

EVALUATION OF CROSS-SECTIONAL CONFIGURATION OF A BRAND OF STAINLESS STEEL K FILES

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Abstract

Objectives: To determine the cross-sectional design of handheld stainless steel K files (Mani, Inc. Japan), acquired from Pakistan and the United Kingdom, in accordance with the manufacturers' design. This study was conducted at the Institute of Space Technology, Islamabad, over a period of one month

Materials & Methods: A total of 40 stainless-steel K files (Mani, Inc. Japan) of identical size (ISO#25), were collected and divided into two groups. Group A consisted of 20 K files purchased from the Rawalpindi/Islamabad city in Pakistan, while Group B consisted of 20 K files that were purchased from London, United Kingdom. The cross-sectional design of the two groups of files was evaluated using a scanning electron microscope.

Results: Both the groups of files had a square cross-sectional shape.

Conclusion: Cross-sectional shape of the files identified well with the design intended by manufacturers.

Key Words: Cross section, stiffness, cutting efficacy

Introduction

Stainless steel K-files, basically cutting instruments used for root canal debridement and shaping are the strongest of the handheld files, bypassing obstructions with far greater ease and are produced to give the operator a smooth tactile sensation within the canal during instrumentation¹. Stainless-steel prototypes are characterized by five different cross-sectional shapes (square, triangular, rhomboidal, "S"-shaped, and the cross-sectional design of H-type files). The cross-sectional configuration of an instrument delivers information regarding its stiffness, strength, and cutting efficacy². K files were introduced by the Kerr Company in 1915 by grinding square or triangular cross sections into stainless steel blanks and rotated to create a spiral shape on the file's working surface². Traditional stainless steel K files

are square shaped. Flexoiles, more flexible variety of stainless steel files, are made from triangular blanks for flexibility in curved canals. Another type of hand file, the Hedstrom file, is manufactured by cutting triangular segments out of a round blank².

The design of different instruments dictates the manner in which they can be used most efficiently. Several studies have been done in the past to evaluate the cross-sectional designs and areas of numerous brands of handheld and rotary endodontic files, to extract their maximum cutting and debridement benefit³. Oliet and Sortin found that instruments formed from triangular blanks cut more efficiently than those made by twisting a square blank⁴. Schäfer, E. et al., and Sargent, J., et al., found an exponential relationship between the cross-sectional area/design and stiffness of endodontic files⁵. They concluded that as the area is increased, stiffness increases. Camps and Pertot substantiated these findings almost 30 years later when they established that stainless steel K files, having a square cross-section were significantly less flexible than rhombus cross-sectional K files, which

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was less flexible than triangular cross-sectional Flexoiles⁶.

Some of the possible complications of root canal treatment include root fracture or crown fracture, post-op infection, instrument breakage within the canal, perforating the side of the root, canal zipping and ledges, recurrent decay, tooth colour changes, post-op pain or swelling⁷. Efficacious endodontic treatment is governed by a set of systematic techniques including proper instrumentation, successful irrigation, decontamination and filling of the root canal system, each requiring a high level of efficiency⁷. The clinician must take into account the information regarding the instrument geometry including measurement specification and cross-sectional configurations since these variables play a crucial part in maintaining the integrity of a file and the outcome of endodontic treatment⁸. Inefficacy in attending to these requirements may lead to an increased probability of instrument failure and poor prognosis⁸.

Traditional stainless K files are generally square shaped. However, the availability of non-standardized endodontic files in local markets makes it essential to confirm their cross-sectional configuration in accordance with the manufacturers' design, before putting them to clinical use⁹. In one such study conducted by D Souza, J.E., et al., cross-sectional shapes of three brands of endodontic files were evaluated and compared with the manufacturers' design. Data showed that overall the cross-sections compared well with the designs intended by the manufacturers⁹.

Reported discrepancies in the geometric designs of stainless steel endodontic files call attention towards strict adherence to the available standards to avoid any untoward clinical occurrences¹⁰. Therefore, this study was aimed at evaluating the cross-sectional configuration of a brand of stainless K files (Mani Inc. Japan), acquired from Pakistan and the United Kingdom. Files from one particular brand were selected because of the availability of non-standardized and poorly machined files of this brand in the local and international markets¹⁰.

Materials and Methods

The description of the files used for the testing purpose in this study is given in table 1

Files from each group were analyzed for the determination and comparison of cross-sectional shapes. The samples were prepared by separating the handles and sectioning the files at 3mm from the tip¹¹. The files were then mounted on Bakelite using Metkon, Metapress-M mounting press.

The hot mounting press technique was used which consists of mounting specimens under heat and pressure to produce specimens with uniform sizes. The files were placed in the plunger which was then filled with Bakelite powder. The mounting procedure was carried out at 170--190°C for 4 to 8 minutes. The mounting cycles consisted of three files each. After retrieving the mounted instruments from the press, they were subjected to grinding and polishing to obtain a flat surface. For this purpose a device manufactured by Metkon, model Forcipol 2V was used.

It has two discs and a variable speed range between 50-600rpm. Rpm was adjusted followed by fitting of emery paper. Grinding and then polishing was continued until a smooth mirror-like the surface was obtained.

The cross-sectional shapes of the files were then determined using a scanning electron microscope at 500x (TESCAN Mira-3; Field emission scanning electron microscope¹¹. (Czech Republic. High resolution imaging, 1.2nm at 30 kV; magnification range, 2x to 10,000,00x).

Results

SEM examination of the cross-section of the files belonging to groups A and B revealed a square-shaped surface in all the samples. Figures (1) and (2) show the cross-sectional shapes of files belonging to Group A and Group B, respectively.

Discussion

Cross-sectional analysis in this study showed that stainless steel K files in both the groups had a square cross-section, in confirmation with the previous studies^{12,13}. In general, the cross-sectional shape is responsible for the bulk of the instrument, the area of contact between the instrument and dentinal walls, its flexibility and cutting efficacy¹². Square

Table 1: Patterns and etiology of redicular cyst

Groups Assigned	Country of Purchase	File Specification	Number of Files	Manufacturer	Lot Number
Group A	Pakistan	Stainless steel K files 21mm #25	20	MANI, INC. 8-3 Kiyohara Industrial Park. Utsunomiya, Tochigi. Japan	R151412100
Group B (Control Group)	United Kingdom	Stainless steel K files 21mm #25	20	MANI, INC. 8-3 Kiyohara Industrial Park. Utsunomiya, Tochigi. Japan	R110868200

Fig: 1 The Cross-sectional shape of a Group A ile

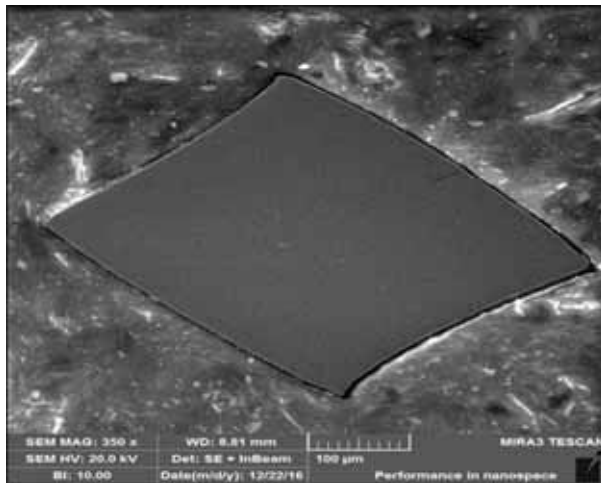
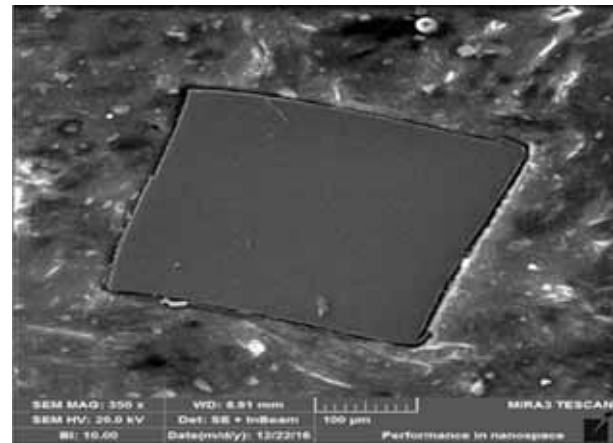


Fig: 2 Cross-sectional shape of a Group B ile



shaped stainless steel K files, having the larger cross-sectional area, have 37.5% more metal mass than triangular cross-sectional files. Consequently, they are stiffer, have higher bending moments and therefore can resist higher amount of stresses^{6,12}. However, they have reduced cutting efficiency as compared to the triangularly shaped instruments. The well-recognized cutting performance of triangular cross-sectional files is ascribed to the fact that a smaller blade angle (60 degrees) interacts with the dentinal walls, thus terminating in a better cutting action, as compared to a 90-degree blade angle in the square cross-sectional files¹⁴. Furthermore, with their increased flexibility and small bending moment, they are superior to square-shaped files regarding better angular deflection at failure¹⁵.

As the canal curvature increases and the contact area with the canal walls becomes greater, instruments are imperilled to greater stresses¹⁶. Triangular-

ly shaped instruments with their smaller cross-sections are, therefore, more appropriate for curved canals with lesser chances of transportation as compared to the larger and stiffer square cross-sectional files¹⁶. Stiffer instruments exert lateral forces which cause the instrument to straighten in curved canals, thus increasing the incidence of instrument fracture. These forces are particularly accentuated at the commissure of the instrument tip and its cutting edges³. The subsequent transportation and canal anomalies (comprising ledges, zipping and perforations) may leave a major segment of the canal wall un-instrumented, besides creating an uneven cross-sectional form that is difficult to obturate³. Moreover, if a file nearly lodges the entire root canal volume, the cut dentin chips during apical advancement cannot be coronally removed due to space restriction; the dentin chips are hence shoved apically and may result in loss of the working length and apical patency¹⁷. This may also lead to choking of the cutting blades, thus

reducing the cutting efficacy of the instrument⁷.

From the above discussion, it is clear that different types of handheld endodontic files come with their pros and cons, owing to their cross-sectional designs¹¹. However, the availability of sub-standardized endodontic files in the local and international markets make it difficult to predict their clinical efficiency⁹. Selection of appropriate endodontic instrument, based on the knowledge of their design and working characteristics is therefore essential to ensure the successful clinical outcome of endodontic treatment. Information regarding the cross-sectional area and design of the instrument gives the clinician the ability to choose the desired instrument about the canal anatomy³. Within the limitations of this study, the cross-sectional area and its effect on the bending moment of the files could not be tested. Further studies on evaluating the effect of cross-sectional configurations on the bending flexibility of the files are required to evaluate how these files would react to forces in-vivo.

Conclusion

Files belonging to both the groups had a square cross section, identifying well with the design intended by the manufacturer.

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