest of both the public and the orthodontic community has diminished, for many have had to replace the lingual apparatus with the conventional one, in order to finalize their cases efficiently [27-29]. Public demand and initial commercial interest rushed the product to market prematurely, resulting in disappointment [10].

In 1988, the Task Force was reduced to only three members, Craven Kurz, Jack Gorman, and Bob Smith, in order to identify problems and develop solutions of lingual technique. The reasons given for the decline of the lingual technique were: inadequate training of professionals, poorly developed laboratory systems, low completed cases pattern and high public expectation that required immediate technique results. As a solution, small classes were created for teaching by more experienced professionals, longer hands-on courses and encouragement of continuing education with the support of study associations, scientific journals and professional meetings [10,26].

In 1992, the Associazione Italiana Ortodonzia Lingual (AIOL) was founded and has been one of the most active since then. Dr. Scuzzo in partnership with Dr. Takemoto published a series of articles and texts on lingual technique and developed a prototype lingual straight wire bracket and its technique. A few years later they presented the STb (Scuzzo/Takemoto bracket from Ormco), one of the most revolutionary already available. Its design facilitated the use of light forces and its reduced size generated greater patient comfort [10,26].

In 1996, the study group was created in Denver, Colorado, the USA, which was composed by Craven Kurz, Willian Laughlin, Thomas

Creekmore, Jim Wildman, Giuseppe Scuzzo, Didier Fillion and Pablo Echarri, with the aim of relaunching Orthodontics Lingual. Also, that same year, ESLO sponsored the international meeting in Monte-Carlo. In 1997, ALOA was reactivated, after many years without activity [10].

In Germany, Dirk Wiechmann developed a custom high-tech lingual bracket called Incognito. It is perfectly adapted to the lingual faces of the teeth, since it is made from a digitized base model, where each bracket is personalized individually for each tooth [24-30].

In Israel, Silvia Geron and Rafi Romano promoted lingual orthodontics. Geron developed a lingual Jig bracket for direct and indirect bonding [31]. Romano published a book, presenting an update on the lingual technique [10]. South Korea is one of the countries with large numbers of orthodontists who practice Lingual Orthodontics. Tae Weon Kim has created the Model Checker, a specific positioner of brackets and transfer trays, which form the Korean Indirect Bonding Set-up System (KIS). And Hee-Moon Kyung founded the Korean Society of Lingual Orthodontics - KSLO [26].

In Japan, besides Dr. Kinja Fujita, another one that stands out is Dr. Kyoto Takemoto who, together with Dr. Giuseppe Scuzzo (Italy), has created the STb bracket (a bracket that works with light forces, low friction, and great comfort). Dr. Hitoshi Koyoata has written a book on the biomechanics of lingual orthodontics. And JLOA (Japanese Lingual Orthodontics Association) is the largest Lingual Orthodontic Society in the world [26]. In 2002, in Brazil, Dr. Marcelo Marigo and a group of professionals specialized in orthodontics and facial orthopedics interested in improving in lingual orthodontics founded the ABOL - Brazilian Association of Lingual Orthodontics [32].

Currently, many courses are taught worldwide by Doctors Didier Fillion (France), Giuseppe Scuzzo (Italy), Pablo Echarri (Spain), Kyoto Takemoto (Japan) and Courtney Gorman, Bob Baker, Mario Paz, and João Napolitano USA) [10,26].

Advantages and Disadvantages

All techniques have advantages and disadvantages, in the case of lingual orthodontic technique the advantages are as follows: Invisible device, optimizing aesthetics, comfort for the lips and cheeks, soft tissues in contact with the vestibular face of the teeth are unaffected by brackets and wires, does not alter the lip contour, generating accurate profile visualization and lip posture, the buccal surfaces of the teeth are not damaged by gluing, detachment, adhesive removal or descaling, as it occurs on lingual/palatal surfaces and is easier to perceive. results during treatment, since the vestibular surfaces are not obstructed with brackets and wires [29].

However, the disadvantages of lingual technique are oral hygiene procedures may be more difficult due to limited accessibility, increase in plaque index and gingival irritation, oral discomfort, tongue irritation and lesions, temporary speech impairment, difficulty in chewing, difficulty in swallowing, high cost of treatment, variation in morphology of lingual surfaces, especially in anterior teeth, need for laboratory phase, need for knowledge and training by the orthodontist, need for specific instrumentation for the technique, difficulty in direct visualization and access to the orthodontist, difficulty of insertion and removal of arches, difficulty in controlling dental rotations, need to control mandibular rotation. In some cases, the treatment time is longer [29].

Indications and Contraindications

All patients can be treated with lingual orthodontics, but there are

more favorable cases and others not so much. The favorable cases are: 1) light crowding and deep bite in the anterior region; 2) diastemas; 3) extensive, uniform lingual surfaces without restorations or crowns; 4) good periodontal condition; 5) patient collaborator; 6) Skeletal Class I patient; 7) moderately brachiocephalic and brachiocephalic patients; 8) patient with good mouth opening [4,26,33,34].

On the other hand, the unfavorable cases are: 1) variations in the anatomy of the lingual face as excessively large cingules, but can be reduced or removed [6,20,31]; 2) short clinical crown, but a clinical crown increase may be performed; 3) severe periodontal disease; 4) dolichocephalic patient; 5) need for maximum anchorage; 6) short and fractured lingual surfaces; 7) presence of crowns and multiple restorations; 8) poor patient; 9) low tolerance to discomfort; 10) patient with little mouth opening [4,25,30].

Lingual orthodontics is undoubtedly the orthodontic technique of choice for the treatment of the adult patient [4]. In general, the lingual orthodontic appliance, because it is totally invisible, is ideal for people exposed in the media, as well as for those who simply want the device not to be visible, including those who need orthodontic retreatment.

In addition to the aesthetic reasons, the lingual apparatus also meets needs for practitioners of collective sports or martial arts. For, in cases of oral trauma, they will avoid lesions on the inside of the lips and/or cheeks.

Laboratory Mounting

Unlike the orthodontic technique, it is very difficult to directly position the lingual brackets precisely enough to allow treatment under normal conditions. Therefore, it is necessary to position the brackets in the model of malocclusion in the laboratory, which allows the transfer of all brackets to the mouth, making the glue quite precise [5,9,35-40]. The positioning of the brackets in the laboratory is a meticulous operation, whose quality will determine the good final alignment of the teeth [4]. Since the brackets are positioned during the laboratory phase, this is the most important phase during lingual orthodontic treatment and is fundamental to guarantee an effective result [40-42].

Due to the importance of the positioning of the lingual brackets, many assembly techniques have already been described [25]. Currently, bracket assembly systems for the lingual technique can be divided into three categories: 1) laboratory assembly in the malocclusion model itself; 2) laboratory assembly by means of set up; 3) assembly by means of computer assisted system (CAD/CAM system).

Discussion

In recent years, there has been a significant increase in the search for orthodontic treatment among adults [4,5,7,8,36] found that the relationship between the two variables was not statistically significant. This range of patients has a high level of demand in the result and greater aesthetic expectations at the end of the case [33,34]. In addition to the concern with aesthetics, another important factor to be considered in the adult patient is the presence of ceramic prosthetic crowns. This factor imposes the need for studies related to the bonding of orthodontic brackets on the ceramic surface on the lingual surface since the adhesion in the ceramics occurs differently from the adhesion to the enamel [19].

To meet this demand, in 1970 Fujita and Kurz created the "invisible" orthodontic appliance, pioneering the lingual orthodontic technique [21]. Since then, extensive research has been initiated by several orthodontists around the world, in order to improve this technique.

However, in order to achieve satisfactory results in treatments through the lingual technique, something beyond the simple adaptation of the conventional technique was necessary. It was proposed something revolutionary in design and engineering, in order to obtain good adhesion of the brackets to the lingual aspect of the teeth, as well as the search for new gluing materials. Further according to Creekmore, the lingual scope is different, what works well on vestibular surfaces does not necessarily work well on lingual surfaces.

In order to analyze the efficacy of the lingual technique, it would be convenient to compare it with the conventional technique, its predecessor.

By examining the performance of both techniques, it is possible to check the most appropriate option for orthodontic treatment. For this, it is pertinent to verify some of the following parameters: aesthetics, positioning, and bonding of the brackets, obtaining final results, difficulties to the patients and difficulties for the orthodontist.

Among the most important factors of the lingual technique is the aesthetic [4,6,7,9,33,34]. Since this is not restricted to only hiding the brackets by the lingual face, since it covers other concepts, such as: the use of bands in first and second molars is limited to only some cases, in which these are covered by composite resin; minimizing the use of brackets or buttons on vestibular faces; minimization of the use of intermaxillary elastics; use of temporary resin teeth to cover spaces of missing/extracted teeth, minimization of the use of extraoral appliances or lip anchors for reinforcement of anchorage [4,33].

In addition, bonding of brackets on the lingual surface causes the potential side effects of decalcification, caries or blemishes to occur only on the lingual surface of the teeth [4,26,33]. That is, the damages caused by gluing, taking off, adhesive removal or decalcification do not exist in the vestibular faces, contributing for the permanence of the natural aesthetics of the teeth existing before the beginning of the treatment.

Due to the positioning of the brackets on the lingual surface of the teeth, the aesthetic evolution of the case becomes much more accurate when compared to the conventional technique, where the brackets are on the buccal surface. There are no distortions that make it difficult to see the case and modify the actual positioning of the lips during treatment. In addition, with an unaltered labial contour, dental positioning can be analyzed more rigorously by both the patient and the orthodontist, since the buccal surface of the teeth and the gingival contour is not obstructed by brackets and wires (in this paper, we present the results of a study that has been carried out in the literature [41-43].

The patient in lingual orthodontic treatment suffers from some difficulties and discomfort in the adaptation with the orthodontic appliance during the first three weeks of the initial treatment [6,7,30,37,39].

The oral discomfort, more specifically in the language [9,21,29,33,40,44-47] As the brackets are glued to the lingual surface, are in direct contact with the tongue, especially the brackets of the lower dental arch. There may be discomfort, pain, irritation and even the formation of lesions on the tongue [7,28]. However, this is common in the initial phase of treatment, after the adaptation, the disappearance of these signs and symptoms occurs [4,7,9].

The patient with a lingual appliance may have difficulty speaking temporarily [4,6,7,9,37]. It is very common, the difficulty in pronouncing the phonemes "S", "T" and "TR" [7,33]. The speech impairment is caused by the brackets attached to the lingual surface of the teeth, resulting in disturbances in the sound produced by the speech process [7].

The difficulty in mastication [7,40,48-50] is another factor of patient discomfort in orthodontic treatment as well as the difficulty of swallowing [7,33,39].

The oral hygiene of the patient in lingual orthodontic treatment is also affected, the difficulty in dental brushing is reported [7]. Oral hygiene procedures may be more difficult due to limited accessibility [6,46,47]. As a result, there is an increase in plaque index [46,47].

Hohoff et al. [7] compared the influences of lingual devices of different dimensions on the sound performance and oral comfort. Through the recording of the sound with a recorder and digital audio tape, before and after the placement of the devices, through the semi-objective evaluation of three blind speech professionals and through complementary subjective evaluations by the patients, it was concluded that all the brackets analyzed induced significant impairment in sound performance and oral comfort. However, there was a significant variation with respect to the degree of disability. The smaller the bracket, the less disability was caused. Therefore, with the use of smaller, customized brackets, the orthodontist can significantly improve patient oral comfort and reduce damage to sound performance compared to larger-size brackets.

In another study by Hohoff et al. [7] oral comfort, speech, chewing and swallowing were analyzed before and after insertion of the lingual brackets at different times. Before the placement of the brackets (t0), 24 hours after the placement of the brackets (t1) and three months after the placement of the brackets (t2). Compared with t0, significantly worse results were recorded in t2 for the parameters "language space restriction", "tongue lesions", "tongue position", "subjective and semi-objective joint evaluation", "mastication", and "oral hygiene". It is worth mentioning that between t1 and t2 there were significant improvements, that is, the patients were able to adapt to the lingual brackets.

Miyawaki, Yasuhara, and Koh carried out research in 111 adult patients, in order to verify the discomfort that the lingual devices can cause. Despite instructions to avoid or relieve discomfort, 57.0 to 76.0% of patients complained of tongue pain, difficulty in chewing fibrous food, difficulty in pronouncing S and T sounds, and difficulty after the placement of the lingual orthodontic appliance. Furthermore, oral injury levels were found to be significantly higher for lingual treatment compared to vestibular treatment.

Echarri [33,37] described some clinical maneuvers that allow the orthodontist to maximize the patient's comfort during the treatment through the lingual technique, among them are information to the patient about the inconveniences during the treatment, education in oral hygiene, use of protectors on the bracket, and do not perform the collating of all brackets in just one query.

According to Hohoff et al. [7] patients should be informed about the possible effects of using the lingual appliance, such as decreased oral comfort and poor sound production when speaking. It is recommended to indicate to the patient all the necessary products to ensure that the patient will perform adequate hygiene. Interdental brushes, electric toothbrushes, mouthwashes, dental floss and toothpaste. In addition, it is necessary to provide the patient with bracket protectors (dental wax), which prevent direct contact of the bracket with the mucosa, preventing the formation of lesions in this [33]. Oral hygiene instructions and motivation should be carried out from the first moment of care and reinforced throughout the treatment. When bracket bonding is performed in stages, for example, a dental arch at each visit, the patient becomes more tolerant of the discomfort generated by the brackets and the pain generated by the arcing mechanics [51-55].

Conclusion

The lingual orthodontics is in the process of evolution and the success of this can be achieved when professionals are able to apply it. Optimization of aesthetics is its main advantage, as it does not compromise the buccal aspect of the teeth, making the treatment discreet to the patient. However, it presents some disadvantages, such as the difficulty of initial adaptation, due to the discomfort in the language and temporary alteration of the diction. A careful differential diagnosis and clear patient exposure of the treatment goals should be taken into account during the choice of technique to be used. According to the literature, the lingual orthodontic technique is a viable and safe option to achieve correction and alignment of the teeth.

Conflict of Interests

There is no conflict of interest between authors.

References

1. Lee S, Hwang S, Jang W, Choi YJ, Chung CJ, et al. (2018) Assessment of lower incisor alveolar bone width using cone-beam computed tomography images in skeletal Class III adults of different vertical patterns. *Korean J Orthod* 48: 349-356
2. Graber TM, Vanarsdall RL (2000) *Orthodontics: Current principles and techniques*. (3rd edn). Rio de Janeiro: Guanabara Koogan.
3. Maltagliati LA, Montes LA (2007) Analysis of factors that motivate adult patients to seek orthodontic treatment. *R Dental Press Ortodon Ortop Facial* 12: 54-60.
4. Echarri P (2003) *Lingual orthodontics: Complete technique step by step*. Nexus Edition.
5. Fillion D (2000) *Lingual orthodontics for adults: Multidisciplinary treatments*. R Dental Press Ortodon Ortop Facial 7: 93-101.
6. Geron S (1999) The lingual bracket jig. *J Clin Orthod* 33: 457-460.
7. Hohoff A, Stamm T, Goder G, Phys D, Sauerland C, et al. (2003) Comparison of 3 bonded lingual appliances by auditive analysis and subjective assessment. *Am J Orthod Dentofac Orthop* 124: 737-745.
8. Khan RS, Horrocks EN (1991) A Study of adult orthodontic patients and their treatment. *British J Orthodontics* 18: 183-194.
9. Fillion D (1998) The thickness measurement system with the DALI Program. In: Romano, R. *Lingual Orthodontics*. Hamilton: BC Decker Inc. pp: 175-184.
10. Romano R (2006) Concepts on control of the anterior teeth using the lingual appliance. *Semin Orthod* 12: 178-185.
11. Mattos AM, Capelli JR (2006) Evaluation of porcelain surface after orthodontic bracket removal. *Rev Dental Press Ortodon Ortop Facial* 11: 151-158.
12. Wang X, Stone ML, Prince JL, Gomez AD (2018) A Novel filtering approach for 3d harmonic phase analysis of tagged MRI. *SPIE Medical Imaging. Int Soc Opt Eng* 10574.
13. Yu M, Gao X (2018) Tongue pressure distribution of individual normal occlusions and exploration of related factors. *J Oral Rehabil*.
14. Chan EKM, McCrostie S, Petocz P, Darendeliler MA (2007) Profile of lingual orthodontic users in Australia. *Aust Dent J* 52: 288-294.
15. Phan X, Ling PH (2007) Clinical limitations of invisalign. *J Can Dent Assoc* 73: 3.
16. Demling A, Demling C, Schweska-Polly R, Stiesche M, Heuer W (2009) Influence of lingual orthodontic therapy on microbial parameters and periodontal status in adults. *Eur J Orthod* 31: 638-642.
17. Hamdan AM (2004) The relationship between patient, parent and clinician perceived need and normative orthodontic treatment need. *Eur J Orthod* 3: 265-271.
18. Prieto MGL, Prieto NT, Prieto LT, Prieto L (2009) Instrumentais em ortodontia lingual. *Orthod Sci Pract* 2: 560-565.
19. Imakami MB, Valle-Corotti KM, Carvalho PE, Scocate AC (2011) Evaluation of shear strength of lingual technique brackets bonded to ceramic surface. *Dental Press J Orthod* 16: 87-94.

20. Alexander CM, Alexander RG, Gorman JC, Hilgers JJ, Kurz C, et al. (1982) Lingual orthodontics: A Status report. *J Clin Orthod* 16: 255-262.
21. Fujita K (1978) Development of lingual bracket technique: Esthetic and hygiene approach to orthodontic treatment. *Soc Dent Mater Appliances* 46: 81-86.
22. Kurz C (1989) Lingual orthodontics. Atlas of adult orthodontics. Philadelphia, London: Lea & Febiger, UK. pp: 607-610.
23. Chenin DA, Trosien AH, Fong PF, Miller RA, Lee RS (2003) Orthodontic treatment with a series of removable appliances. *J Am Dent Assoc* 134: 1232-1239.
24. Wiechmann D (2003) Bracket system for lingual orthodontic treatment. Part II: First clinical experience and further development. *J Orofacial Orthop* 64: 372-388.
25. Galvão MCS, Maltagliati LA, Bommarito S (2006) Lingual orthodontics: Assembly laboratory techniques. *Rev Clin Ortod Dent Press* 5: 20-27.
26. Echarri P (2006) Revisiting the history of lingual orthodontics: A basis for the future. *Semin Orthod* 12: 153-159.
27. Creekmore T (1989) Lingual orthodontics: Its renaissance. *Am J Orthod Dentofac Orthop* 96: 120-137.
28. Creekmore TD, Kunik RL (1993) Straight wire: The next generation. *Am J Orthod Dentofac Orthop* 104: 8-20.
29. Cerroni S, Pasquantonio G, Condò R, Cerroni L (2018) Orthodontic fixed appliance and periodontal status: An updated systematic review. *Open Dent J* 12: 614-622.
30. Fritz U, Diedrich P, Wiechmann D (2002) Lingual technique- patient's characteristics, motivation and acceptance. *J Orofac Orthop* 3: 227-233.
31. Geron S Romano R (2001) The positioning of brackets in lingual orthodontics: Critical review of different techniques. *Ortod Clin* 4: 136-141.
32. Brazilian Association of Lingual Orthodontics. Institutional 2012. Available at: <<http://www.abolortolingual.com.br/portal/default.asp?Page=Institucional>>. Accessed on: September 17, 2012.
33. Echarri P (2001) Invisible Aesthetic Orthodontics in Adults. *Clinical Orthodontics* 4: 134-135.
34. Geron S (2006) Finishing with lingual appliances, problems, and solutions. *Semin Orthod* 12: 191-202.
35. Fillion D (2011) An interview with didier fillion. *Dental Press J Orthod* 16: 22-28.
36. Pithon MM, Oliveira MV, Ruellas AC (2008) Removal of ceramic brackets with How pliers associated with diamond drill - Enamel topography evaluation. *R Dental Press Ortodon Ortop Facial* 13: 101-106.
37. Echarri P (2002) Comparison of orthodontic treatments performed with vestibular orthodontics and lingual orthodontics. *Rev Esp Ortod* 32: 207-232.
38. Hüge SA (1998) The customized lingual appliance set-up service (CLASS) system. *Lingual orthodontics*. Hamilton: BC Decker Inc :163-73.
39. Gandini JRLG, Gandini MR, Martins RP (2004) Lingual technique: Clinical case report. *Rev Clin Ortod Dent Press* 3: 56-67.
40. Fillion D (1997) Improving patient comfort with lingual brackets. *J Clin Orthod* 31: 689-694.
41. Cal-Neto JOP (2013) Lingual orthodontics: Principles and clinical applications. São Paulo: Santos.
42. Cal-Neto JP, Castro S, Moura PM, Ribero D, Miguel JAM (2011) Influence of enamel sandblasting prior to etching on shear Bond strength of indirectly bonded lingual appliances. *Angle Orthod* 81: 149-152.
43. Cal-Neto JOP, Mattos AM, Moura PM, Ribeiro D (2005) The right arch technique in lingual orthodontics with the use of PW-MBP. *Rev Clin Ortodont Dental Press* 4: 73-77.
44. Koyata H (1996) Esthetic orthodontics: Basic technique of lingual orthodontics. Tokyo: Quintessence Int pp: 12-13.
45. Fillion D (1992) The viewpoint of the french lingual orthodontics society. *Orthod Fr* 63: 562.
46. Anirudh A (2011) Lingual orthodontics – An overview. *Dent Update* 38:390-395.
47. Fillion D (1989) Lingual orthodontics: A system for positioning the appliances in the laboratory. *Orthod Fr* 60: 695-704.
48. Fillion D (1986) Precision the lingual bracket technic. *Rev Orthop Dento Faciale* 20: 401-413.
49. Fillion D (2010) Clinical advantages of the Orapix-straight wire lingual technique. *Int Orthod* 8: 125-151.
50. Buso-Frost L, Fillion D (2006) An overall view of the different laboratory procedures used in conjunction with lingual orthodontics. *Semin Orthod* 12: 203-210.
51. Echarri P (1998) Lingual orthodontics, invisible orthodontics, current state of the art. *Sonhiadent Magazine* 12: 16-25.
52. Procedure for the positioning of brackets in lingual orthodontics. Part I. *J Clin Orthod* 1: 69-77.
53. Echarri P (1998) Procedure for the positioning of brackets in lingual orthodontics. Part II *J Clin Orthod* 1: 107-117.
54. Echarri P (2006) Lingual orthodontics: Patient selection and dignostic considerations. *Semin Orthod* 12: 160-166.
55. Echarri P (1998) Segmental lingual orthodontics in preprosthetic cases. *J Clin Orthod* 32: 716-719.