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THE CURRENT EVIDENCE COMPARING LABIAL AND LINGUAL FIXED ORTHODONTICS IN TERMS OF CLINICAL OUTCOMES AND ADVERSE EFFECTS

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ABSTRACT

For patients who are aesthetically conscious, lingual orthodontic appliances provide an outstanding alternative to labial appliances. This study is intended to review the latest literature comparing labial and lingual orthodontics in terms of clinical outcomes and adverse effects. The electronic database search was done on PubMed, Cochrane Library, Embase, Web of Knowledge, and Google Scholar to find the current evidence. Lingual appliances were associated with increased overall oral discomfort, poorer speech performance, increased difficulty in eating and reduced intermolar width compared to labial appliances. On the other hand, lingual appliances were associated with increased intercanine width and substantially reduced loss of the first molar maxillary anchorage during space closure.

KEYWORDS: Lingual orthodontics, labial orthodontics, fixed appliances, treatment outcomes, adverse effects.

1. INTRODUCTION

Traditionally, orthodontic appliances have been fixed on the labial or buccal surface of the teeth (labial fixed appliances). Over the years, the rapidly increasing number of adult patients [1] seeking orthodontic care and their greater aesthetic demands [2] have resulted in the development of numerous aesthetic treatment alternatives, including aesthetic brackets, clear aligners, and appliances fixed on the lingual or palatal surface of the teeth (lingual fixed appliances). Lingual orthodontics began in the 1970's when lingual brackets were first used by Fujita in Japan and Kurtz in the USA. [3][4] As lingual brackets were invisible it made a spectacular debut. An electronic review of the literature was conducted to distinguish the fixed lingual orthodontics with labial orthodontics in terms of treatment outcomes and adverse effects. The electronic data search was conducted on PubMed, Cochrane library, Embase, Web of Knowledge, and Google Scholar.

2. CLINICAL OUTCOMES:

According to most studies [5][6][7], the centre of resistance (Cr) in a single rooted tooth is 24% to 55% of the root length from the alveolar crest. The relationship between the location of the Cr and the positioning of the brackets (buccal or lingual) directly affects the magnitude and direction of the moments produced by the forces applied. Often a critical factor in fixed-appliance therapy is frictional resistance. Typically, the arch wires in lingual orthodontics are smaller in diameter than those used in labial orthodontics. Using smaller arch wires produces less friction in lingual orthodontics and therefore less torque control, although in the presence of a small inter bracket gap the wire engages. [8]

- **MOVEMENTS IN THE SAGITTAL DIRECTION:**

The direction of force applied in both systems, lingual and labial orthodontics, passes relatively far from the centre of the resistance, and thus a moment is created. The moment tends to move the crown in the direction of the force and the apex in the opposite direction . There is no distinction between the two systems, in this context. The sagittal force also creates a moment in the buccal– lingual direction, which tends to rotate the tooth. In labial orthodontics, the force vector passes labial/buccal to the Cr, and in lingual orthodontics, it passes lingual to it. Therefore, the directions of these rotations are opposite. For example, retracting a premolar in labial orthodontics will tend to rotate the tooth in a distal– lingual direction. In lingual orthodontics, the same retraction will create a mesial–lingual rotation of the tooth. [9]

- **MOVEMENTS IN THE VERTICAL DIRECTION:**

The distance between a lingual bracket and the Cr in the sagittal plane is far shorter than that between a labial bracket and the Cr. The lingual bracket is located closer to the centre of resistance of the tooth than is found with the labial bracket position. Hence the magnitude of moment in lingual orthodontics is much smaller than labial orthodontics for forces in vertical direction therefore, pure intrusion movement in lingual orthodontics will be closer to bodily movement than in labial orthodontics. [9]

- **MOVEMENTS IN THE TRANSVERSE DIRECTION:**

Clinically, expansion is easier in lingual orthodontics than in labial orthodontics, due to the posterior disocclusion caused by the anterior bite plane and the equilibrium change in lingual orthodontics between the tongue and the lips. [9]

There are numerous studies which compare labial and lingual orthodontics. In Gorman et al's [10] study, 120 patients treated in three dental clinics, were divided into six groups according to the orthodontic technique used (labial or lingual) and the dental clinic where treatment was provided. All measurements were made pre-treatment and post-treatment. No statistically significant differences were recorded in treatment results between labial and lingual appliances. The significant differences in results were found only when the cases were grouped with respect to practitioner or extraction pattern, rather than the type of appliance used.

One study by Fulmer et al [11] evaluated four clinical scenarios (bite opening, incisor inclinations and torque control, incisor intrusion and soft-tissue profile) in 36 patients subjected to lingual orthodontic treatment. These authors found lingual appliances to cause clockwise mandibular rotation due to intrusion of incisors and extrusion of molars.

In 2010, Alexander Harry Pauls conducted a retrospective study of 25 patients with customised Incognito® brackets to show the likelihood of achieving the target of the therapeutic setup in actual therapy. Using a 3D printer, the clinical setup casts and final treatment casts were digitalised and then the scans superimposed. In the three spatial dimensions the differences in rotation and translation of each tooth were determined. The front teeth display variations in rotations of < 4.6 ° and under 0.5 mm in translations. Using individualised brackets, the final outcomes after lingual orthodontic treatment correspond satisfactorily with the therapeutic setups.[12]

Fillion et al outlined the clinical benefits of the fully customizable lingual bracket and archwire system, known as the Orapix digital system. Brackets are located very close to the lingual surface of incisors in this bracket system and thus have enhanced 3D control. High precision and completely customized brackets and archwires are found to provide ideal clinical positions of teeth as defined on the digital virtual setup. [13]

Another research in 2011 by Grauer and Proffit analyzed accuracy in tooth positioning with fully designed appliance (Incognito™). For this study, dental casts of 94 patients were scanned. The results of this study showed that fully customised appliances (Incognito™) were successful in achieving the intended treatment goals in the initial virtual digital setup except for the planned arch expansion and the inclination of the second molar. [14]

Mistakidis et al. published their first systematic review of the clinical outcome of lingual orthodontics to evaluate the data available on the efficacy of lingual orthodontic treatment and other associated clinical parameters such as anterior teeth position, lower intercanine width, lower incisor proclination in lingual technique + Herbst appliance, deviations in peer assessment rating (PAR) scores, anchorage loss, lower incisors crowding, WSLs, accidental brackets debonding, and treatment duration. The results of this systematic review were positive regarding the clinical outcomes, particularly of lingual orthodontic treatment especially the achievement of individualised treatment goals and also the reduction of decalcifications on the bonded surfaces of the teeth. [15]

According to the metanalysis by Papageorgiou et al. [16], treatment with lingual appliances was associated with a marked increase in the intercanine width and a decrease in intermolar distance. This is possibly due to the prominent premolar offset built into the lingual wire, along with the limited interbracket distance in the anterior region [17]. A possible explanation for the decrease in intermolar distance might be because the lingual appliances causing irritation to the tongue, move it to a more posterior and inferior position, and thereby affecting the equilibrium of forces at the posterior teeth [17]. When compared with patients fitted with labial appliances, lingual appliances were associated with significantly less sagittal anchorage loss of the first maxillary molar after retraction to close first premolar extraction spaces. This could be possible due to smaller arch perimeter, with lingual appliances leading to higher wire rigidity and better anchorage control during retraction and increased anchorage value of the posterior teeth as a result of closeness of the lingual brackets to the center of resistance of the tooth which leads to cortical bone anchorage as a result of buccal root torque and distal rotation of the molar crown. [18][19][20]

3. ADVERSE EFFECTS

Recently published systematic reviews and RCTs have analysed various adverse effects like speech, pain, eating difficulties, WSLs, oral hygiene, and periodontal status related to fixed lingual orthodontics and have compared these with that of fixed labial appliance.

Speech

Both lingual and labial appliances have been shown to induce speech impediment but speech difficulties were more common with lingual than with labial systems as seen by objective auditory analysis and subjective questionnaire-based research. Patients with lingual appliances were more likely to show a perception of articulation change and avoidance of some forms of communication even after 3 months compared to patients with labial appliances. The patho-mechanism of speech impairment during lingual appliance therapy results from the contact area of the tongue being shifted further palatally as a result of the presence of lingual brackets. [16][21][22]

Pain

The difference in the perception of pain in both techniques is that the patients with lingual appliances experienced more tongue pain, while those treated with labial appliances experienced more lip and cheek pain. Patients treated with lingual appliances have reported experiencing pain longer than those treated with labial appliance. [23][24] In a study by Caniklioglu et al., [25] two groups of 30 adolescent patients were asked to completed a seven-part survey with 12 questions 3 months after starting the treatment, evaluating intraoral discomfort; tongue-lip-cheek soreness; difficulties in eating, speech, and oral care; adaptation period; and general problems. In the lingual group, tongue soreness and speech difficulties were significantly greater than in the labial group, whereas cheek and lip soreness were greater in the labial group.

Eating difficulties

In the systematic review by Ata-Ali et al. [9] eating problems were not found to be statistically more prevalent with lingual than with labial appliances. This was confirmed by another study in which there were no statistically significant differences in eating and oral care difficulties between the groups but there was more adherence of food particles in the lingual group. [25]

White spot lesions

Lingual fixed appliances are associated with reduced incidence of WSLs as compared to labial fixed appliance as reported by various studies including RCT and systematic reviews and this is considered to be a major advantage to the lingual system. An RCT conducted by van der Veen *et al*. in 2010, reported that the number of new WSLs developing or progressing on brackets fixed on labial or buccal surfaces was 5 times higher than the number of new WSL developing or progressing on fixed lingual surfaces. Wiechmann *et al*. in 2015, in their study on completely customized fixed lingual appliance also found distinctly reduced occurence of WSLs. [9][6][26][27]

Oral Hygiene and Periodontal Status

Long *et al*. in their systemic review revealed that the prevalence of oral hygiene problems was similar within the first 3 months between lingual and labial fixed appliance.[21] Ata-Ali *et al*. in their meta-analysis, found a greater compromise in oral hygiene levels with the lingual appliance. They analyzed the clinical findings like bleeding on probing, plaque index, and probe depth, and microbiological findings like detection of *Aggregatibacter actinomycetemcomitans* and *Porphyromonas gingivalis* in crevicular fluid. The study concluded that lingual orthodontics significantly worsen these parameters.[9] One split-mouth study tested clinical periodontal and microbial indices before bonding and 4 weeks after bonding of lingual appliances and concluded that plaque index and bleeding on probing significantly increased in this period in the bonded sites, however no significant difference was detected for pocket depth and periodonto-pathogenic bacteria. [28]

4. CONCLUSION:

Lingual orthodontics have some advantages and disadvantages relative to labial orthodontics. Lingual appliances may be more effective than labial appliances in achieving intrusion of anterior teeth, maxillary arch expansion, combining mandibular repositioning therapy with orthodontic movements and distalization of maxillary molars. They also show less sagittal anchorage loss in retraction mechanics. Lingual appliances show reduced intermolar width and increased intercanine width compared to labial appliances. Both lingual

and labial appliances have been shown to induce some speech impediment but in the case of lingual brackets there is a higher degree of impairment due to bracket interference with the tongue. Both systems are associated with pain perception but the sites are different, tongue in the lingual system and cheek and lips in the labial system. Customized lingual brackets may be associated with less pain than with the pre-fabricated ones. There is some evidence that the lingual surfaces of the teeth are more resistant to early demineralization and caries. However, there is little evidence comparing lingual and labial appliances regarding treatment outcome.

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