Proper teeth alignment is a fundamental objective of orthodontic treatment. The exact evaluation of the dental crowding and the space required to solve it is essential for the correct diagnosis and treatment planning. An index of crowding is also useful from other perspectives: public health programs, epidemiological studies, and post-treatment recurrence monitoring [1-8]. Additionally, a valid and reproducible crowding index would be useful for audit and research purposes. The degree of crowding in the dental arches is determined by the difference between the available space and the required space and can be expressed directly in millimeters or by an index [7]. Tooth - arch length discrepancy measurement is the most commonly used technique that evaluates the relationship between the available space of dental-alveolar arches and the required space to solve it. The first permanent molars and used digital calipers. The results showed the Lüdström method to be more reliable, reproducible and less time consuming.

Keywords: dental crowding, arch length, Nance method, Lüdström method
The aim of our study was to compare these two techniques and to determine the most accurate, reliable, reproducible and rapid method to be used.

**Experimental part**

**Material and method**

The study was carried out on 60 patient’s study casts. Including criteria were: age between 6 and 12 years old, mixed dentition, no previously orthodontic treatment, correctly molded casts with completely erupted dental units, no fractures or injuries caused by carious lesions. The materials used were: soft brass wire 0.012”, scale, digital Vernier caliper (Mitutoyo Corporation, Japan) and a stopwatch. Tooth - arch length discrepancy was measured on every cast using two methods, Nance and Lündstrom consecutively, by a single examiner. Digital Vernier caliper was used in the Lündstrom method, digital Vernier caliper, brass wire and scale were used in the Nance method. The measurement time was recorded with the stopwatch for each individual method. For both methods the ideal perimeter was calculated using a prediction chart. The measurements were resumed in two other stages by the same examiner at two weeks’ intervals. Mean values, standard deviation, random error using Dahlberg formula, systemic error using t-Student test and Pearson correlation coefficient were calculated for each method.

**Results and discussions**

Measuring arch length the mean values were higher when using the Lündstrom method in both arches, 95.4 ± 4.3 compared with 78.2 ± 3.5 according to Nance method in the maxilla and 86.5 ± 3.3 compared with 69.1 ± 3.6 in the mandible. (Table 1) The same results were obtained when the degree of dental crowding was evaluated with a very significant difference in the mandible: 4.2 ± 7.2 according to Lundstrom compared with 1 ± 4.5 according to Nance method (table 1).

In terms of time spent per cast and per method to measure the dental arch length, Lündstrom method was more rapidly compared with Nance: 1.35 min versus 2.05 min.

**Random error**

By comparing the two methods, a lesser random error was obtained when using the digital caliper than the brass wire, both in upper and lower arch. In the upper arch, random error was of 0.59 mm and 0.86 mm when measuring the arch length and the dental crowding respectively, with the wire compared with 0.29 mm in both measurements using digital caliper. In the lower arch, random error was only 0.13 mm when Lündstrom method was used compared with 0.50 mm for the Nance (table 2).

**Systematic error** was significant with the Nance method: 0.60 mm in upper arch crowding and in both,

| Method     | Arch length (mm) | Dental crowding (mm) | Arch length (mm) | Dental crowding (mm) |
|------------|------------------|----------------------|------------------|----------------------|
| Maxilla (Nance) | 0.59            | - 0.17               | - 0.60*          |
| Maxilla (Lündstrom) | 0.29           | 0.29                 | 0.15             |
| Mandible (Nance)  | 0.30            | 0.30                 | 1.15*            |
| Mandible (Lündstrom) | 0.13          | 0.13                 | 0.15             |

Table 1: MEAN VALUE AND STANDARD DEVIATION OF DENTAL ARCH PERIMETER AND CROWDING

*SIGNIFICANT

Table 2: RANDOM AND SYSTEMATIC ERRORS

*SIGNIFICANT
lower arch length (1.18 mm) and degree of crowding (1.11 mm) (table 2).

Pearson correlation coefficient was very high in both methods but especially in Lündstrom method. The difference was more significant in the upper arch when the degree of dental crowding was calculated: \( r = 0.99 \) compared with \( r = 0.87 \) with the Nance method (table 3). Limiting the study to completion by a single examiner significant errors can appear.

| Method          | Arch length | Dental crowding |
|-----------------|-------------|-----------------|
| Maxilla (Nance) | 0.92        | 0.87            |
| Maxilla (Lündstrom) | 0.98        | 0.99            |
| Mandible (Nance) | 0.96        | 0.94            |
| Mandible (Lündstrom) | 0.99        | 0.99            |

Table 3

PEARSON CORRELATION COEFFICIENT (r)

Random errors occur as a result of unpredictable factors that may be associated with the limitations of the work equipment, the technique used, or the practitioner's experience in reading the instrument results and affect each measurement differently. According to the Houston study, the main source of random error occurs because of the difficulty of identifying or defining reference points for measurements. When measurements are repeated, it is difficult to reposition the instruments exactly in the same position [16]. In our study, lower values of random error were obtained using the Lündstrom than using the Nance method. These results are supported by another comparative studies between the two methods did by Machado, Battagel, Bathia, Harisson et al [17,18]. Opposite results were obtained by comparing the two methods with the electronic microscope, the wire method recording lower values of random errors [19]. The systematic errors that occurred during Lündstrom's study model analysis were insignificant in both the arch perimeter measurement and the dental crowding estimate. Instead, they were detected during Nance’s analysis, making this method less reliable [17]. The current study showed a higher degree of reproducibility of the digital caliper method compared to the wire method following the three steps of resuming the measurements as confirmed by other studies, too [20-37].

Conclusions

No large differences were found between the two methods in terms of random errors. Instead, from the perspective of systemic errors, the Nance method is considered inappropriate for measuring available space and assessing dental crowding. The results reported a higher degree of reproducibility of the Lündstrom than the Nance method and a shorter completion.

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