ProTaper Ultimate®

SCIENTIFIC MANUAL

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Dentsply Sirona

ProTaper Ultimate®

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1 ProTaper Ultimate® solution description, with a focus on files

Successful endodontic therapy requires shaping, cleaning and obturation of the root canal **[1]**. The necessary mechanical preparation of the canal generates debris and a smear layer, that can compromise the seal of the root canal filling. The removal of the debris and the smear layer by irrigation is less predictable in the apical part than in the coronal part of the canal and can be significantly influenced by the shape of the apical canal **[2]**. With ProTaper, Dentsply Sirona introduced the specific concept of Deep Shape (increased apical taper) to the market, in 2001. Consequently, the Deep Shape philosophy also became an inherent part of the new ProTaper Ultimate® file system and is obtained by the combination of specially designed files (Figure 1). The ProTaper Ultimate® rotary file system, launched in 2021, is the 5th generation of the ProTaper brand, and consists of a Slider, a Shaper and Finishers (F1, F2, F3, FX, FXL) **[3]**. The Slider is used to create a reproducible pathway to the apical/canal terminus and paves the way for the Shaper. The Shaper's hauling of debris in the coronal two-thirds provides an easy access to the apical third for the Finishers. The Finishers finally create the ProTaper Ultimate® Deep Shape. All files work at the same recommended motor speed of 400 rpm, and at the same torque range of 4 – 5.2 Ncm. A dedicated Hand-Use version is available for all ProTaper Ultimate® files with the same technical features as the rotary ones.

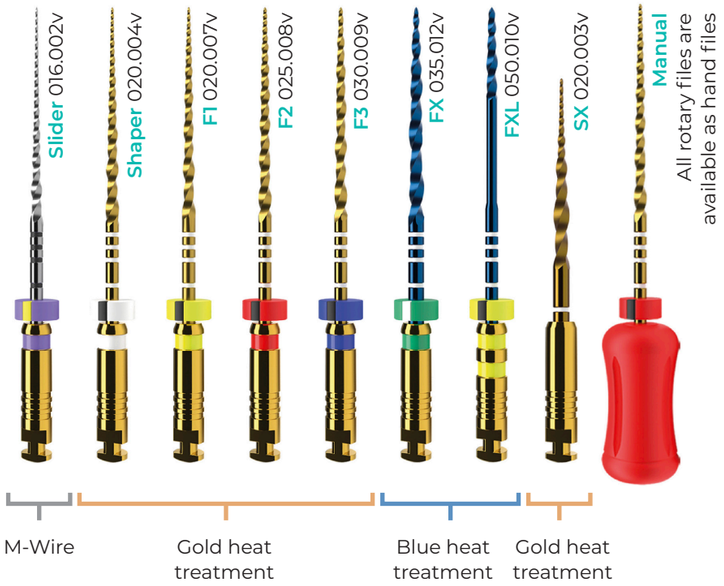


Figure 1:
Slider, Shaper and Finisher Files (F1/F2/F3). The assortment is completed by one Orifice opener (SX) and two auxillary Finishers (FX, FXL), numbers along the instruments provide the size and the taper.

To maintain the original ProTaper philosophy of Deep Shape, the Finisher files have an apical preparation size with a taper of at least 7% (F1: 7%, F2: 8%, F3: 9%). The F2 Finisher file, for example, creates a 19% higher apical volume compared to comparable ISO files **[4]**. The ProTaper Deep Shape leads to optimized hydraulics of the disinfection fluid **[4]** and better evacuation of the debris, preparing the canal for a better fill with reliable seal and less apical extrusion, while preserving the upper canal portion thanks to the multiple taper design.

A specific parallelogram cross section geometry with variable acute angles at different lengths of the instrument was applied on all files (**Figure 2**). This allowed to specifically adjust the cutting efficiency of each part of the file depending on the expected workload in certain areas during operation. By using specific alternating off-set machining manufacturing process, the files possess a geometry in which the center of mass of the instrument is not aligned with the center of rotation. This reduces the stress level during cutting and increases the available space for debris removal.

The key feature that sets the ProTaper Ultimate® sequence apart from previous ProTaper generations is its tailored heat treatment for each instrument function, developed for an optimal clinical performance (see **Figure 1**).

- The ProTaper Ultimate® Slider is made of M-Wire NiTi, known for its superelasticity, allowing the glide path instrument to navigate canal anatomy, but still stiff enough to withstand torsional stress.
- The shaper and finishers up to F3 are made of NiTi with a gold heat treatment, showing both martensitic and austenitic phases for improved flexibility and resistance to cyclic fatigue.
- The larger finishers, FX and FXL are made of blue heat treatment NiTi, known to be even more flexible and fatigue and torsional resistant than gold heat-treated NiTi **[5]**.

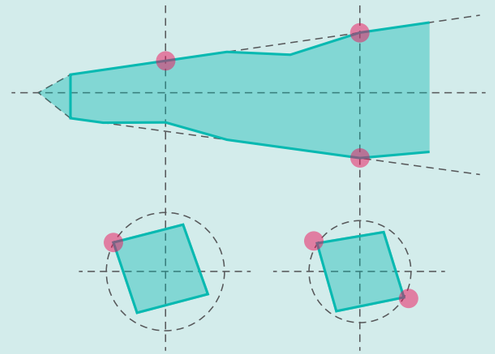


Figure 2:
Parallelogram cross section of ProTaper Ultimate® files. Variable acute angles are applied at different lengths of the file. The off-centered geometry in certain parts of the file was achieved by alternated off-set machining.

2 Key literature focus

The ProTaper brand is one of the most heavily researched endodontic NiTi system, with more than 1'800 scientific publications. The ProTaper Ultimate® system is the 5th generation and was launched worldwide in 2021. So far, 12 peer-reviewed scientific papers have been published and are available on PubMed on this endodontic system, with various topics of interest as shown in the **Figure 3** below.

This scientific manual provides a synopsis of the key published research findings on the ProTaper Ultimate® system with focus on performance aspects, defined as shaping ability, mechanical properties, and clinical cases. Each summary is based on facts retrieved from the original research article.

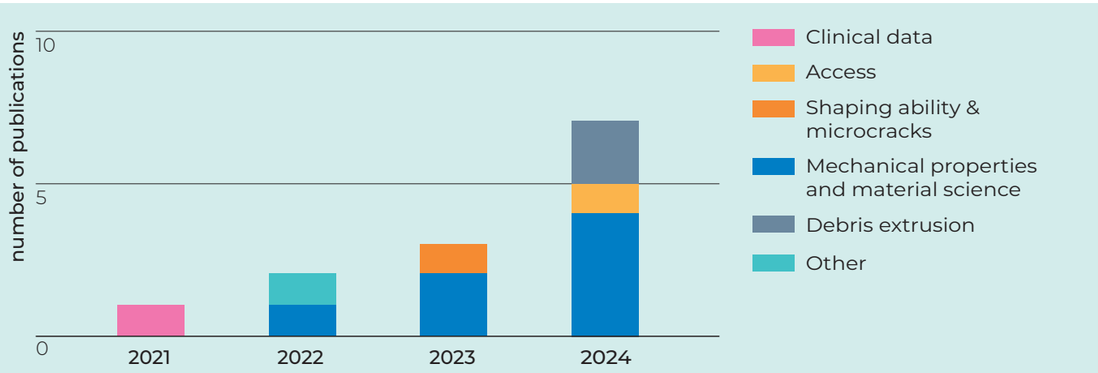


Figure 3:
Total number of publications on the ProTaper Ultimate® system.
From PubMed (key words : Protaper Ultimate, on December 2, 2024).
"Other" category means publications not in English, ProTaper Ultimate® not used according to IFU, or studies using ProTaper Ultimate® without focusing on it.

Apical debris extrusion

Even though some researches also focus on in vitro apical debris extrusion studies, they were excluded from this manual, as their study models are mostly obsolete, not incorporating the biological circumstances in which extrusion occurs **[6]**.

It is important to emphasize that conclusions drawn from the excluded studies on all topics did not reveal any compromised performance or safety when using ProTaper Ultimate® following the instructions for use.

* *Impact Factor means the yearly mean number of citations of articles published in the last two years in a given journal, reflecting the importance of the journal in the field. For example, in Dentistry, the Journal of Endodontics, the International Endodontic Journal, or the Journal of Clinical Medicine have an IF >4, as of 2024.*

3 Shaping ability

An ideal mechanical objective of root canal instrumentation is complete and centered incorporation of the original canals into the prepared shape, meaning that all root canal surfaces are mechanically prepared **[6]**. This theoretical goal is not achievable in most clinical cases, considering the complex internal anatomy of root canals.

Therefore, the “shaping ability” of endodontic instrument is often described in literature but without any clear definition of it. It is nonetheless often expressed as a minimal canal transportation, a good centering ability and a sufficient amount of root canal wall removed during canal preparation while retaining as much as possible cervical and radicular dentin **[7]**. In particular, one critical area is the peri-cervical zone around the cemento-enamel junction (see **Figure 4**) **[8]**. This area provides structural support to the tooth, distributing forces during chewing and preventing fractures. Preserving the peri-cervical zone during root canal treatment is essential to maintain the tooth’s strength and long-term functionality.

Microcomputed tomography (MicroCT) is the state-of-the-art tool for analysis of canal shaping outcomes, thanks to its non-destructive and reproducible analysis of high-resolution scans before and after treatment. In this section, two scientific studies are summarized, evaluating the “shaping ability” of ProTaper Ultimate® in terms of centering ability, peri-cervical zone preservation but also studying time to working length. A third study, focusing on the shaping ability of ProTaper Ultimate® but also exploring other scientific aspects, is already summarized in the previous section **[9]**, and revealed a good shaping ability, without any instrument breakages.

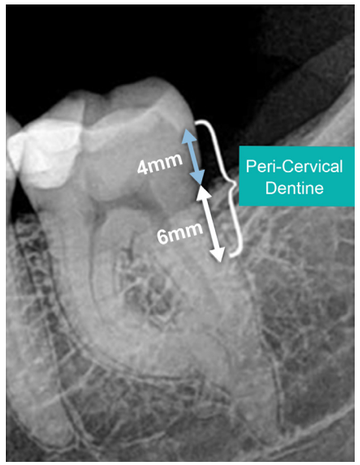


Figure 4:
Peri-cervical dentine **[8]**

Comparison of the shaping ability of contemporary instruments : ProTaper Ultimate® vs EdgeTaper Platinum® [10]

Authors: P. Riaza, V. Navarro, O.A. Peters, J.J. Perez-Higueras, A. Arias
Published in: study not published yet

In this ex vivo study, the preparation of 36 mesial root canals in mandibular molars with ProTaper Ultimate® or EdgeTaper Platinum® was compared (n = 18). A single operator with more than 25 years of experience in rotary shaping performed all the treatments. Each root canal in the same mesial root was randomly assigned to one of the two rotary systems tested. This way all mesial roots received both techniques in order to eliminate individual variability between specimens.

In terms of performance and safety, shaping ability was determined from microCT images. Firstly, each root canal was individually assessed for gross preparation errors (perforations, zips, ledges, instrument fracture). Secondly, changes in canal volume and surface area, percentage of shaped canal walls and degree of canal transportation were calculated and compared between the 2 different instruments. Time required to shape the complete canal with each of the instruments, as well as total preparation time was also compared between groups. Preoperative and postoperative photographs of all instruments were taken. Subsequently, a calibrated evaluator analyzed the images and determined the presence or absence of unwinding or deformation and the location of the deformation (measured in millimeters from the tip of the instrument).

The outcomes are:

Shaping ability:

- No statistically significant differences were detected for any of the variables related to root canal geometry (e.g. transportation, touched/untouched surfaces), between groups. At the same time, ProTaper Ultimate® exhibited similar percentage of untreated areas, while the mass of metal of the instrument is lower (mean value of 7% for ProTaper Ultimate® and 6% for EdgeTaper Platinum®). See **Figure 5** showing microCT 3D reconstructions.

- One gross preparation error was observed in one tooth treated with EdgeTaper Platinum®, showing an apical perforation (see **Figure 6**).

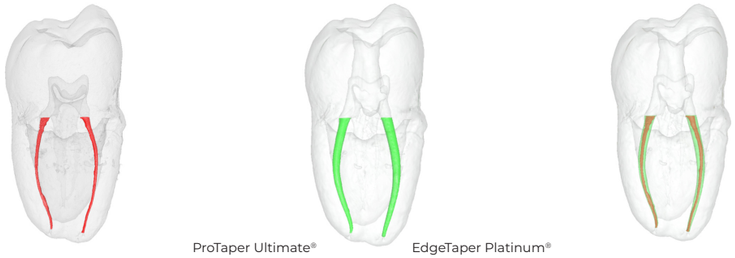


Figure 5:
The preoperative (red), post-operative (green) and superimposed images for evaluation.

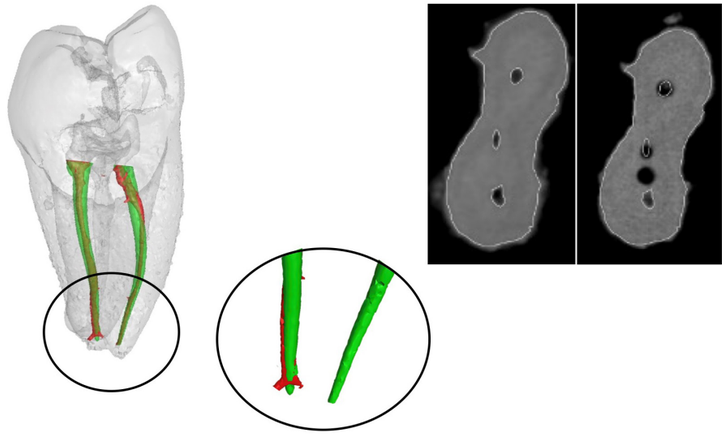


Figure 6:
On the left: *microCT 3D reconstruction showing the apical perforation in the EdgeTaper Platinum® group.*
In green: *the instrument shape.*
In red: *the original canal anatomy.*
In the middle: *microCT cross section, before shaping.*
On the right: *microCT cross section showing apical perforation with EdgeTaper Platinum®.*

Working time:

- The total working time was significantly shorter with the ProTaper Ultimate® system (p=0.02): 33 seconds for ProTaper Ultimate® sequence for shaping of one root canal, 52 seconds for EdgeTaper Platinum® sequence (see **Table 1**).

Plastic deformation, unwinding of instruments:

- No plastic deformation was observed in ProTaper Ultimate® instruments after shaping a single root canal.
- Significant differences were found between groups in the plastic deformation of the instruments after canal preparation (p = 0.009). While no instruments in the ProTaper Ultimate® group deformed during canal shaping, 34.4% of the instruments in the EdgeTaper Platinum® group exhibited deformation.
- No instruments fractured during the study.

In conclusion,

- Both ProTaper Ultimate® and EdgeTaper Platinum® produced an adequate postoperative geometry of the root canal, even though one apical perforation was observed with EdgeTaper Platinum®. At the same time, ProTaper Ultimate® exhibited similar percentage of untreated areas, while the mass of metal of the instrument is lower.
- ProTaper Ultimate® files work faster than EdgeTaper Platinum® files.
- ProTaper Ultimate® files are more resistant to plastic deformation/unwinding than EdgeTaper Platinum® files.

Figure 7:
Plastic deformation of EdgeTaper Platinum® instrument.
On the top: *before shaping (no deformation).*
On the bottom: *after shaping one canal, plastic deformation is observed.*

Instrument	ProTaper Ultimate®		EdgeTaper Platinum®	
	Time in s (SD)	Plastic deformation n (%)	Time in s (SD)	Plastic deformation n (%)
Slider/EdgeGlider	8,9 (11,76)	0 (0%)	12,52 (11,37)	5 (27,8%)
Shaper S1	12,54 (12,42)	0 (0%)	9,49 (5,29)	11 (61,1%)
S2	-	-	12,84 (10,51)	1 (5,6%)
F1	6,25 (3,53)	0 (0%)	8,68 (6,53)	6 (33,3%)
F2	4,98 (2,79)	0 (0%)	8,05 (5,42)	8 (44,4%)
Total	**32,68 (28,86)**	**0 (0%)**	**51,59 (33,03)**	**31 (34,4%)**

Table 1:
Mean (SD) working time in seconds and plastic deformation (n and %) for ProTaper Ultimate® and EdgeTaper Platinum®.

Comparative Evaluation of the Canal Shaping Ability, Pericervical Dentin Preservation, and Smear Layer Removal of TruNatomy®, WaveOne® Gold, and ProTaper Ultimate-An Ex Vivo Study in Human Teeth [11]

Authors: G. Ribeiro, V. Martin, C. Rodrigues and P. Gomes
Published in: J Endod 2023 Vol. 49 Issue 12 Pages 1733-1738

The canal preparations of ProTaper Ultimate® (Dentsply Sirona, Ballaigues, Switzerland), of TruNatomy® (Dentsply Sirona, Ballaigues, Switzerland) and of WaveOne® Gold (Dentsply Sirona, Ballaigues, Switzerland) were compared in maxillary incisors via micro-computed tomography (n=15 per group). Teeth were scanned before and after preparation. Volume variation (i.e. transportation and centering ability) and peri-cervical dentin preservation were quantified. Scanning Electron Microscopy (SEM) was used to evaluate the smear layer removal. The authors did not specify up to which instrument size the root canal have been shaped.

The outcomes are:

- **In terms of volume variation:** TruNatomy® showed the lowest volume variation, followed by ProTaper Ultimate® and then WaveOne® Gold (significant differences between WaveOne® Gold and the two other) (see **Figure 8**).
- **In terms of peri-cervical dentin preservation,** the trend is very similar: TruNatomy® showed the highest peri-cervical preservation, with a significant difference, followed by ProTaper Ultimate® and then WaveOne® Gold (significant differences between TruNatomy® and the two other systems).
- **In terms of smear layer removal in the apical third,** no significant differences between the three evaluated systems were found, all showing open or partially opened dentinal tubules.

In conclusion, ProTaper Ultimate® instruments showed a good peri-cervical preservation, close to TruNatomy®'s performance, but a significant difference persists (TruNatomy® instrument diameter: 0.8 mm, ProTaper Ultimate® diameter: 1 mm). ProTaper Ultimate® instruments have also demonstrated a low dentin volume variation, again promoting their ability to respect the original canal's anatomy while still removing as much as smear layer in the apical third (i.e. the most critical part of the canal due to its direct contact with periapical tissues) as the other evaluated instruments.

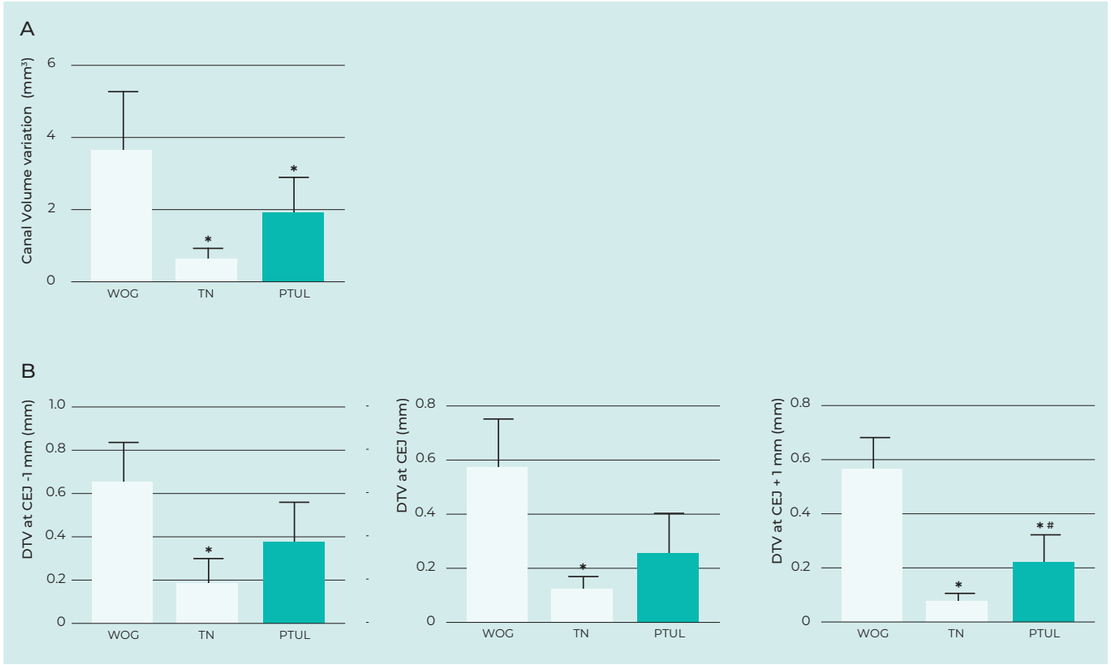


Figure 8:
A *Assessment of the linear variation of the dentin thickness at the selected references bordering the CEJ.*
B *Assessment of the dentin thickness variation at the selected region of interest, delimited at 1 mm coronal and 1 mm apical of the CEJ.*
***** *Significanlly different from WOG (P < .05);*
# *Significantly different from PTUL (P < .05).*
CEJ: *cementoenamel junction.* **DTV:** *dentin thickness value.*
PTUL: *ProTaper Ultimate®.* **TN:** *TruNatomy®.* **WOG:** *WaveOne® Gold.*

Take home message

The studies summarized above showed that ProTaper Ultimate® exhibit good centering ability, with no defect creation. It was also shown that ProTaper Ultimate® files work faster than EdgeTaper Platinum files, and that ProTaper Ultimate® files are more resistant to plastic deformation / unwinding than EdgeTaper Platinum files. They also confirms that engine-driven NiTi instrumentation systems are unable to contact 100% of the root canal wall **[12]**. Such results are nevertheless expected, and in alignment with another peer-reviewed publication indicating that 35% or more of canal surface remains untouched after mechanical instrumentation, mainly due to the anatomical complexity of the root canal system **[12]**. Thus, biofilms remain on these inaccessible root canal walls and may recolonize the root canal system, which can adversely affect treatment outcome. Irrigation is therefore an essential part of root canal debridement to achieve intracanal disinfection, to dissolve and to remove pulp tissue, dentinal debris, smear layer, microorganisms and their by-products **[2]**.

4 Mechanical properties

Fatigue resistance remains a major concern for dentists **[7]**. In general, instruments used in rotary motion such as ProTaper Ultimate® can break in two distinct modes - torsional and flexural. Torsional fracture occurs when an instrument tip is locked in a canal while the shank continues to rotate, thereby exerting enough torque to fracture the tip. In contrast, flexural fracture occurs when the cyclic loading leads to metal fatigue. NiTi instruments can withstand several hundred flexural cycles before they fracture **[7]**. Repeated loading and cyclic fatigue tests for endodontic instruments are not described in pertinent ISO norms. Nonetheless, several in vitro studies on the fatigue behavior and mechanical performance of ProTaper Ultimate® instruments, ideally performed at 37°C to simulate clinical conditions, have been published and are summarized below.

Characterization of the file-specific heat-treated ProTaper Ultimate® rotary system [13]

Authors: J. N. R. Martins, E. Silva, D. Marques, N. Ajuz, M. Rito Pereira, R. Pereira da Costa, et al.
Published in: Int Endod J 2023 56(4): 530-542.

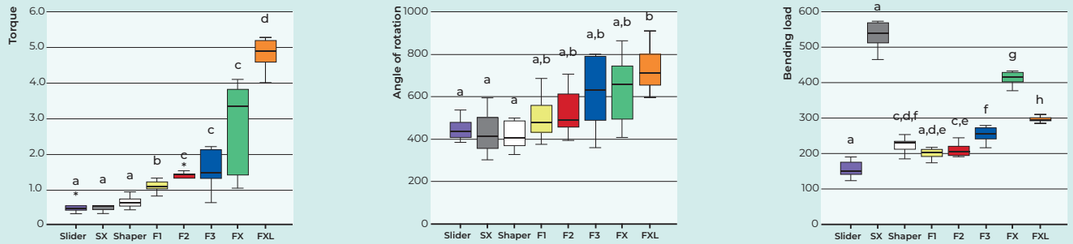
The study compared the design, metallurgy, and mechanical performance of the ProTaper Ultimate® system with instruments from previous ProTaper generations.
In details, ProTaper Ultimate® instruments (n = 248) were compared with instruments of similar dimensions from ProGlider (n = 31), ProTaper Gold (n = 155) and ProTaper Universal (n = 155) systems. The mechanical evaluation of the instruments was performed following international specifications (ANSI/ADA specifications, ISO 3630-3631 2008).

The main outcomes were:

- ProTaper Ultimate® instruments had similar phase transformation temperatures to their heat-treated analogues from ProTaper Gold system.
- ProTaper Ultimate® Slider and ProGlider instruments showed similar torsional strength and bending loads, meaning the two instruments have comparable robustness and flexibility.
- Other ProTaper Ultimate® instruments demonstrated statistically significantly lower maximum torque, higher angle of rotation, and higher flexibility (expressed as lower bending load in the **Figure 9**) compared to their counterparts.

Overall, the study concluded that the ProTaper Ultimate® system comprises instruments with specific heat treatments and mechanical performance characteristics. ProTaper Ultimate® instruments demonstrated lower torsional strength and higher flexibility compared to instruments from other ProTaper systems (except the Slider, see above).

ProTaper Ultimate®



Comparison with counterparts

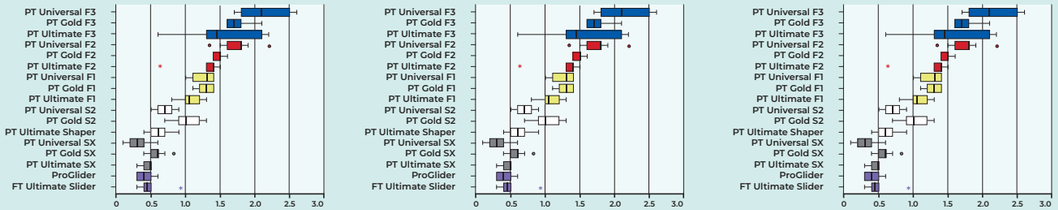


Figure 9:
Comparison of the mechanical behaviour amongst the ProTaper (PT) Ultimate® instruments and their equivalent counterparts.
On the upper column: *In the ProTaper Ultimate® system, the maximum torque, angle of rotation and bending load progressively increased with instruments' sizes, except for the FXL that was more flexible than the FX instrument.*
On the lower column: *ProTaper Ultimate® showed lower torsional strength, superior flexibility and higher angle of rotation than ProTaper Gold and ProTaper Universal counterparts. Slider and ProGlider had similar mechanical behaviour.*
Different letters in the charts represent statistically significant differences (p < 0.05).

Multimethod Analysis of a Novel Multi-coloured Heat-treated Nickel-Titanium Rotary System: Design, Metallurgy, Mechanical Properties, and Shaping Ability [9]

Authors: E. Silva, J. N. R. Martins, N. Ajuz, V. T. L. Vieira, R. Pinto, D. Marques, et al.
Published in: J Endod 2024

The study compared the design, metallurgy, mechanical performance and shaping ability of the ProTaper Ultimate® system (Dentsply Sirona), RCS Rainbow (Ramo Medical), VDW. Rotate (Dentsply Sirona), RaCe EVO (FKG), OneCurve (Micro-Mega).

300 instruments of each brand, all with a size tip of 25 and 25 mm long, were evaluated (n = 60). The mechanical evaluation of the instruments was performed following international specifications (ANSI/ADA specifications, ISO 3630-3631 2008).

Instruments	Time to fracture (s)	Maximum torque (N.cm)	Angle of rotation (°)	Bending load (gf)	Buckling strength (gf)	Cutting ability (mm)
RSC Rainbow One File 25/.06	86 ± 18^{b}	1.50 ± 0.17^{ab}	529.0 [137]^{b}	400.5 [31]^{a}	286 ± 25^{a}	7.1 ± 0.9^{b}
RaCe Evo 25/.06	51 ± 10^{d}	1.20 ± 0.26^{c}	675.0 [87]^{a}	261.5 [37]^{bc}	174 ± 25^{c}	4.2 ± 0.6^{c} / 7.6 ± 1.1^{ab}
Rotate 25/.06	84 ± 8^{b}	1.30 ± 0.15^{bc}	593.0 [122]^{b}	334.5 [33]^{ab}	217 ± 20^{d}	7.6 ± 0.7^{ab}
One Curve N25 25/.06	112 ± 11^{a}	1.30 ± 0.21^{bc}	597.5 [123]^{ab}	340.0 [60]^{a}	252 ± 20^{b}	8.4 ± 1.0^{a}
ProTaper Ultimate® F2 25/.08v	68 ± 6^{c}	1.60 ± 0.34^{a}	611.0 [105]^{ab}	262.0 [14]^{c}	280 ± 25^{ab}	7.0 ± 0.7^{b}

Different superscript letters in the same column represent statistically significant differences (P < .05).
** The cutting ability parameter of RaCe Evo instrument was tested in 2 different setups: 400 rpm/60 s (4.2 ± 0.6) and 800 rpm/60 s (7.6 ± 1.1).*

Table 2:
Mean (± Standard Deviation) or Median [Interquartile Range] Results of Time to Fracture (seconds), Maximum Torque (N.cm), Angle of Rotation (°), Maximum Bending Load (gf), Buckling Strength (gf), and Cutting Ability (mm) of Tested Instruments.

The main outcomes were:

- ProTaper Ultimate® showed high torque and angle of rotation, with comparable bending load to RaCe EVO, highlighting its robustness, high flexibility and tolerance to deformation before fracturing.
- All mechanical performances are summarized in the table above. Please note that cyclic fatigue testing (expressed as time to fracture in **Table 2**) was not performed at intracanal temperature (35°C) but at 20°C, not fully reflecting the behavior of the instrument in clinical conditions.
- No significant differences were found in the shaping ability of the instruments in maxillary molars. No instrument breakages were observed.

Take home message

It is known that NiTi heat treatment influences the mechanical properties of endodontic instruments, attempting to improve their flexibility, shape memory effect or fatigue resistance. It's also important to emphasize that other factors should be considered in the instrument's performance, including the design of the instruments such as the cross-section or the taper, the manufacturing process, the specific alloy composition, etc. All together, these features determine the overall clinical behavior of an endodontic instrument.
These studies provide valuable insights into the characteristics of the ProTaper Ultimate® rotary system for endodontic procedures, highlighting that ProTaper Ultimate® instruments offer distinct heat treatments and mechanical properties that contribute to their flexibility and performance during endodontic treatments.

5 Clinical cases

Peet van der Vyver and Martin Vorster have published several clinical case reports illustrating the clinical benefits of the full ProTaper Ultimate® solution. A selection of some of them is presented below.

Minimally invasive, conventional and large root canal system endodontics using a new Rotary File System – Part 1 [14]

Authors: P. J van der Vyver and M. Vorster
Published in: International Dentistry South Africa 2021 Vol. 11 Issue 6. Reprinted with permission from Modern Dentistry Media.

Case Report 1

A 48-year-old male patient presented with irreversible pulpitis on his recently crowned first left maxillary molar tooth. A pre-operative periapical radiograph **(Figure 10a)** revealed a calcified pulp chamber and three roots. An axial slice of a pre-operative CBCT scan **(Figure 10b)** revealed the presence on a second mesiobuccal (MB2) canal. After administering local anaesthesia, a rubber dam was placed and a conservative access cavity was prepared through the zirconia crown. Three root canal systems were detected under magnification (mesiobuccal, distobuccal and palatal). A dentine shelf **(Figure 11a)** which was observed under magnification was removed with EndoTracer burrs (Komet) **(Figure 11b)** operating in an endodontic motor operating at 1000rpm. A fourth, second mesiobuccal (MB2) canal **(Figure 11c)** was located. It was established that the MB2 joined the mesiobuccal canal in the midroot

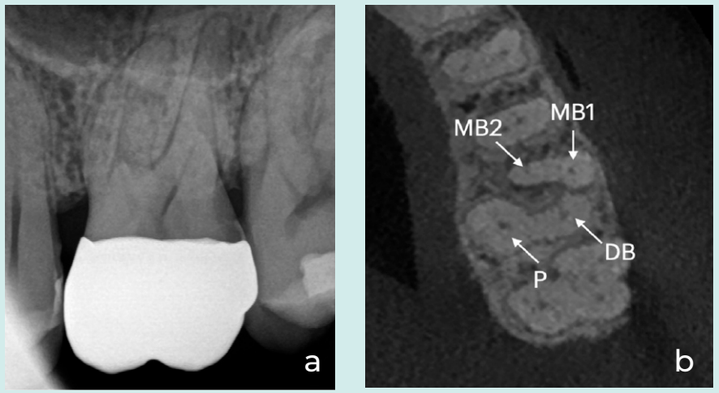


Figure 10:
a *Pre-operative periapical radiograph of maxillary left first molar revealed a calcified pulp chamber.*
b *Axial slice of pre-operative CBCT scan revealed the presence of an MB2 canal, originating very close approximation to the palatal root canal system.*

position. A ProTaper Ultimate® SX **(Figure 11d)** instrument was used to slightly enlarge the orifices of the located canals **(Figure 11e)**. All four canals were negotiated to patency using Glyde Root Canal Conditioner (Dentsply Sirona) and a size 08 K-File **(Figure 12a)**. Working length was determined using a Propex IQ Apex locator (Dentsply Sirona) and confirmed radiographically.

A RMG was prepared in all four root canal systems before expanding the glide path in all canals using the ProTaper Ultimate® Slider instrument **(Figure 12b)**, using 8–12 backstroke brushing motions in a circumferential motion. The root canal systems were irrigated with 3.5% heated sodium hypochlorite, the canals recapitulated to check patency using a size 08 K-File and the canals re-irrigated.

In the presence of 3.5% heated sodium hypochlorite the ProTaper Ultimate® Shaper **(Figure 12c)** was allowed to advance passively apically into the canals, using backstroke brushing motions to progress until full working length was reached. All the canals were irrigated, recapitulated and irrigated again as described above.

In the presence of an irrigation solution, ProTaper Ultimate® Shaper F1 instrument **(Figure 12d)** was allowed to advance passively apically towards full working length. During canal preparation it was observed that the F1 file did cut dentine apically in the combined mesiobuccal and distobuccal canals. However, due the larger size of the palatal root canal system, the F1 progressed easily to full working length without any sensation of dentine being cut. ProTaper Ultimate® F2 instrument **(Figure 12e)** was introduced, and the tactile feedback of dentine being cut in the apical part of the canal was confirmed.

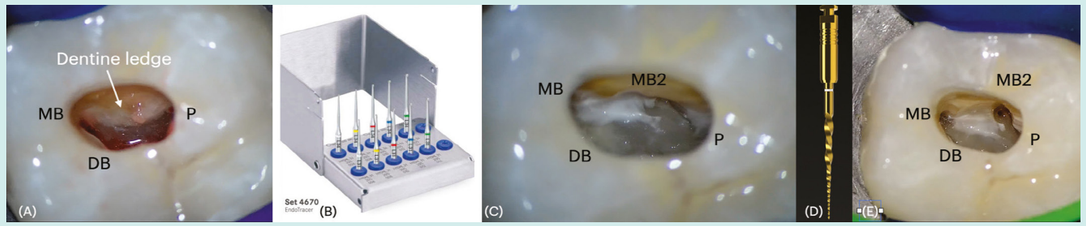


Figure 11:
a *Dentine shelf obscuring the location to the MB2 canal.*
b *EndoTracer burrs (KOMET) that were used to remove the dentine ledge under magnification.*
c *Orifice of the MB2 canal located.*
d *and* **e** *ProTaper Ultimate® SX was used to relocate the MB2 orifice and to slightly enlarge the other canal orifices.*

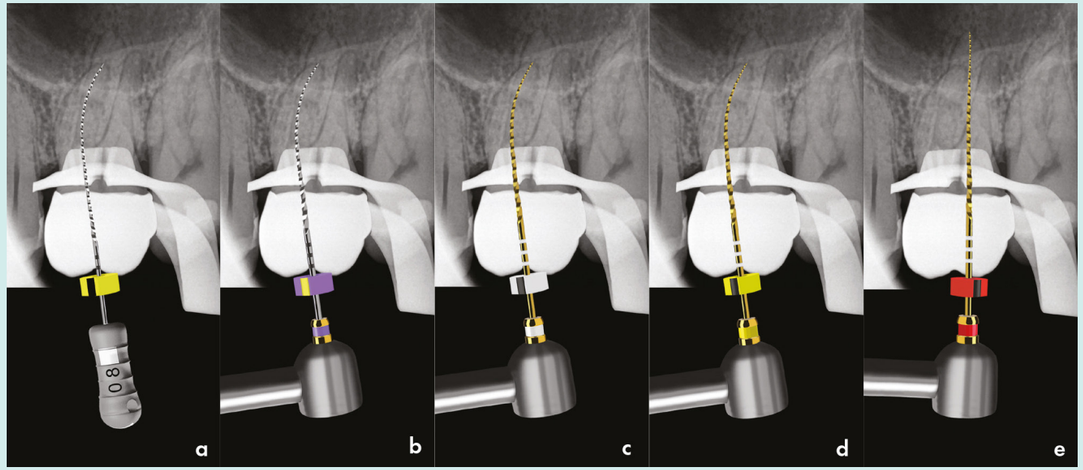


Figure 12:
a *All four canals were negotiated to patency with a size 08 K-file, working length determined and a reproducible micro glide path prepared until the size 08 K-file was "loose" in the canals.*
b *ProTaper Ultimate® Slider was taken to full working length in each root canal system and the micro glide paths expanded by using the instruments in five to eight backstroke brushing motions.*
c *ProTaper Ultimate® Shaper was allowed to advance passively downwards into the canals and cut shape in the coronal two-thirds of the root canal systems.*
d *Clinically, the tactile feedback of dentine being cut in the apical parts of the combined mesiobuccal and distobuccal root canal systems was observed but not in the palatal root canal system.*
e *ProTaper Ultimate® F2 instrument was introduced and the tactile feedback of dentine being cut in the apical part of the canal was observed with this instrument.*

When full working length was reached with the selected files (F1 in the mesiobuccal and distobuccal canals and F2 in the palatal canal), the preparation was completed by performing four to five backstroke brushing motions with the file from working length coronally.

The shaped root canal systems were flooded with 17% EDTA solution activated for two minutes. Finally, 3.5% heated sodium hypochlorite was activated for two minutes with the EndoActivator (Dentsply Sirona) and by means of negative pressure using the EndoVac (Sybron Endo) system.

The canals were dried with matching paper points of the ProTaper Ultimate® System and the fit of ProTaper Ultimate® Conform Fit Gutta Percha Points was confirmed radiographically **(Figure 13a)**. The canals were obturated using ProTaper Ultimate® Conform Fit Gutta Percha Points in conjunction with AH Plus ® BioCeramic Sealer (Dentsply Sirona) **(Figure 13b)** and the GuttaSmart System (Dentsply Sirona). **Figure 13c** depicts the final postobturation result. Note the excellent preservation of the pericervical dentine due the conservative coronal shapes of the canal preparations.

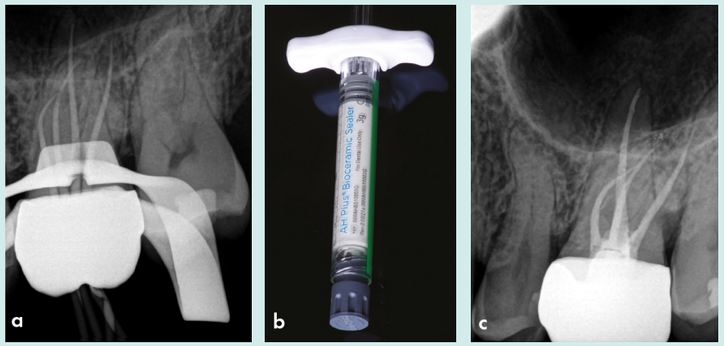


Figure 13:
a *Conefit periapical radiograph checking the fit of the ProTaper Ultimate® Conform Fit Gutta-Points.*
b *AH Plus® BioCeramic Sealer (Dentsply Sirona).*
c *Final postoperative result after obturation. Note the excellent preservation of the pericervical dentine.*

Case Report 2

A 29-year-old female patient presented with a large carious lesion and pain on her mandibular left second molar tooth **(Figure 14a)**. Upon examination it was discovered that the patient was very anxious and had very limited mouth opening. After administering local anaesthesia a rubber dam was placed. The carious lesion was removed and the tooth built up with composite resin. An access cavity was prepared through the composite restoration and three root canal systems were located.

During this part of the procedure, it was noticed that the patient often attempted to close her mouth, limiting the intra-oral working space despite the fact that a bite block was placed on the opposite side to keep her teeth apart. Being the last tooth in the arch with minimal working space, there is a considerable risk of file separation when using rotary or reciprocating file systems in an endodontic handpiece. It was decided to use ProTaper Ultimate® manual hand instruments for this case to minimise the risk.

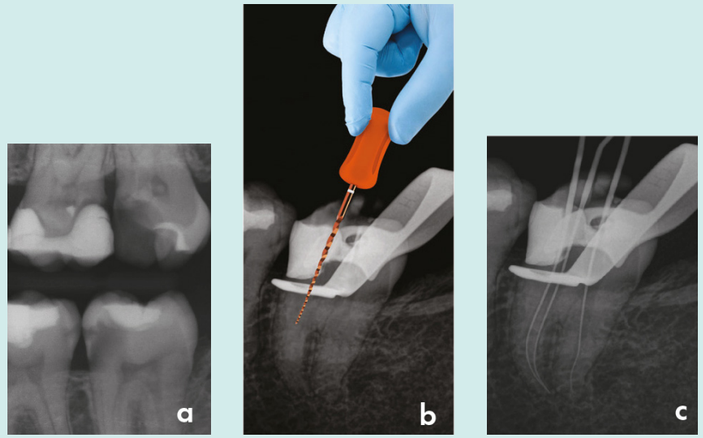


Figure 14:
a *Pre-operative bitewing radiograph showing the large carious lesion on the mandibular left second molar tooth.*
b *ProTaper Ultimate® Shaper X used to create more straight-line access into the two mesial root canal systems.*
c *Length determination periapical radiograph.*

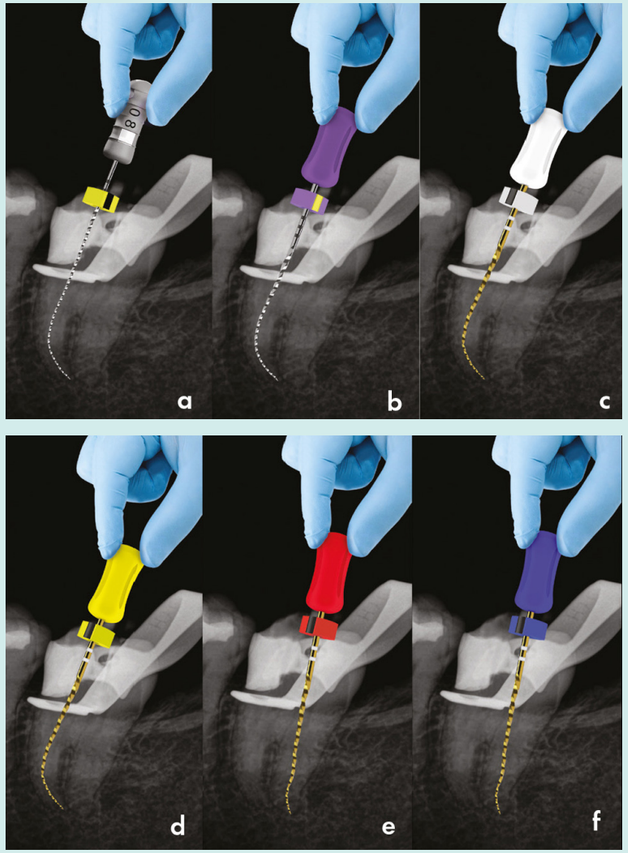


Figure 15:
a *Size 08 K-file was used to create a reproducible micro glide path.*
b *ProTaper Ultimate® Slider was used to expand the micro glide paths.*
c *ProTaper Ultimate® Shaper was used to cut shape in the coronal two-thirds of the root canal systems.*
d *ProTaper Ultimate® F1 instrument completed the shape for the mesial root canal systems.*
e *ProTaper Ultimate® F2 in the distal root canal system still did not cut dentine.*
f *ProTaper Ultimate® F3 completed the shape in the distal root canal system.*

A ProTaper Ultimate® Shaper X **(Figure 14b**) was used to create more straight-line access into the two mesial root canal systems. This was followed by length determination **(Figure 14c)** and glide path preparation using a size 08 K-file **(Figure 15a)** and the ProTaper Ultimate® Slider **(Figure 15b)**. Canal preparation in the mesial root canal systems was completed by using the ProTaper Ultimate® F1 instrument **(Figure 15c)**. Due to the larger size of the distal root canal system, the ProTaper Ultimate® F1 instrument went immediately to full working length and canal preparation was completed using the ProTaper Ultimate® F2 **(Figure 15d)** and F3 **(Figure 15e)**. After irrigation the fit of matching ProTaper Ultimate® Conform Fit Gutta Percha Points was confirmed radiographically **(Figure 16a)**. The canals were obturated with AH Plus® BioCeramic Cement and ProTaper Ultimate® Conform Fit Gutta Percha Points using vertical condensation with the GuttaSmart System. **Figure 16b** depicts the final postoperative result. Note the apical lateral canals that were obturated with the AH Plus® BioCeramic sealer.

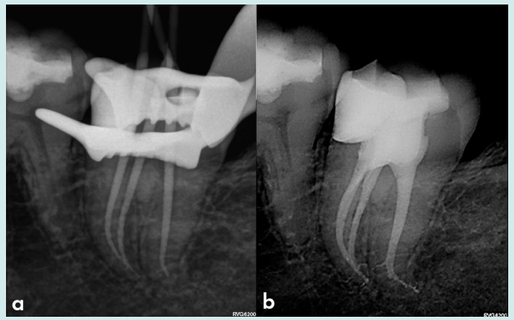


Figure 16:
a *Conefit periapical radiograph.*
b *Final post-operative result. Note the apical lateral canals that were obturated with the AH Plus® BioCeramic sealer.*

Clinical application of a new rotary file system – Part 2 [15]

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Case Report 3: Minimally Invasive Endodontic Preparations

Many practitioners believe that increased apical instrumentation with minimal taper leads to weakening of root structure and loss of control during the obturation phase, specifically in the apical third of the root canal system. Contemporary endodontic techniques advocate smaller apical preparations and continuous taper. This promotes apical resistance form and a continuous shape and taper for adequate disinfection (Gluskin et al, 2014).

In small, narrow root canal systems it is possible to obtain an apical taper of 7% and an ISO size of 20 by using only two preparation files, the Shaper and the Finishing file F1. The maximum flute diameter of 1.0mm of the majority of the instruments of ProTaper Ultimate® system promotes conservative coronal shapes, preserving the maximum amount of pericervical dentine.

The patient, a 45-year-old female, presented with leaking crowns on her non-vital maxillary left central and lateral incisor (**Figure 17a**). Conservative access cavities were prepared and working length confirmed using an electronic apex locator and verified radiographically (**Figure 17b**). Calcium hydroxide was then placed as an intracanal medicament (**Figure 17c**). At a second visit, a rubber dam was placed and glide path preparation was completed with the ProTaper Ultimate Slider (Dentsply Sirona) (**Figure 17d**). Canal preparation was done using the ProTaper Ultimate Shaper (**Figure 17e**) and F1 instruments (**Figure 17f**). The fit of the gutta percha cones was confirmed radiographically (**Figure 17g**) before the canals were irrigated with 3.5% heated sodium hypochlorite using the EndoVac system (Sybron Endo). **Figure 17h** shows the final result after obturation with AH Plus Bioceramic cement (Dentsply Sirona) and ProTaper Ultimate F1 gutta percha cones using the Gutta Smart System (Dentsply Sirona). Note the conservative canal preparations with maximum preservation of pericervical dentine.

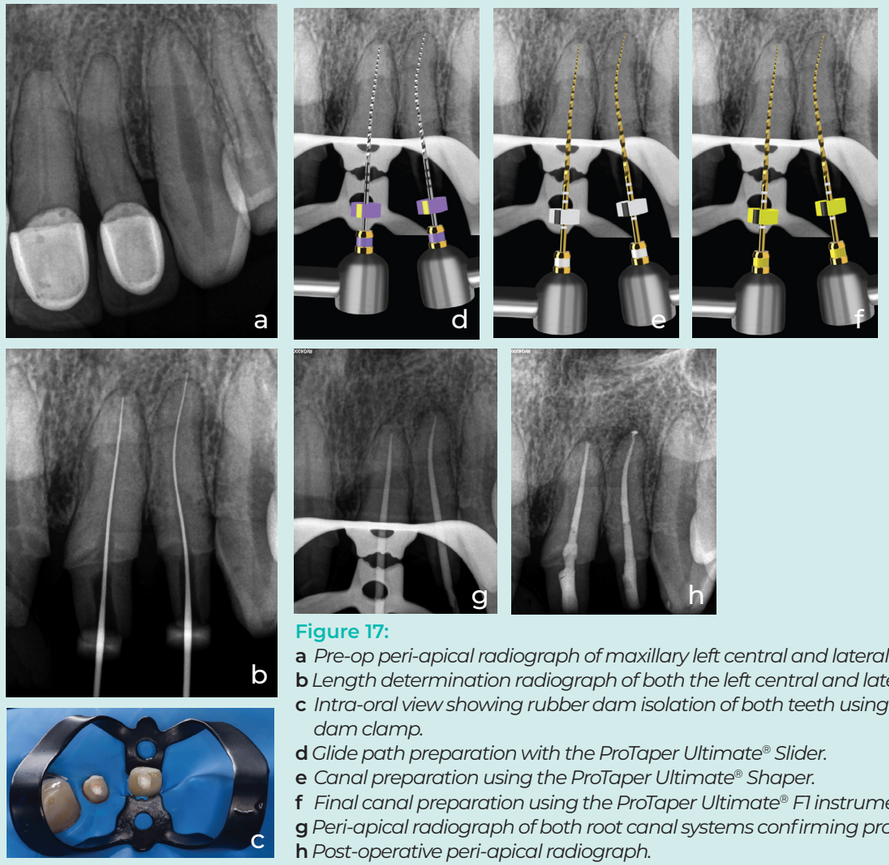

Figure 17:
a *Pre-op peri-apical radiograph of maxillary left central and lateral incisors.*
b *Length determination radiograph of both the left central and lateral incisors.*
c *Intra-oral view showing rubber dam isolation of both teeth using an anterior rubber dam clamp.*
d *Glide path preparation with the ProTaper Ultimate® Slider.*
e *Canal preparation using the ProTaper Ultimate® Shaper.*
f *Final canal preparation using the ProTaper Ultimate® F1 instruments.*
g *Peri-apical radiograph of both root canal systems confirming proper gutta percha fit.*
h *Post-operative peri-apical radiograph.*

Case Report 4

The patient, a 52-year-old female, presented with a non-vital left mandibular first molar (**Figure 18a**). **Figure 18b** depicts a length determination radiograph showing the location of the two mesial and two distal root canal systems. A size 08 K-file (**Figure 19a**) was utilized to create a reproducible micro glide path in all the canals before expanding the glide paths with the ProTaper Ultimate Slider instrument (**Figure 19b**). Canal preparation was completed in the mesial root canal systems using the ProTaper Ultimate Shaper (**Figure 19c**) and, finally, the ProTaper Ultimate F1 instrument (**Figure 19d**). The canals were dried with matching paper points from the ProTaper Ultimate® System, and the fit of the ProTaper Ultimate® Conform Fit Gutta Percha Points was confirmed radiographically (**Figure 20a**). The canals were then obturated using ProTaper Ultimate® Conform Fit Gutta Percha Points in conjunction with AH Plus® BioCeramic Sealer (Dentsply Sirona) (**Figure 20b**) and the GuttaSmart System (Dentsply Sirona). **Figure 20c** depicts a magnified view of the apical parts of the roots, showing apical lateral canals in the mesial and distal root canal systems, which confirms the benefit of the deep shape provided by the ProTaper Ultimate® F1 instrument (20/07), facilitating 3D disinfection.

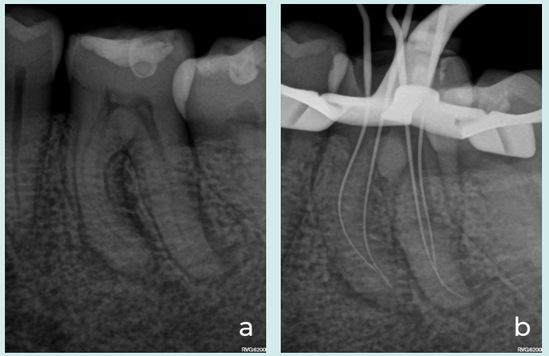

Figure 18:
a *Pre-op peri-apical radiograph of non-vital left mandibular first molar.*
b *Length determination radiograph.*

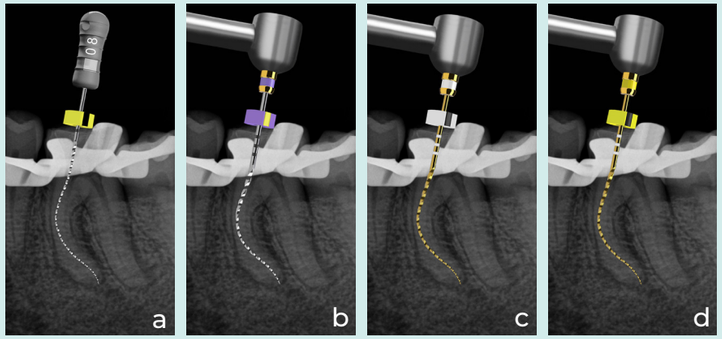

Figure 19:
a *A size 08 K-file used to create reproducible micro glide paths in all the canals.*
b *Glide path expansion using the ProTaper Ultimate Slider instrument.*
c *Canal preparation with the ProTaper Ultimate® Shaper instrument.*
d *Canal preparation with the ProTaper Ultimate® F1 instrument.*

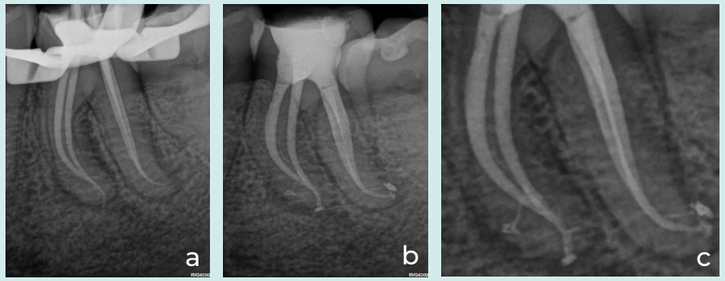

Figure 20:
a *Conefit periapical radiograph checking the fit of the ProTaper Ultimate® Conform Fit Gutta-Points.*
b *Final post-operative result after obturation.*
c *Magnified view of the apical parts of the roots showing apical lateral canals in the mesial and distal root canal systems. This confirms the benefit of deep shape of the ProTaper Ultimate F1 (20/07) file to facilitate 3D disinfection.*

6 Conclusion

In summary, the following insights regarding ProTaper Ultimate® system were gained:

- Regarding shaping ability, ProTaper Ultimate® files work faster than EdgeTaper Platinum files **[10]**. ProTaper Ultimate® files are also more resistant to plastic deformation / unwinding than EdgeTaper Platinum files **[10]**. It was also shown that ProTaper Ultimate® is able to maintain the original anatomy, to preserve the pericervical area while showing as good cleaning ability in the apical third, as the other evaluated systems **[10, 11]**.

- Mechanical and metallurgical analysis highlighted that ProTaper Ultimate® instruments offer distinct heat treatments and mechanical properties that contribute to their flexibility and robustness during endodontic treatments **[9, 13]**.

Clinical cases confirmed the performance and safety of the ProTaper Ultimate® solution, highlighting the use of these instruments in both routine and challenging endodontic anatomy **[14, 15]**. According to the authors, the benefits of these instruments to clinicians are the great preservation of pericervical dentine while maintaining good apical taper and a high level of versatility, avoiding the need for instrument hybridisation as has commonly been practised in the past **[15]**.

These key peer-reviewed studies emphasize the performance, reliability and clinical advantages of ProTaper Ultimate, which should be your endodontic system of choice to treat a vast majority of cases in a reliable and fast manner.

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		EC REP	CE
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