Comparison of complications in the conventional telescopic Herbst rod and tube and Manni telescopic Herbst: A retrospective clinical study

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ABSTRACT

Objectives: To compare the prevalence of clinical complications between two different telescopic Herbst systems: the conventional telescopic system, with traditional rod and tube (RMS), and the Manni telescopic Herbst appliance (MTH).

Materials and Methods: Ninety subjects treated with RMS were compared to 89 patients treated with MTH. All of the complications that occurred were reported, and percentages of prevalence were calculated.

Results: MTH showed a significantly lower percentage of reversible complications (that did not require appliance removal) when compared to the reversible complications during RMS treatment (20.2% vs 51.1%). No statistically significant differences were found between RMS and MTH regarding irreversible complications (that required appliance removal and full re-make). All of the irreversible complications occurred after reversible complications in the RMS group, while most of the irreversible complications in the MTH group occurred without any previous reversible complication.

Conclusions: MTH exhibited a smaller number of clinical complications during Class II skeletal malocclusion therapy. (Angle Orthod. 2018;88:377–383.)

KEY WORDS: Herbst; Complications; RMS; MTH

INTRODUCTION

The Herbst appliance is a noncompliance device commonly used for skeletal Class II malocclusion correction.1,2 The original design was first described in 1910,3 but the device went through multiple changes, mainly because of the high percentage of breakage during treatment.4–6 Howe and McNamara5 introduced a fixed acrylic splint both in the upper and the lower arch.

In 1989, Valant and Sinclair7 preferred the application of a removable acrylic splint (RMS) only on the lower arch (Figures 1 and 2) to prevent the flaring of the lower incisors. Although the percentage of failure decreased, complications were still reported in 59% of the cases,8 including low comfort level of the appliance, reduced mandibular range of motion, and ulcerative lesions of the mucosa overlying the coronoid process. Common findings also included breakage of the band on the lower first premolars and cases of appliance disassembly.9–11

In order to overcome these residual complications, different types of telescopic Herbst appliances were introduced, such as PMA (3M Unitek/Abzil, Sao Jose do Rio Preto, SP, Brazil), the miniscope Herbst (American Orthodontics, 3524 Washington Avenue, Sheboygan, Wisc, USA), the Hanks telescopic system (HTH; American Orthodontics, 3524 Washington Avenue, Sheboygan, Wisc, USA), the Manni telescopic Herbst (MTH; Micerium Avegno, Genova, Italy), and many others.

Rollo Bands (American Orthodontics) were introduced in association with the miniscope Herbst, the...
HTH, and the MTH. Compared to the traditional bands of the RMS, Rollo Bands are similar to pre-formed metallic crowns, are thicker (0.007 inches), and are sandblasted.

The main difference among the miniscope Herbst, the HTH, and the MTH (Figures 3 and 4) is the lateral excursion movements of the mandible allowed by the devices: up to approximately 6° in the miniscope Herbst, approximately 20° in the HTH, and approximately 12° in the MTH version. This lateral excursion is observed on the dental cast models when the appliance is fabricated and clinically at the patient evaluation.

Both RMS and MTH appliances include an acrylic splint on the lower arch that prevents flaring of the lower incisors and reduces the probability of idiopathic condylar resorption. In the case of RMS, the lower splint can be completely removed during oral hygiene procedures (Figure 5), but it can be difficult for the patient to reassemble the different components. With the MTH appliance, the splint cannot be completely disassembled, but it can be gently elevated to allow access for oral hygiene procedures (Figure 6).

The RMS is a traditional telescopic system that does not allow any lateral excursions, while the MTH allows lateral movement of up to 12°. To reduce the consequent ulcerative lesions of the contralateral oral mucosa during lateral excursions of the mandible, the posterior part of the cylinder in MTH has been reduced, smoothed, and beveled.

Manni et al. reported double the percentage of complications with RMS vs HTH and therefore claimed that HTH was more efficient than RMS. Information is still lacking about the MTH Herbst in terms of complications, breakage, ulcerative lesions, etc. Because of the decreased incidence of idiopathic condylar resorption reported and the decrease in lower incisor flaring, two appliances fabricated with a lower acrylic splint (RMS vs MTH) and the percentages and types of complications for each were compared in this study.

**MATERIALS AND METHODS**

The patient sample was retrospectively selected from the database of a single orthodontist (AM) and included patients between 9 and 14 years of age exhibiting a retrusive chin/mandible and who could...
benefit from mandibular advancement with the Herbst appliance. Before treatment, the patients exhibited half-cusp or full-cusp Class II dental malocclusions.

There were 179 subjects consecutively treated (in time): 90 patients (42 females: mean age 10.8 years; standard deviation [SD] = 1.4 years; and 48 males: mean age 11.2 years; SD = 1.4 years) were treated with RMS between February 1994 and December 2006, and 89 patients (41 females: mean age 11.0 years; SD = 1.4 years; and 48 males: mean age 11.3 years; SD = 1.5 years) were treated between July 2008 and October 2015 with the MTH.

The components of the appliances were conventional bands (Dentsply GAC Europe Rochecorbon, France) and Herbst components (Dentaurum, Ispringen, Germany) for the RMS group (Figure 2), while Rollo Bands and telescopic MTH (Micerium, Avegno, Italy) (Figure 4) were used in the MTH group. Conventional fixation screws were used in both of the appliances. No additional glue was used to increase fixation; the screws were eventually gently turned every 6 weeks to avoid their loosening. The same technician assembled the pieces and fabricated the acrylic splint for both of the appliances.

Clinically, the advanced position of the mandible for the RMS group was an upper and lower end-to-end incisor position, whereas the mandible was at first advanced 4–6 mm in the MTH group and reactivated 2 mm every 2 months by placing 2-mm-long crimpable shims. Treatment in both groups was stopped when a dental Class I relationship was achieved and stabilized.

RMS was bonded with zinc oxide–eugenol cement (Harvard Cement, Harvard Dental International GmbH, Hoppegarten, Germany), while MTH was bonded by means of a glass ionomer cement (ULTRA BAND-LOK, Reliance Orthodontic Products, Itasca, IL, USA).

The mean treatment time was 7.8 months for the RMS group and 9.8 months for the MTH group.

The overall complications were listed as follows:

- **Reversible complications**: when the repair process did not require the full re-make of the appliance (eg, partial detachment of the upper band/bands that became loose, a screw of the lower part of the appliance that broke and that had to be replaced, partial breakage of the acrylic splint).
- **Irreversible complications**: when the repair process required the removal of the appliance, new impressions, and full re-make of the appliance (eg, band fractures on the upper first permanent molars, the acrylic splint and the inferior part of the Herbst appliance detached from each other). Irreversible complications could also occur after reversible complications.
- **Complications due to oral lesions**: classified as “mild” if they did not require appliance removal and were easily managed by means of orthodontic wax and mouth-rinse products or as “severe” when the appliance was removed and orthodontic therapy continued with other types of devices.

**Statistical Analysis**

Data were analyzed by means of STATA 14.2 software (StataCorp LP).

Descriptive statistics were computed for all analyzed variables and described as mean and SD or as median and interquartile range when the distribution was not normal.
RMS was compared to MTH by means of a Pearson's Chi-square test and a Fisher's exact test. The treatment time variable was not normally distributed; therefore, the two-sample Wilcoxon rank sum test was performed. Probabilities of less than .05 were accepted as significant in all statistical analyses (\( P < .05 \)).

Sample size was calculated a priori using the Pearson’s Chi-square test with the hypothesis of a difference of 20% of reversible complications between the two groups corresponding to a percentage of 21% in the MTH group and a percentage of 41% in the RMS group, in order to obtain a statistical power of the study at 80%, with \( \alpha = .05 \). Based on these parameters, the sample size required was 83 subjects per group.

**RESULTS**

The Class II malocclusion was resolved in 99% of the cases with manageable complications that did not require appliance removal. The Herbst appliance was removed only in one patient who refused to go further with this type of therapy, even though no complications were reported for that case (Table 1). There was no significant difference in sex and age before treatment between the two groups. (Pearson Chi-square test, \( P = .936 \), but the treatment time was significantly less in the RMS group (two-sample Wilcoxon rank sum test, \( P < .001 \), as shown in Table 1).

Of the patients treated with MTH, 74.1% showed no complications during treatment, while 48.8% of the RMS sample patients reported no complications. This difference was statistically significant (\( P < .001 \)), as shown in Table 2. The prevalence of reversible complications was significantly lower in MTH than in RMS (Pearson’s Chi-square test, \( P < .001 \)) (Table 2), while no statistically significant differences between RMS and MTH were found regarding irreversible complications (Table 2). All of the irreversible complications occurred after reversible complications in the RMS group, while most of the irreversible complications in the MTH group occurred without any previous reversible complication.

Table 3 shows the type and prevalence of reversible complications in both groups together with the total amount of reversible complications. Every single or multiple detachment or breakage was significantly lower in the MTH group.

Table 4 summarizes the total amount of both reversible and irreversible complications. There were 0.95 complications per patient in the RMS group and 0.42 per patient in the MTH group.

None of the patients in either group developed severe ulcerative lesions that required appliance removal. Only one patient of the RMS group required appliance removal because of discomfort (Table 1). Mild ulcerative lesions that did not require the appliance removal were significantly more common in the MTH group than in the RMS group (Fisher’s exact test, \( P = .014 \); Table 5).

**DISCUSSION**

The likelihood of patient cooperation is one of the most important factors influencing the choice of orthodontic treatment. O’Brien et al.\(^4\) showed that cooperation with the Herbst appliance was greater than that with the Twin-block and, therefore, the Herbst appliance is a very efficient device used to treat Class II malocclusion since it does not require patient compliance.\(^1,2\) However, the Herbst appliance is prone to debonding and component breakage,\(^4\) so it is important to analyze the different types of complications that may occur.
Table 3. Prevalence of Patients with Detachments or Repairable Fractures in the RMS and MTH Groups

<table>
<thead>
<tr>
<th>Herbst RMS (N = 90)</th>
<th>Herbst MTH (N = 89)</th>
<th>Total Amount of Complications, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with detachments</td>
<td>Patients with detachments</td>
<td></td>
</tr>
<tr>
<td>No detachments, N (percentage)</td>
<td>67 (74.4)</td>
<td>79 (88.8)*</td>
</tr>
<tr>
<td>1 detachment, N (percentage)</td>
<td>21 (23.3)</td>
<td>10 (11.2)*</td>
</tr>
<tr>
<td>2 detachments, N (percentage)</td>
<td>1 (1.1)</td>
<td>0*</td>
</tr>
<tr>
<td>5 detachments, N (percentage)</td>
<td>1 (1.1)</td>
<td>0*</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>Patients with repairable breakages</td>
<td>Patients with repairable breakages</td>
<td></td>
</tr>
<tr>
<td>No breakages, N (percentage)</td>
<td>61 (67.8)</td>
<td>77 (86.5)*</td>
</tr>
<tr>
<td>1 breakage, N (percentage)</td>
<td>18 (20.0)</td>
<td>9 (10.1)*</td>
</tr>
<tr>
<td>2 breakages, N (percentage)</td>
<td>3 (3.3)</td>
<td>2 (2.3)*</td>
</tr>
<tr>
<td>3 breakages, N (percentage)</td>
<td>4 (4.4)</td>
<td>0*</td>
</tr>
<tr>
<td>4 breakages, N (percentage)</td>
<td>4 (4.4)</td>
<td>0*</td>
</tr>
<tr>
<td>8 breakages, N (percentage)</td>
<td>0</td>
<td>1 (1.1)*</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>21</td>
</tr>
<tr>
<td>Total amount of reversible complications</td>
<td>80</td>
<td>31</td>
</tr>
</tbody>
</table>

a RMS indicates traditional rod and tube type Herbst appliance; MTH, Manni telescopic Herbst appliance; detachment, the upper band/bands on the upper first permanent molar/molars becomes/become loose; and breakage, a piece of the acrylic splint that can break, a screw that breaks and that is therefore substituted.

* P < .05.

Data from this study showed a difference in treatment time between the two designs of Herbst appliances. All of the patients were treated by the same operator, who followed the published protocol regarding treatment time and stabilization according to the type of device cemented. However, treatment time in both groups was reasonable, considering that the longer the treatment, the higher the probability of a complication. In 2016, Tomblyn et al. reported that a longer treatment with a reinforced Herbst could promote a better skeletal effect. However, the patients in the current study began in 1994, and the protocol of retention of about 7 months recommended by Pancherz and Hägg in 1985 was used.

Regarding reversible complications, MTH was more efficient than RMS in terms of percentage of detachments and repairable breakage. Silva et al. compared two groups of patients treated with two Herbst groups: RMS (n = 125) and HC (a lower cantilever Herbst using lower stainless-steel crowns and a lingual arch; n = 34). They were further subdivided according to the telescopic system used (Dentaurum type 1 or PMA) and fixation mode (splat with crowns or Grip Tite bands). The difference between the telescopic system PMA (3M Unitek/Abzil, SP, Brazil) and Dentaurum type 1 (Dentaurum) was the lateral range of movement allowed to the mandible, which was present in the PMA and absent in the Dentaurum Type 1 telescopic system. Since the PMA allows about 10° of lateral excursion and the Dentaurum Type 1 system does not allow lateral movement, this comparison was similar to the current MTH to RMS comparison. In that study, a patient with the Dentaurum system was 2.9 times more likely to have at least one complication than was a patient with the PMA system, while in the current study, having one complication event (one detachment or one breakage) was twice as likely in the RMS group compared to the MTH group (Table 3.) Regarding all of the reversible complications, the prevalence in the current study was 20.2% in the MTH group and 51.1% in the RMS group, indicating that RMS is, in general, 2.5 times more prone to have reversible complications (Table 2).

The number of episodes involving detachment and breakage shown in Table 3 demonstrated that every...

Table 4. Total Amount of Reversible and Irreversible Complications and Mean Complications per Patient

<table>
<thead>
<tr>
<th></th>
<th>RMS</th>
<th>MTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amount of reversible complications, No.</td>
<td>80</td>
<td>31</td>
</tr>
<tr>
<td>Total amount of irreversible complications, No.</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Total amount of reversible and irreversible complications, No.</td>
<td>86</td>
<td>38</td>
</tr>
<tr>
<td>Complications per patient (mean)</td>
<td>0.956</td>
<td>0.427</td>
</tr>
</tbody>
</table>

a RMS indicates traditional rod and tube type Herbst appliance; MTH, Manni telescopic Herbst appliance.

Table 5. Prevalence of Patients with Mild Ulcerative Lesions Due to the Herbst Appliance in RMS and MTH Groups

<table>
<thead>
<tr>
<th></th>
<th>Herbst RMS (N = 90)</th>
<th>Herbst MTH (N = 89)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients without ulcerative lesions, N</td>
<td>90</td>
<td>83</td>
</tr>
<tr>
<td>% of the sample</td>
<td>100</td>
<td>93.3*</td>
</tr>
<tr>
<td>Patients with mild ulcerative lesions, N</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>% of the sample</td>
<td>6.7</td>
<td></td>
</tr>
</tbody>
</table>

a RMS indicates traditional rod and tube type Herbst appliance; MTH, Manni telescopic Herbst appliance.

* P < .05.
single or multiple detachment or breakage was significantly lower in the MTH group compared to the RMS group. As already mentioned, the difference between the RMS and MTH groups could be ascribed not only to the new telescopic system in the MTH Herbst but also to the new type of band, the Rollo Band, which is thicker than the conventional bands used in the RMS, is sandblasted, and that adapts well to the crown surface of the upper first permanent molars. Moreover, the difference in the percentage of crown debonding between the two groups may also be attributed to the type of cement used (glass ionomer cement in the MTH group and zinc oxide–eugenol cement in the RMS group). The RMS group was treated before the MTH group, from February 1994 to December 2006, and at that time the conventional bands were cemented with the old zinc oxide–eugenol cement. Subsequently, Rollo Bands, the telescopic Herbst design, and new luting materials were introduced to the market, and all of the patients of this study, treated from July 2008 to October 2015, received a telescopic Herbst with Rollo Bands cemented with glass ionomer cement. The two groups of patients were treated during two different periods of time. Therefore, patients in the two groups received two completely different fixed functional appliances aimed at correcting their Class II malocclusion. Each of these was used with their set of bands, rod-tube, and cement. The cement \(^1\) and the bands \(^1\)–\(^3\) may have influenced the percentage of complications reported. However, both groups were treated according to the protocols of that current period of time. Despite the differences, both RMS and MTH can be considered successful and effective in terms of Class II malocclusion correction.

No severe or mild ulcerative lesions were reported in patients treated with RMS. In the event that the piston of the RMS is long and irritates the oral mucosa, it can be easily cut and shortened to prevent lesions. This reparative procedure cannot be performed on HTH and MTH appliances; therefore, the posterior part of the MTH is markedly reduced in size, smoothed, and beveled to decrease the risk of an eventual ulcerative lesion. Manni et al.\(^1\) reported a 7% rate of failure of the HTH appliance due to severe ulcerative lesions of the oral mucosa in the area corresponding to the postero-superior part of the appliance that required appliance removal and consequent refusal by the patient to continue treatment. That complication was likely due to the great lateral mandibular movement allowed (up to 20°) because of the upper screw of the HTH Herbst appliance. During lateral excursive movement of the mandible, the balancing side of the appliance slides buccally and sometimes can contact the oral mucosa of the cheeks and cause ulcerative lesions.

An upper screw is not present in the MTH appliance. Therefore, lateral excursion of the mandible is reduced to 12° with the MTH Herbst as compared to the HTH design. The contact between the appliance and the oral mucosa is consequently less traumatic. Thus, none of the patients treated with MTH exhibited severe ulcerative lesions of the oral mucosa that required appliance removal. Nevertheless, mild ulcerative lesions were significantly more likely in the MTH group compared to the RMS group. These lesions generally occurred at the very beginning of MTH treatment, until the third or fourth day, and appeared on the postero-superior part of the mucosa of the cheeks. They were easily controlled by means of orthodontic wax applied on the area of the MTH Herbst that was in contact with the oral mucosa. Clinically, these lesions did not cause subjects to terminate treatment. No patients asked for appliance removal after the onset of these mild ulcerative lesions.

Finally, the current study showed promising results for the MTH Herbst appliance. However, it is important to consider that the study was conducted retrospectively, using patients who were consecutively treated in different time periods, with two different mandibular propulsive systems, and using different luting materials and requiring different treatment durations. Therefore, further prospective studies are needed to standardize a new protocol and confirm these results.

CONCLUSION

- Compared to the traditional RMS Herbst, the telescopic MTH Herbst resulted in a smaller number of clinical complications during Class II skeletal malocclusion therapy.

ACKNOWLEDGMENT

We would like to thank Dr Alexandre Moro for his useful information regarding lateral excursion of the mandible with the PMA appliance.

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