

MATCHING GUTTA-PERCHA CONES

— to NiTi rotary instrument preparations

Introduction

With the widespread use of rotary nickel-titanium (NiTi) instruments, matched-taper gutta-percha (GP) cones of greater tapers were developed to make root canal obturation techniques easier and more predictable, and possibly to improve quality of 3-D fillings. Nowadays, many manufacturers produce matched-taper GP cones intended for use with a specific instrumentation technique. Consequently, the single-cone technique has regained popularity, since a single matched-taper cone can produce a satisfactory 3-D fill, and warm vertical techniques benefit from the use of a matched-taper master cone by a reduced risk of voids inside the filled endodontic space.

However, the larger number of and variability in design and dimensions of commercially available NiTi instruments and GP cones of greater tapers can easily create confusion among practitioners, especially if using instruments and cones of different brands. If the GP cones selected do not precisely match with the NiTi instruments used, the whole concept fails and in many cases the GP cones do not reach the desired working length or do not precisely fill the apical preparation.

In order to understand how matched-taper GP cones should work, it is important that clinicians be aware of the differences in size, taper, design and manufacturing process of these products. Even if these factors are usually taken in account when a manufacturer produces matched-taper GP cones to be used with a specific instrumentation technique, the goal of the present paper is to discuss all of these variables and give clinicians a better understanding of the possible clinical problems they may encounter in cone fitting and practical solutions to these.

*Prof. Gianluca Gambarini,
Dr. Gianluca Plotino,
Dr. Nicola Maria Grande,
Dr. Simone Staffoli,
Dr. Federico Valenti Obino,
Dr. Lucila Piasecki,
Dr. Dario di Nardo,
Dr. Gabriele Miccoli
& Prof. Luca Testarelli, Italy*



— **Gianluca Gambarini**

is Professor of Endodontics at the Sapienza University of Rome's dental school in Italy. He is an international lecturer and researcher, and actively collaborates with a number of manufacturers all over the world to develop new technologies, operative procedures and materials for root canal treatment. Prof. Gambarini also works in a private endodontics practice in Rome.

Size, tolerance and manufacture of GP cones

Conventionally, GP cones are hand rolled, a manufacturing process that is neither very precise nor consistent. Therefore, according to ISO standards, the tolerance allowed for GP cones is 0.05 mm, much larger than the tolerance allowed for endodontic instruments produced by grinding or twisting (0.02 mm). This has always been a problem in endodontics and it explains why correct fitting of the master cones in all techniques (single-cone, lateral condensation, warm vertical condensation, continuous wave of obturation) has always been described as a fundamental step in the procedure.

With the conventional ISO 0.02-tapered cones, the problem was mainly related to the lack of precision of the tip of the GP cones. Therefore, GP tips needed to be manually adjusted to fit the apical preparation with good retention (tug-back) in order to avoid underfilling or overextension of cones through the apical foramen. The same procedure was needed for non-

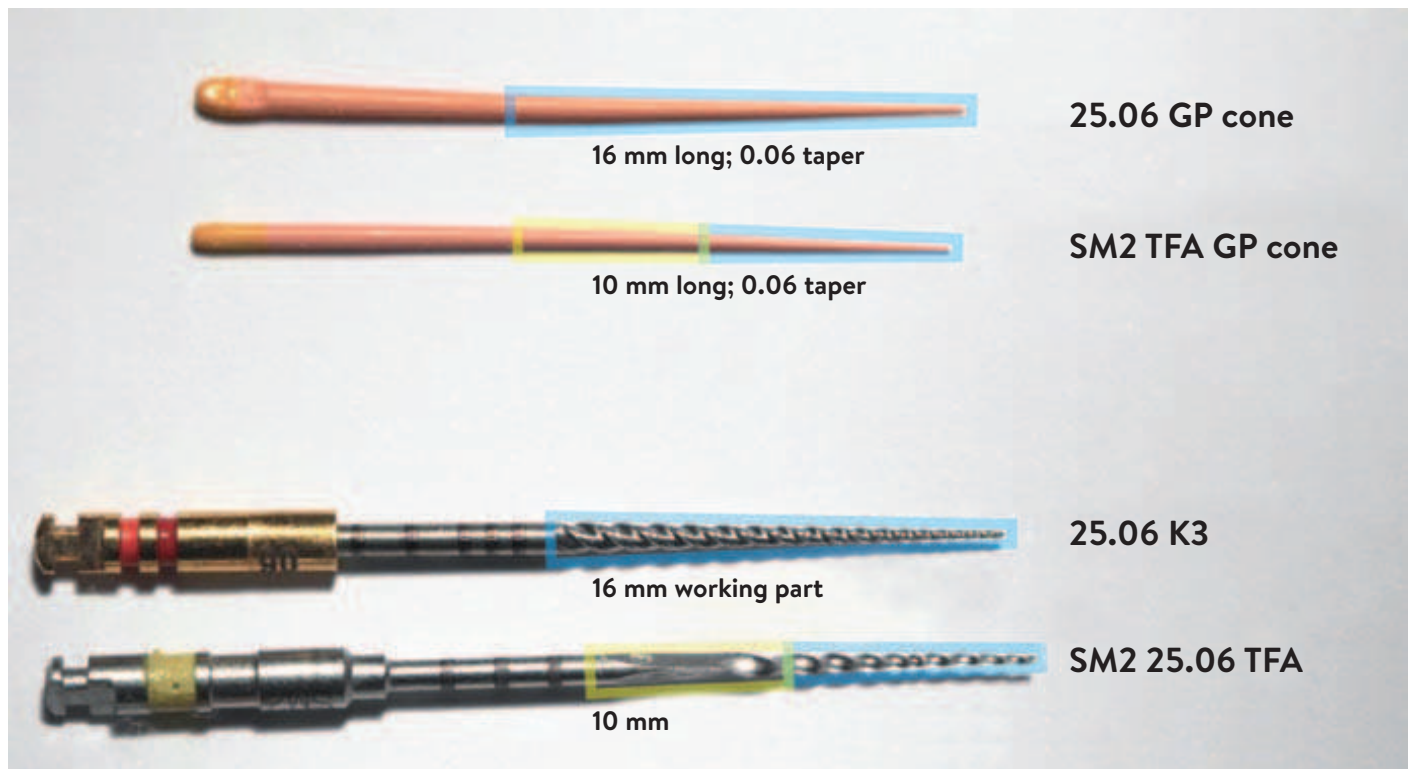


Fig. 1

standardized GP cones with feathered tips. For this reason, specific calipers and instruments to cut GP cones precisely were developed.

With the introduction of GP cones of greater tapers, a problem related also to the taper arose. These new GP cones can be grouped into two categories: uniform and nonuniform taper. The former cones are usually marketed as 0.04- or 0.06-tapered cones, while the latter are usually marketed in association with a brand name related to a specific instrumentation technique (e.g., ProTaper cones, DENTSPLY; and TF Adaptive [TFA] cones, Kerr). Development of these cones was necessary, since nowadays more NiTi rotary instruments have a nonuniform taper (e.g., ProTaper; and HyFlex EDM, Coltène/Whaledent) or a working part smaller than 16 mm (e.g., Twisted Files [TF], Kerr; and TFA).

Tip sizes and tapers of NiTi instruments

While some instruments have a nonuniform taper, the majority of endodontic NiTi rotary instruments have a uniform taper, and the associated techniques are intended to create at least a 0.04- or 0.06-tapered preparation. For this reason, GP cones of greater tapers are usually sold in 0.04 and 0.06 tapers.

However, NiTi instruments with the same nominal size and taper may not have the same dimensions and consequently not create an identical root canal preparation, since the length of the working part may be different (**Fig. 1**). For example, in a 25.06 K3XF instrument (Kerr; or other instruments, including Revo-S, MICRO-MEGA; ProFile, DENTSPLY; and Race, FKG Dentaire), the working part is 16 mm, while in a 25.06 TF instrument, it is 10 mm. Even if the taper and tip sizes are the same, a 25.06 K3XF instrument will enlarge the root canal to 1.21 mm. This calculation can be made as follows: 0.06 mm increase for each millimeter, multiplied for 16 mm = 0.96 mm + 0.25 mm tip size = 1.21 mm. In contrast, a 25.06 TF instrument (a file with a reduced working part) will enlarge the canal to a lesser extent: 0.85 mm (0.06 mm × 10 mm = 0.60 mm + 0.25 mm tip size = 0.85 mm).

Similar differences can be found between any NiTi instrument with a conventional 16 mm working part compared with any other instrument with a reduced working part. NiTi instruments with a shorter working part are widely used because a shorter working part creates less stress during instrumentation by reducing taper lock and torsional stress in the coronal part, the largest section of the instrument. With a lower operative torque, efficiency and safety are more easily improved. For

Fig. 1
Comparison of instruments and cones with uniform and nonuniform tapers.

the same reason, some instruments have a nonuniform taper, which usually is smaller in the coronal part, in order to gain more torsional strength in the apical part and more flexibility in the coronal part. Nevertheless, instruments with shorter working parts or nonuniform tapers need GP cones with the same design and dimensions in order to allow a good match between the prepared canals and the obturating materials.

Matching instruments with nonuniform tapers with GP tapered cones

The same differences in dimensions previously described between instruments (e.g., K3XF compared with TF) can be found between 0.04-/0.06-tapered GP cones and cones with nonuniform tapers (e.g., ProTaper and TFA cones). The first few millimeters are usually similar, but in the middle or coronal part, the GP cones might be much wider. Therefore, if a 0.04-/0.06-tapered GP cone is used in a root canal prepared with nonuniform-taper instruments, the GP cone will probably not go to working length, because of the greater dimensions of the cone in the middle or coronal part. This could be considered GP taper lock.

This is a different problem to that experienced by dentists in the past, which was mainly related to cone fitting in the apical part, and consequently requires a different approach. Choosing a cone with a smaller tip size may not solve the problem, while choosing a smaller-taper cone may significantly increase the risk of iatrogenic errors such as underfilling and overextension of the cone through the apical foramen, because the tug-back in the coronal part does not allow for correct fitting of the apical part of the cone.

Therefore, the best and easiest solution is to choose brand-associated GP cones that precisely fit the root canal preparation achieved by the specific NiTi instruments and allow for ideal 3-D filling and good apical tug-back. However, with the K3XF system, clinicians could use both types of cones (i.e., the 0.04–0.06 cones or TF/TFA cones) because they will both fit the root canal preparation in the apical and middle thirds well, where tug-back and 3-D matching are more critical.

More clinical hints

Thus far, dimensions and sizes have been discussed to help clinicians understand the difficulties in matching instruments and cones. However, there are also clinical ways to seek to solve problems encountered during these procedures. The following advice may be useful for both instruments with nonuniform tapers and many instrumentation techniques.

– Create greater coronal flaring

If a GP cone does not perfectly match the root canal preparation and thus does not reach the working length, one possible solution is to increase the coronal flaring by brushing with the last instrument used. By doing so, the NiTi instrument will increase the dimensions of the prepared canal in the coronal part, solving the problem of GP taper lock.

– Ensure correct apical fit

Clinicians may experience two different clinical problems in the apical fit: the need for a better apical tug-back, which may require slightly cutting the tip of the master cone, and the fit related to the amount of canal transportation. The first situation may occur when, owing to the different dimensional tolerance, a GP cone is slightly smaller than the nominal size, increasing the risk of overfilling during obturation. In such a case, the advice is to increase the dimensions of the master cone slightly by cutting 0.5–1 mm off the tip, or ideally to recalibrate the master cone precisely using a tip-snip device. This can also occur if a canal is slightly overinstrumented (e.g., owing to an error in determination of the working length or in the position of the rubber stop on the file). In such a situation, the apical constriction would have been modified and the cone fit would have to compensate for the error by increasing the tip size of the GP master cone.

Some NiTi instruments (HyFlex; TFA; TRUShape, DENTSPLY; NEONITI, NEOLIX; etc.) are significantly more flexible than the majority of competing NiTi rotary instruments. As a consequence, they tend to follow and maintain the original trajectory of the root canals more precisely, minimizing canal transportation. Canal

transportation frequently occurs when a rigid file is inserted into a curvature and tends to straighten it by cutting more in the inner part of the curvature coronally and in the outer part apically. However, this error, which can affect the quality of debridement, makes insertion of master GP cones easier, especially when complex, double or triple curvatures are present. For this reason, clinicians using such flexible NiTi instruments may experience slightly more difficult insertion of the master GP cone to the working length. If this problem occurs, once again slightly increasing flaring by circumferential filing can help.

Conclusion

It may be concluded that clinicians who use instruments with nonuniform tapers or with reduced working parts should preferably use brand-associated GP cones that perfectly match with the prepared canals. By doing so, fitting the master GP cone becomes much easier and more predictable. In the very few cases in which problems still arise, the clinical hints provided may help practitioners to understand the problem and find a proper solution.