ACCURACY OF THE INITIAL DIAMETER OF FINISHING FILES AND GUTTA-PERCHA CONES OF THE PROTAPER UNIVERSAL® SYSTEM

Manoela Teixeira de Sant'Anna **Dadalti**[1], Fabíola **Ormiga**[1], Marcos César Pimenta de **Araújo**[1], Patrícia de Andrade **Risso**[1*]

[1]Departamento de Clínica odontológica da Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

Palavras-chave: Acurácia da Medição Dimensional. Cone de Guta-percha. Instrumentos Dentários. Instrumentos Rotatórios de Ni-Ti.

RESUMO

Objetivo: Analisar a acurácia do diâmetro inicial dos instrumentos de acabamento do sistema ProTaper Universal® e seus respectivos cones de guta-percha. **Método**: Foram utilizados instrumentos de acabamento do sistema ProTaper Universal® F1, F2, F3, F4 e F5 e cones de guta-percha ProTaper correspondentes (10 de cada). O projetor de perfil foi usado para avaliar o diâmetro inicial dos instrumentos e cones. Todas as medições foram feitas duas vezes por um único operador treinado. Uma análise descritiva do diâmetro inicial dos instrumentos foi realizada considerando o limite de tolerância proposto pela ADA número 101. De acordo com essa norma, os instrumentos F1, F2 e F3 tem um limite de tolerância de ± 0.025 mm e os instrumentos F4 e F5 ± 0.05 mm. O mesmo limite de tolerância foi utilizado para avaliar os cones. Os diâmetros iniciais dos instrumentos e cones estudados foram comparados com os valores nominais dados pelo fabricante através do teste T (pd"0.05). **Resultados**: Foi verificada acurácia somente do cone de guta-percha ProTaper do grupo F5 (p>0,05). Nenhum grupo de instrumento de acabamento apresentou acurácia (pd"0,05). Foi verificado que 30% (n=15) dos instrumentos de acabamento e 20% (n=10) dos cones excederam o limite de tolerância. **Conclusão**: Acurácia não foi verificada em nenhum instrumento ProTaper Universal® e somente o cone F5 apresentou acurácia. A maioria dos instrumentos e cones estavam dentro do limite de tolerância proposto pela ADA.

Keywords: Dimensional Measurement Accuracy. Gutta-percha Cone. Dental Instruments. Ni-Ti rotary files.

ABSTRACT

Objective: to assess the accuracy of the nominal initial diameter of ProTaper Universal® finishing files and their respective gutta-percha cones.

Method: ProTaper Universal® finishing files, F1, F2, F3, F4 and F5 and corresponding ProTaper cones were used (10 of each). A Profile Projector was used to evaluate the initial diameter of files and cones. All measurements were repeated twice and performed by a single trained operator. A descriptive analysis of the files' initial diameters was performed considering the tolerance limit established by the ADA number 101. According to this standard, the files F1, F2 and F3 have a tolerance limit of ± 0.025 mm and the files F4 and F5 ± 0.05 mm. The same tolerance limit was used to evaluate the cones. The initial diameters of the instruments and cones studied were compared with the nominal values given by the manufacturer through Student's T test (pd"0.05). **Results**: No finishing file group showed adequate accuracy (pd"0.05). Accuracy was verified only from the F5 ProTaper cone group (p> 0.05). It was verified that 30% (n=15) of the finishing files and 20% (n = 10) of the cones exceeded the tolerance limits. **Conclusion**: Accuracy was not observed for any file and it was identified only in the F5 ProTaper Universal® cone. Most files and cones were within the tolerance limits established by the ADA.

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***Corresponding author:**
Patrícia de Andrade Risso
Address: Prof. Rodolpho Paulo Rocco, 325, 2º andar - Cidade Universitária, Rio de Janeiro, RJ, Brasil, CEP: 21941-913
Telephone number: +55 21 3938-2032
E-mail: patriciarisso@ufrj.br

INTRODUCTION

Although there are specific standards for the manufacture of standardized files and gutta-percha cones,[1] studies have reported variability in the diameter and taper of both.[2-4] This variation may lead to errors such as difficulty in reaching the working length of the subsequent file,[5] facilitating apical transportation,[5]and difficulty in choose master cone and during the filling.[6]

The rotary files have a specific diameter and taper, so manufacturers offer in gutta-percha points for each system. Different studies have been published for the purpose of evaluating the diameters and taper of these systems.[7,8-11] According to some studies, the actual diameters of the files and cones differ from the nominal diameters .[7,8,10,11]

Among the rotary systems available, the ProTaper Universal® system (Dentsply, Maillefer, Ballaigues, Switzerland) stands out for its widespread use even after the release of the ProTaper Next® system (Dentsply, Maillefer, Ballaigues, Switzerland), a new version of ProTaper Universal®. In this system, the nominal values of the initial diameter (D_0) and the taper as a percentage are informed. Among the studies that evaluated the diameter of ProTaper Universal® files and cones,[4,9-11] Chesler et al.[9] evaluated the F3 files and reported that they had a diameter smaller than the nominal diameter. Islambasic et al.[11] verified that the F2 files did not have values similar to nominal. Castilho et al.[4] evaluated the D_0 diameters of F2 and F3 cones and verified that all had appropriate values. However, the authors considered a tolerance limit of ± 0.01 mm. Oliveira et al.[10] evaluated the F1, F2 and F3 cones and found that the F2 and F3 cones did not meet the ANSI/ADA number 78 recommendations and presented several types of defects.

The authors are not aware of any studies that evaluated the D_0 diameter of F1, F4 and F5 files and the gutta-percha cones F4 and F5. Thus, this study aimed to assess the accuracy of the D_0 diameter of ProTaper Universal® finishing files and of the respective gutta-percha cones.

MATERIALS AND METHODS

In the present study, ProTaper Universal® finishing files F1, F2, F3, F4 and F5 and corresponding ProTaper cones were used (10 of each) of varied batchs.

A Nikon Profile Projector (6C-2 - Nippon-Tokyo, Japan) was used to evaluate the D_0 diameter of files and cones. For this, the files and cones were positioned on the table of the profile projector with the aid of utility wax (Technew, Brazil) to confer stability. The "Shadow" option of the equipment was chosen to perform file and cone measurements through the projected shadow on the screen.

The baseline of the profile projector, which is represented by a horizontal line projected on the screen, was positioned tangentially to both the upper (Figure 1) and the lower profiles of the samples. The measurements recorded in the upper and lower profile of the D_0 were subtracted, establishing the diameter through the vertical movement of the table. Due to oscillations of the projected profile of the ProTaper Universal® files, the baseline was adequate through the tangent formed by the turns closest to D_0. All measurements were repeated twice and performed by a single trained operator.

The nominal D_0 diameter of the ProTaper Universal® F1, F2, F3, F4, and F5 files and cones are 0.20 mm, 0.25 mm, 0.30 mm, 0.40 mm and 0.50 mm, respectively. A descriptive analysis of the files' D_0 diameters was performed considering the tolerance limit established by the ADA guidelines number 101.[12] According to this standard, the files F1, F2 and F3 have a tolerance limit of ± 0.025 mm and the files F4 and F5 ± 0.05 mm. There is no standardization for the cones' corresponding rotary files. Thus, the same tolerance limit that was used for the files was also used for the cones.

The data were analyzed using the SPSS 16.0 program (IBM

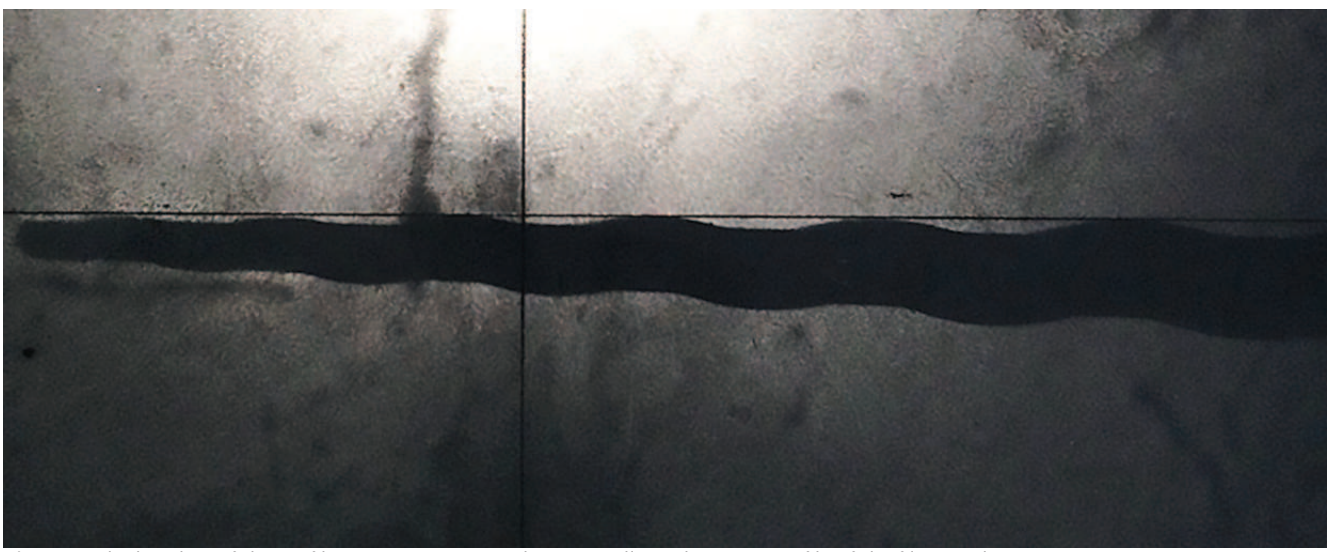

Figure 1: *The baseline of the profile projector positioned tangentially to the upper profile of the file sample.*

SPSS Statistics, Chicago; USA). The mean and standard deviations of the D_0 diameters were determined and the accuracy of the files and cones within each group was evaluated through Student's T-Test. The level of statistical significance was 0.05.

RESULTS

Table I and Table II shows the means and standard deviations of the D_0 diameters of the ProTaper Universal® files and cones, respectively. The files groups F1, F4 and F5 presented mean values lower than the nominal diameter. All cones groups presented mean values higher than the nominal diameter. While No finishing files group showed the desired accuracy (pd"0.05). It was verified that only the ProTaper gutta-percha cone F5 group were dimensionally accurate (p>0.05).

Table III presents a descriptive analysis considering the tolerance limits of the files and cones. Only the cones F5 group presented all the samples within the tolerance limit followed by the file group F1 and the cones groups F2 and F4 that presented 90% of the sample within the tolerance limit. It was also verified that there was a tendency for the files to have lower actual diameters in groups F1, F4 and F5 and for the cones to have actual diameters higher than nominal.

***Table 1**: Mean and standard deviation (SD) of the D_0 diameter of the ProTaper Universal® files (mm)*

Sample	F1	F2	F3	F4	F5
1	0.195	0.283	0.319	0.406	0.491
2	0.156	0.260	0.313	0.356	0.489
3	0.185	0.260	0.319	0.370	0.488
4	0.207	0.309	0.339	0.323	0.502
5	0.184	0.197	0.313	0.412	0.480
6	0.193	0.239	0.315	0.365	0.391
7	0.197	0.272	0.328	0.355	0.454
8	0.192	0.306	0.319	0.371	0.463
9	0.197	0.219	0.303	0.367	0.411
10	0.179	0.284	0.326	0.333	0.420
Mean	0.189	0.263	0.319	0.366	0.459
SD	0.014	0.036	0.010	0.028	0.039

***Table 2**: Mean and standard deviation (SD) of the D_0 diameter of the ProTaper Universal® cones (mm)*

Sample	F1	F2	F3	F4	F5
1	0.266	0.250	0.323	0.426	0.518
2	0.214	0.266	0.302	0.409	0.497
3	0.249	0.255	0.298	0.459	0.515
4	0.225	0.260	0.332	0.409	0.510
5	0.203	0.272	0.347	0.435	0.450
6	0.244	0.262	0.299	0.422	0.512
7	0.238	0.297	0.299	0.438	0.493
8	0.217	0.261	0.320	0.387	0.488
9	0.271	0.253	0.322	0.445	0.523
10	0.221	0.254	0.337	0.416	0.511
Mean	0.235	0.263	0.318	0.425	0.502
SD	0.023	0.014	0.018	0.021	0.021

***Table 3**: Frequency of files and cones that were within tolerance limits*

Group	F1	F2	F3	F4	F5
Files	9[a]	4[a]	7[a]	8[b]	7[b]
Cones	5[a]	9[a]	7[a]	9[b]	10[b]

***Note**: [a]tolerance limit of ± 0.025 mm; [b]tolerance limit of ± 0.05 mm*

DISCUSSION

The rotary files and their respective gutta-percha cones may exhibit dimensional variability, presenting diameters higher or lower than the nominal specifications.[9,10] These variations may cause errors in instrumentation such as apical deviation[5] and difficulty in selecting the master cone at obturation.[3] Although the ProTaper Universal® system is widely used, few studies have evaluated the actual diameters of its files and cones.[4,9-11]

In order to measure the files' and cones' D_0 diameters, a profile projector was used as it allows accurate and reliable measurements.[10,13] However, other studies have used methods such as digital imaging obtained by an optical microscope,[14] a measuring microscope,[3,8] a scanning electron microscope [11] and a digital caliper.[4] Only D_0 was measured because the accuracy and consequent compatibility of files and cones in this regard have a direct influence on the quality of apical sealing. [4]

The absence of accuracy was verified from the results of the present study for all groups of finishing files and cones of groups F1, F2, F3 and F4. A similar result was observed by Chesler et al.[9] when evaluating the ProTaper F3 files and by Islambasic et al.[11] when evaluating ProTaper F2 files. It was also verified that there was a tendency for the files to have lower actual diameters in groups F1, F4 and F5 and for the cones to have actual diameters higher than nominal. The same finding was verified by Chesler et al.[9] when evaluating the ProTaper F3 files and Oliveira et al. (10) when evaluating the ProTaper F1, F2 and F3 cones. This incompatibility may hamper the obturation time, as well as introduce errors during instrumentation.[5,6,10]

In the present study, the tolerance limits proposed by ADA number 101 [12] were used, which states that the diameter of the nickel-titanium files should be within 50% of the difference of the nominal diameter of the next smaller file and/or of the next larger file. Considering this tolerance limit, 30% (n=15) of the finishing files exceeded this limit. However, there is no standardization for the cones' corresponding rotary files. Thus, the same tolerance limit that was used for the files was also used for the cones.[12] It was verified that 20% (n=10) of the cones exceeded this limit. In contrast, Castilho et al.,[4] when establishing the tolerance limit of ± 0.01 mm, verified that no cones from the F2 or F3 groups exceeded that limit. Another study verified that 75% of the ProTaper cones F2 were within the tolerance limit of ± 0.07 mm. [9] The use of different values of cones tolerance limit between studies,[4,9] makes it difficult to compare them.

In the present study, the diameter variability beyond the tolerance limits of files and cones can be considered to be high. This suggests the need for greater control over the manufacturing processes to ensure better standardization of files and cones. In addition, clinical studies should be performed taking into account factors such as shape and dimension of canals, since in this study only the virtual space created by the files was evaluated and the cutting capacity of the dentin was not taken into account. Due to the lack of accuracy inherent to most cones, we recommend that dental professionals be prepared for any difficulties during the selection of the master cone.

Based on the results of the present study, dimensional accuracy was verified only for the ProTaper Universal® F5 gutta-percha cone. No ProTaper Universal® finishing files exhibited complete accuracy. Most files and cones were within tolerance limits.

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