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EVALUATION OF CYCLIC FATIGUE RESISTANCE OF THREE PATH FILES IN S-SHAPED SIMULATED CANAL

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ABSTRACT

The cyclic fatigue resistance of m-pro, M3pro gold, and RaCe glide path files were investigated in a double curved simulated canal. 10 files from each group were examined. The files were tested in s-shaped groove prepared in a block made of stainless steel simulating a double curved root canal. Cyclic fatigue resistance was assessed by counting the number of cycles of separation (NCS). Moreover, the lengths of the separated parts were calculated. All data were analyzed by the one-way analysis of variance. RaCe Scout files showed higher (NCS) significantly compared to m-pro and M3pro gold (P<0.00L) but when compared with each other, no significant difference (P=0.68). According to the results of this study Scout RaCe files had the highest cyclic fatigue resistance in double curved simulated canals among the three types evaluated, therefore, Scout RaCe Files could be used with more trust in preparing of S-shaped canals as the first step of clinical chemo-mechanical preparations.

Keywords : glide path files; chemo mechanic preparation; s-shaped canal

INTRODUCTION

Many significant problems in root canal treatment are related to root canal complexity [1-3]. Curvature of multiple root canals are one of these challenges [4-6]. In human teeth even, a small degree of root canal curvature is a role, straight canal is an exception. Complex curvature is frequently present [4]. Chemo mechanical preparation of curved root canals in three dimensional directions is very hard and prone to a multiple iatrogenic error. Double curvature canals **(s-shaped)** stressed the Ni Ti rotary files more than the single curvature ones. In double curvature canals, rotary files are more easily separated and cyclic fatigued [7]. When curved canals are shaped, establishment of a glide path prior to working with large files is very helpful. A smooth and more centered glide path tunnel from the orifice to the apex minimized the instrumentation errors [8]. In double curved canals, glide path establishment using manual files may be so difficult, a less centered configuration, time consuming [10], extraction of a

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special debris [11], post-operative pain and delayed healing [12]. A glide path in comparison to manual ones [13]. Many NI TI glide path rotary files are present in the market as a start for chemo mechanical preparation. Scout RaCe: three glide path files **#10-0.02, #15-0.02, and #20-0.02.** These files have a square cross section with altered pitch between their flutes and manufactured from conventional NI TI alloy [14]. M3 pro gold path files: three files **#10-0.02, #15-0.02, and #20-0.02.**

MATERIALS AND METHODS

By the aid of computer controlled milling machine and AutoCAD software **(Autodesk, San Rafael, CA, USA),** an artificial s-shaped canal was grooved in a stainless block to withstand frictional **wear (diameter at D16 mm=1.4 mm, at D0=1.3mm, Taper=0.06, length=19mm, depth=1.5 mm, the coronal curvature (60o-5mm radium)** located 7mm from the tip of the file and the apical **curvature (70o-2mm radium)** located 3 mm away from the tip **(figure 1).**

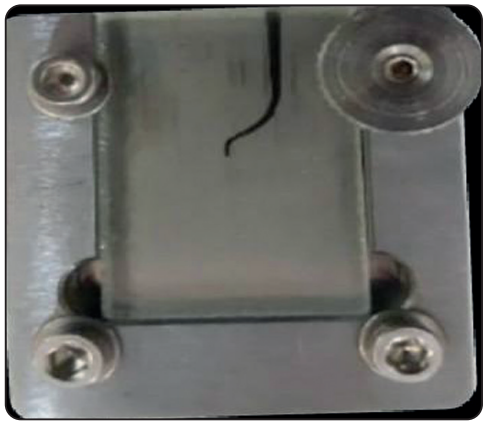

Fig. (1)

A transparent glass **(5mm thickness)** was screwed over the model to observe the file while worked until separation and to prevent the file from slipping out. In our study, these rotary Ni Ti glide path instruments were evaluated **(n=10 each).** RaCe **(tip size :15 – Taper 0.02) (FKG Dentaries La Chaux de Fonds, Switzerland).** M3 pro gold **(United Dental, Shanghai, China) (#13-0.02, #16-0.02, and #19-0.02).** m-pro glide path files **(M-pro, LWD, Guangdong, China).**

To assess the cyclic fatigue in a static mode, an endodontic hand piece **(1:16 reduction ratio NSK Endo-Mate Dt, Nakanishi, Inc.)** was fixed above the St. St. block to avoiding picking movement. The artificial canal was fully flooded with the lubricant to minimize the frictional heat generation. All the glide path files were allowed to work free inside the simulated s-shaped canal at 500 rpm speed and 2.5N/cm torque to standardize the study.

File separation was observed visually through the transparent glass cover and by the computer software automatically. The time (in seconds) was recorded from the start of rotation till the moment of separation. The total number of cycles to separate **(NCS)** was obtained as follows:

NCS= time if separation in minutes X number of rotation per minute.

For each instrument, the separated segment length was measured by a digital caliper with a restoration of 0.01 mm **(Pinrui, Digital LCD Caliper, Shanghai, China).**

Statistical Analysis

One-way analysis of variance was used to analyze our numerical data. The significant differences between the three groups were determined by SPSS version 20 for windows **(IBM Corp. Armonk, NY, USA)**. The significance level was set at **(P≤0.05).**

RESULTS

A statically significant difference was found between the RaCe glide path files and the other groups, with the scout RaCe groups showed a higher NCS than M3 and m-pro groups. However, there was no statically significant difference between M3 and m-pro glide path files fig.2

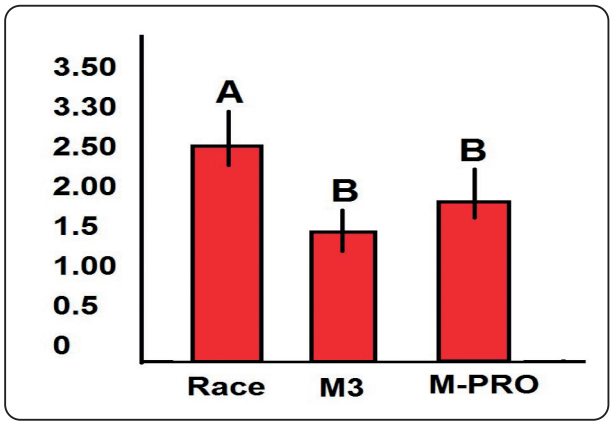

Fig. (2)

Many files were separated at the coronal curvature. Three files of m-pro and two files of M3 were separated at the apical curvature. One file of Scout RaCe separated only after two seconds that may attribute of two experimental group are shown in fig.3

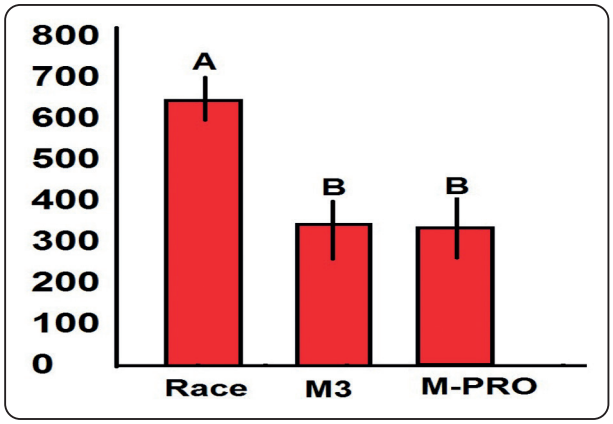

Fig. (3)

DISCUSSION

The risk of files separated inside the root canals affected by many factors such as alloy type, rotational speed, curvature design and radius of curvature and the operator skills [14-15].

The initial step of chemo mechanical preparation is obtaining a smooth glide path. Establishment of the glide path minimizes the torsional stresses on the Ni Ti files and the needed torque to rotate [20-21] this could decrease the risk of file separation [22]. Cyclic fatigue resistance of NiTi rotary files increases in single curved root canals and separation occur in large times when compared to double curved ones [7]. Regarding the glide path files, the same could expected. The S-shaped curved design was selected in this paper due to the great difficulties in the preparation of such cases, also its negative effect on the NiTi cyclic fatigue resistance when compared with the single curved ones [7]. Root canal preparation errors like ledge, zipping and transportation reduced significantly when the operator established a smooth glide path as a first start [23-25]. When rotary glide path files where used alternatively to the manual glide path files, the working time was significantly short [26-27].

Although using the extracted teeth could be the ideal way to investigate the cyclic fatigue resistance to simulate the clinical situation, limitation of this is that you need one tooth for each test [16] because the shape of root canal altered during preparation leading to non-standardized experimental condition. In this study, the artificial St. St. groove was used for more standardization [7, 13, 15]. The glide path files could fit loosely in the St. St. groove; this may be a disadvantage of testing the cyclic fatigue in the stainless-steel models [28]. Clinical situations may not encounter such condition. In this study, Scout RaCe files showed the highest **(NCS)** which were significantly higher than the M3 pro gold and m-pro gold path files, so the null hypothesis was rejected. Alloy materials, thread number, cross section, helical angles, small tip size, Taper and heat treatment have an impact on the cyclic fatigue resistance and flexibility of the files [29, 30, 31, 32, 33].

Although the glide path RaCe files were made of conventional NiTi alloy, their superior flexibility may be due to the taper of these files **(0.02)** [36]. Furthermore, these files were coated with a homogeneous and smooth protective oxide

layer **(surface electro polishing)** which reduce the surface defects subsequently the residual stresses [15]**.** In this study, no significant difference was seen between the **(NCS)** of M3 pro gold and m-pro files. M3 pro-gold glide path files are Chinese files that were recently introduced into the market and manufactured from CM wire: controlled memory with 0.02 constant taper. The cyclic fatigue resistance of these files may be due to the material and technique of fabrication, constant taper and the decreased torque used. M-pro rotary glide path files were constructed from x-wire with special treatment and pre-bending ability showed a lower (NCS) than RaCe files. These results are on the contrary with those reported by many papers [20, 22, 25,26,27,28] who reported that controlled memory files were more resistant to cyclic fatigue than other traditional files. Although, the thermo mechanical treatment allowed a more stable crystal line structure arrangement

and improved mechanical strength, RaCe glide path files were significantly more resistant to separation than m-pro files (3-31).

The success of the bypassing or extracting affected greatly by the fragment length of the separated file, so it has been focused in this paper, RaCe glide path files had the longest separated part among the investigated files (2-3 mm average). Bypassing or extracting separated files of length longer than 5mm is much easier [37]. In my paper, most of glide path files separated at the first curvature regardless of the instrument diameter. Diameters of the instruments were calculating at the level of separation, all the glide path files separated at a diameter level of 0.186 – 0.197 mm. further papers were required investigating the level of separation.

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