APPLICATION OF DENT@LIGN DIGITAL ALIGNERS FOR CORRECTION OF CROWDING

Miroslava Dinkova,
Department of Orthodontics, Faculty of Dental Medicine, Medical University - Sofia, Bulgaria.

ABSTRACT

Purpose: To analyze the possibilities for correction of the crowding in the upper and lower dental arch with DENT@LIGN digital aligners.

Materials and Methods: DENT@LIGN digital aligners (DLN) were applied for correction of the crowding in 127 patients, 69 of whom were treated in both jaws, 36 – only in the upper and 22 – only in the lower.

A complete orthodontic analysis of the patients before and after treatment was made.

The patients were divided into four groups: without crowding; with mild crowding - up to 3 mm; with moderate crowding — from 3.1 to 7.0 mm; with severe crowding - over 7.1 mm arch length deficiency.

The DLN are applied into steps with optimal wearing of 18–21 hours a day. Each step has to be worn for one month and consists of 3 aligners: soft (0.55 mm), medium (0.625 mm) and hard (0.75 mm).

The results were statistically processed.

Results: In the upper dental arch, the percentage of patients without crowding increased significantly after the treatment with DLN from 35% (N = 33) to 92.5% (N = 86). In the lower dental arch, the percentage of patients without crowding increased from 21% (N = 13) to 91.5% (N = 75).

Conclusion: DENT@LIGN digital aligners are a successful and effective method for treatment of crowding in patients of all ages.

Keywords: aligners, crowding, orthodontics,

INTRODUCTION

The crowding of the teeth in the dental arch is one of the most common malocclusions. It is observed mainly in the lower dental arch. Its etiology includes a mismatch between the size of the teeth and the jaw (TSALD) [1, 2]; medialization of the distal teeth; lingual inclination of the frontal teeth; deep bite; as a result of the physiological development, etc. It leads to tooth rotation and inclination, traumatic occlusion and difficult control of the oral-hygiene. The alignment of the teeth in cases of crowding can be solved by creating a space in the dental arch by: expansion in the corresponding jaw, distalization of the lateral teeth, vestibular inclination of the frontal teeth, interproximal enamel reduction, extraction. [1] The well-known fixed appliances are an appropriate choice for the treatment of these malocclusions, but they do not meet the modern requirements for the aesthetics and comfort of an adult patient. An alternative in the cases of crowding are the aligners - invisible, removable orthodontic appliances that offer convenience, aesthetics, reduced clinical time and the possibility to maintain good oral hygiene. Since Kesling developed the concept of the tooth positioning appliance in 1945 [3, 4] and companies from all over the world, have taken his idea and a number of aligner systems have emerged on the market. In modern orthodontics, these types of appliances are widely used, both as a stage or for complete orthodontic treatment, mainly for mild to moderate dento-alveolar forms of malocclusions.

The aim of this study is to analyze the possibilities for correction of the crowing in the upper and lower dental arch with DENT@LIGN digital aligners.

MATERIALS AND METHODS

DENT@LIGN digital aligners were used for the treatment of crowding in both dental arches and in the upper and lower dental arch separately in 127 patients with a mean age of 29.46 ± 11.24 years between 8–62 years. In the study group, women accounted for 78% (N = 99) of the patients, and men were 22% (N = 28). The proportion of women was significantly higher than that of men (p <0.001). The mean age for men was 28.70 ± 11.76 years and 29.67 ± 11.14 for women, with no statistically significant difference (p = 0.694). Treatment in both jaws was conducted to 69 patients (54.4%), in the upper jaw to 36 patients (28.3%) and in the lower jaw - to 22 patients (17.3%).

Each patient underwent complete orthodontic analysis before and after treatment, which included analysis of orthodontic models, cephalometric analysis, orthopantomography, intra- and extraoral photos.

The crowding was measured by applying a method...
to determine the perimeter of the dental arch. We identified three stages of crowding: mild - from 0.1 to 3.0mm, moderate - between 3.1 and 7.0mm, and severe - over 7.1mm lack of space for the alignment of the teeth.

The patients were divided into four groups: without crowding; with mild crowding; with moderate crowding; with severe crowding.

The treatment protocol for DENT@LIGN digital aligners consists of taking impressions, orthodontic analysis and prescription, virtual set-up, digital analysis and visualization of the end result of the treatment as well as 3D printing of motivational models, adjustment and training of the patient how to clean and use the appliance. Diagnosis, treatment plan, order and volume of the prescriptions and evaluation of treatment progress were performed by the author of the article.

Each step of the treatment includes 3 aligners with different thickness: 0.5 mm, 0.625 mm, 0.75 mm (soft, medium, hard). The appliance was applied according to the scheme: 1 week soft, 1 week medium, 2 weeks hard. Optimal wearing is 18-21 hours a day.

The results were statistically processed.

Pre- and post-treatment crowding was compared for upper and lower jaw by cross-tabulation, Chi-square test and Fisher test.

RESULTS
The results showed that crowding is more common in the lower jaw - 89.75% than in the upper jaw - 64.50%.

A correlation was found between the number of steps and the number of teeth to be moved.

There is also a correlation between the number of steps, respectively the duration of treatment, number of the teeth moved and the size of the deviations. The correction of cases with mild crowding was achieved in 2-5 steps (2-5 months), while in the cases with moderate crowding 7-8 steps (7-8 months) were needed until complete leveling of the teeth in the dental arch was achieved.

The results for the upper jaw are summarized in Table 1. 33 patients were diagnosed with no crowding in the upper jaw before the treatment. They formed a control group. After the treatment, 100% of them remained in the same group. Mild crowding was diagnosed in 30 patients before the treatment. In all 30 of them (100%) the crowding was corrected after the treatment. Twenty-two patients were diagnosed with moderate crowding before the treatment. For 18 (78.3%) of them, the crowding was fully corrected after the treatment, and 5 (21.7%) remained with mild crowding. Severe crowding was observed in 7 patients before treatment. In all (100%) of them, the degree of post-treatment crowding decreased as follows: In one patient (14.3%), the crowding changed from severe to moderate; in one patient (14.3%) from severe to mild; and in the remaining five (71.4%) the crowding was completely corrected. The changes described are statistically significant, p <0.001.

The change in the crowding in the upper jaw is shown in Figure 1. The percentage of patients without crowding increased significantly from 35% (N = 33) to 92.5% (N = 86), p <0.001. The opposite tendency is observed in the other degrees of crowding. The percentage of patients with mild crowding decreased significantly from 34% (N = 30) to 6.5% (N = 6), p <0.001; with a moderate crowding from 24% (N = 25) to 1% (N = 1), p <0.001; and with a severe crowding from 7% (N = 7) to 0% (p = 0.014).

<table>
<thead>
<tr>
<th>Crowding in the upper jaw before the treatment</th>
<th>Crowding in the upper jaw after the treatment</th>
<th>Total</th>
<th>Chi-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>No crowding</td>
<td>No crowding</td>
<td>33 (100%)</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>30 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>18 (78.3%)</td>
<td></td>
<td>0.000**</td>
</tr>
<tr>
<td>Severe</td>
<td>5 (71.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>86</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

*Statistical significance at alpha errorlevel <0.05; ** Statistical significance at errorlevel alpha ≤ 0.01
Fig. 1. Statistically significant changes in the crowding before and after the treatment in the upper jaw.

Thirteen patients were diagnosed without crowding in the lower dental arch before treatment and remained in the same category after the treatment. 28 patients were diagnosed with mild crowding before treatment. In all 28 (100%) of them, the crowding was corrected after the treatment. 31 patients were diagnosed with moderate crowding before the treatment, of whom 27 (87.1%) had no crowding after the treatment, and 4 (12.9%) remained mild crowding. Severe crowding was diagnosed in 10 patients before the treatment and all of them (100%) passed in a lower crowding group as follows: in seven patients (79.3%) the crowding was completely corrected; two (18.3%) experienced a transition from severe to mild crowding; and one (2.4%) from severe to moderate. The observed changes were statistically significant, \( p = 0.004 \). The results are summarized in Table 2.

Table 2. Cross-tabulation table before and after treatment in the lower jaw.

<table>
<thead>
<tr>
<th>Crowding in the lower jaw before the treatment</th>
<th>Crowding in the lower jaw after the treatment</th>
<th>Total</th>
<th>Chi-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No crowding Mild Moderate</td>
<td>Total</td>
<td>( p )</td>
</tr>
<tr>
<td>No crowding</td>
<td>13 (100%) 0 (0%) 0 (0%)</td>
<td>13 (100%)</td>
<td>0.004**</td>
</tr>
<tr>
<td>Mild</td>
<td>28 (100%) 0 (0%) 0 (0%)</td>
<td>28 (100%)</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>27 (87.1%) 4 (12.9%) 0 (0%)</td>
<td>31 (100%)</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>7 (70.0%) 2 (20.0%) 1 (10.0%)</td>
<td>10 (100%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>75 6 1</td>
<td>82</td>
<td></td>
</tr>
</tbody>
</table>

*Statistical significance at alpha errorlevel <0.05; ** Statistical significance at errorlevel alpha \( \leq 0.01 \)

The observed changes in the lower dental arch crowding are summarized in Figure 2. The percentage of patients without crowding increased significantly from 16% (\( N = 13 \)) to 91.5% (\( N = 75 \)), \( p < 0.001 \). There was a decrease in the number and percentage of patients in the rest of the groups. The percentage of patients with mild crowding decreased significantly from 34% (\( N = 28 \)) to 7.3% (\( N = 6 \)), \( p = 0.032 \); with moderate crowding from 38% (\( N = 31 \)) to 1.2% (\( N = 1 \)), \( p < 0.001 \); and with severe crowding from 12% (\( N = 10 \)) to 0%, \( p = 0.001 \).
Fig. 2. Statistically significant changes in the crowding before and after treatment in the lower dental arch.

DISCUSSION
Proffit defines the crowding as a mean of 2-4 mm arch length discrepancy. [5] A number of authors have presented cases with treatment of moderate crowding, using a variety of approaches such as expansion, proclination, interproximal enamel reduction (IPR), or extraction. [6, 7, 8]

According to our results, the successful correction of the crowding with DENT@LIGN digital aligners lays on some basic principles:

The digital protocol allows maximum control of the treatment. The virtual analysis determines the number of steps required to complete the treatment before the beginning. This allows determining the treatment time and the cost of treatment. The motivational models made on the basis of the virtual analysis allows the patient to “see” the end result, which motivates him for his compliance. The listed protocol elements - virtual set-up, motivational models, determining treatment time, cost and a clear end result, makes possible the full control of the treatment. The final goal is visualized before the treatment process even begin, which distinguishes and gives priority to digital aligner systems compared to other philosophies of orthodontic appliances. [7] In terms of the ability to control the results with pre-set goals, digital aligners have no analogues in the orthodontic practice. [9,10]

The duration of treatment in the cases of mild crowding in our study is 2-5 months and in cases of moderate 7-8 months. These results differ from those of other authors, who show the duration of the treatment according to crowding severity as follows: 13.4 ± 5.28 months (mild), 15.93 ± 5.17 months (moderate) and 17.92 ± 4.07 months (severe). [11] Krieger et al. reported a 13-month duration of treatment for the correction of moderate crowding. [12, 13]

The DLN analysis showed that the use of IPR is indicated in the moderate and mild forms of severe crowding. The IPR volume is determined during the diagnostic phase and during the virtual set-up. Our study showed a proportional relationship between the degree of the crowding and the need for IPR. [14, 15]

Many studies have shown the efficacy of different aligner systems in a variety of dental movements. [16, 6, 12, 13] There are also many reports examining the crowding and its treatment options. [17,18,19] However, most of them present single clinical cases [9] and less include representative samples from the treatments of a larger number of patients. According to Little, crowding in the frontal segment of an average of 5.39 mm in the upper dental arch and 5.96 mm in the lower dental arch was corrected after treatment with another aligner system to 1.57 mm in the upper and 0.82 mm in the lower jaw. [12, 20]

An article published in 2007 outlines the clinical limitations of aligners. In this report, the authors pointed out malocclusions unsuitable for treatment with aligners, including crowding or spaces greater than 5 mm. [21] On the contrary, we were able to correct moderate crowding between 3.1 and 7.0 mm in 78.3% of cases in the upper dental arch and in 87.1% in cases in the lower dental arch, as well as a severe crowding of more than 7.1 mm in 71.4% in the upper dental arch and 70.0% in the lower, which confirms the contemporary trends of expanding the indications for treatment with aligners, corresponding with the modern digital workflow in the orthodontic practices.

CONCLUSION
DENT@LIGN digital aligners are a successful and effective method for treatment of crowding in patients of all ages.
REFERENCES:
14. Crossley AM, Campbell PM, Tadlock LP, Schneiderman E, Buschang PH. Is there a relationship between dental crowding and the size of the maxillary or mandibular apical base? Angle Orthod. 2020 Mar;90(2):216-223. [PubMed] [Crossref]
16. Lanteri V, Farronato G, Lanteri C, Caravita R, Cossellu G. The efficacy of orthodontic treatments for anterior crowding with Invisalign compared with fixed appliances using the Peer Assessment Rating Index. Quintessence Int. 2018; 49(7):581-587. [PubMed] [Crossref]

Please cite this article as: Dinkova M. Application of DENT@LIGN Digital Aligners for Correction of Crowding. J of IMAB. 2021 Jan-Mar;27(1):3572-3576. DOI: https://doi.org/10.5272/jimab.2021271.3572

Received: 31/03/2020; Published online: 05/02/2021

Address for correspondence:
Assoc. prof. Miroslava Dinkova,
Department of Orthodontics, Faculty of Dental Medicine, MU- Sofia,
St. Jerusalem 6, fl. 4, office 10, Sofia, Bulgaria
E-mail: miroslavadinkova@abv.bg

https://www.journal-imab-bg.org J of IMAB. 2021 Jan-Mar;27(1)