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The Trap of the mesial root of mandibular molars

ABSTRACT

Aim: to draw the practitioners' attention to the difficulties that may be encountered when shaping the mesial roots of mandibular molars.

Summary
It is well known that variability in shape and curvature of the mesial roots of mandibular molars makes them difficult teeth to root treat. The variabilities make it difficult to standardise an instrument sequence for root canal therapy. This paper discusses the concepts and strategies for producing optimal cleaning and shaping results and describes a step by step operative that allows us to achieve our desired clinical shaping objectives before obturation.

Key learning points:
- The importance of a straight line access.
- The management of file separation inside curved canals.
- A step by step preparation technique for proper shaping and cleaning objectives.

Key words:
Anatomy, curvatures Ni-Ti files.

INTRODUCTION

Root canal **treatment** can be a challenge for the clinician. It is generally agreed that rotary Ni-Ti (Nickel-Titanium) endodontic instruments can facilitate root canal preparation (13). However, the preparation of the mesial roots of mandibular molars still remains problematic, because canals are often severely curved and anatomic complexities can be encountered. Moreover the tooth is often restored, and calcifications can be found in the pulp chamber or along canal path.
Due to these complexities, the biologic objectives of cleaning and shaping procedure are difficult tasks to achieve. With more conventional instrumentation, procedural errors such as stripping and apical zipping were relatively common occurrences in these roots. The use of rigid stainless manual files with a cutting tip is likely to produce these iatrogenic errors (6), which can be also common with techniques that employed the incorrect use of gates glidden burs. Such complex anatomies are not simple even for the newest root canal preparation techniques. Since mesial canals tend to exhibit more multiple geometric planes and curves than the roots that harbor them, it is also well recognized that, if abused, rotary Ni-Ti files can separate in such complex root canals (11). This happens especially when anatomic complexities cannot be visualized on a radiograph, even if they should always be suspected by a skilled practitioner.
Due to the fact that variability in shape and curvature of the mesial roots of mandibular molars makes them difficult teeth to root canal treatment, this paper discusses the concepts and strategies for producing optimal cleaning and shaping results in such cases. It also introduces a step by step technique, which combines different instruments' taper and tip diameter, in order to achieve our desired clinical shaping objectives before obturation.

Concepts and strategies

We need to consider root anatomy during the preparation of the mesial roots of mandibular molars if we are to avoid problems when using rotary Ni-Ti files. First and foremost we need straight line entry to the canal system when using Ni-Ti. Even if NiTi rotary files are made of a very flexible alloy, rotation inside a curve canal can induce high metal fatigue. If clinicians provide a more direct access to the apex, instruments will be subjected to less fatigue and less risk of intracanal breakage (5).
All clinicians agree on the fact that preparing a well-designed endodontic access cavity is a fundamental step to achieve successful root canal treatments. Both cleaning and shaping potentials are dramatically improved when instruments and irrigating needles can be easily inserted into the office, with a direct, smooth access to the apical thirds. It is important to ensure that there are no overhangs or lips of dentine to impede the straight li-

ne access required. In the past, Gates Glidden™ were used with a brushing technique directed towards the outer or mesial part of the tooth (anticurvature method). Today orifice openers are commonly used along with the LA access (low speed burs, by Sybron Endo, Orange, Ca), in order to facilitate this process (Fig. 1). Figures 2 and 3 show how the clinical importance of the elimination of all enamel and dentinal interferences both in the pulp chamber and the coronal third to achieve a safer, more efficient root canal instrumentation.
When cutting your access cavity it is important to remember that a third canal can be found in the mesial roots (sometimes having it's own exit or foramen). It is important to check for the presence or absence of such a canal opening. Usually mesial orifices are well separated within the main pulp chamber, and the third mesial canal, if present, is located between the buccal and lingual ones.
When straight-line access has been completed and all orifices have been located, attention is directed towards shaping and cleaning procedures. The most commonly used approach to Ni-Ti rotary preparation (3) is to first pre-enlarge the coronal two thirds, followed by apical third finishing (crown-down techniques). Pre-enlargement procedures improve apical cleaning and shaping, by facilitating insertion of instruments and by reducing mechanical stress on the rotary files in the delicate, complex, apical area. Root canal preparation is often simplified by dividing the entire procedure and canal anatomy into a series of smaller steps. This strategy is very important in lower molars especially when longer roots hold complicate canals with calcifications, challenging curvatures or deep divisions. Usually clinicians divide the root into coronal, middle and apical thirds.
If we now turn our attention to the root canal itself, we can divide it into three parts. We can see that each part is special and may present its own "difficulty". Clinicians are aware that coronal two-thirds of the canal must be scouted and pre-enlarged to facilitate access into apical third, but some problems can be encountered in these steps, especially when canals are narrow and calcified.

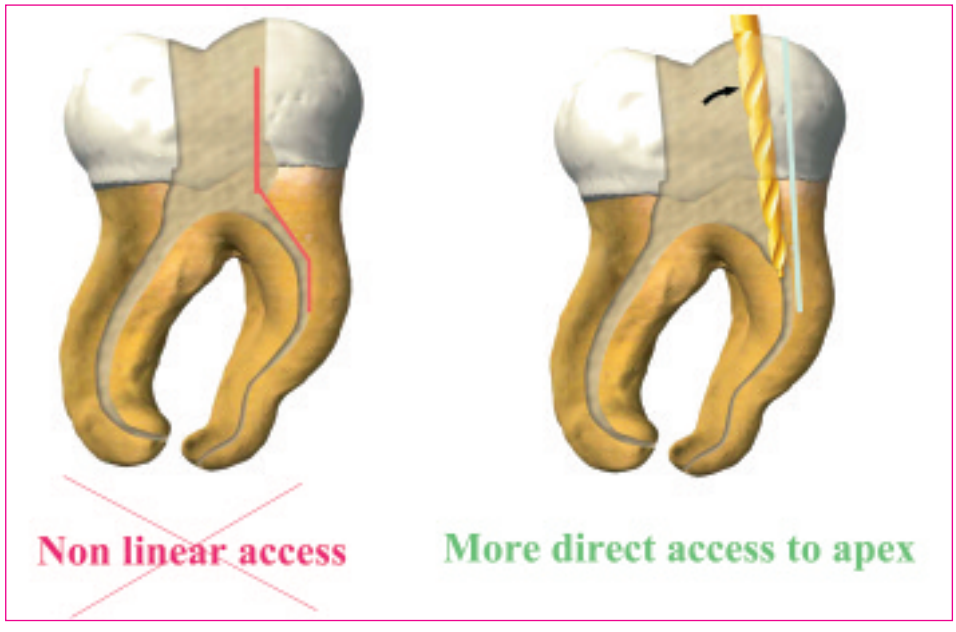

Fig. 1 - *How to create a more direct access to the apex.*
Come creare un accesso più diretto all'apice.

In such cases smaller instruments can initially be placed more easily and deeper, where they can be used with to cut on the pull-stroke (brushing action). This allows to enlarge the root canals reducing the risk of pushing pulp stone, fibrotic tissue and debris deeper inside the canal. Instruments of larger taper can then be used to provide the correct enlargement. Sometimes the first part of the canal has a particularly thin wall on it's distal or internal part. Such a finding often indicates an invagination and when present it increases the chances of stripping the root.
Often, the middle part of the root shows a curve towards the inner part of the tooth followed by a second curvature in a different direction. The second curvature is generally not visible radiographically. A change in direction between the first and second curves represents a high stress area for rotary files and it is where a high number of file separations occurs. Moreover, the two mesial canals can also merge in this area, with one canal exhibiting a straight path and the other one with a severe abrupt, curvature, due to the small radius. This is a very risky, stressful situation for a rotary instrument, especially when instruments of greater taper are used. In fact a more tapered rotary instrument is less resistant to fatigue in such anatomic complexities (5).
In the apical part of the root, the canal generally narrows and curves towards the distal, but sometimes it can be seen to curve sharply towards the mesial aspect of the tooth. It is interesting to note that with the mesial root of mandibular molars the radiographic and anatomical areas rarely coincide. It is important to use Ni-Ti rotary instruments only in portions of the canals that have been first scouted with small flexible hand instruments to reduce risk of intracanal separation. An accurate determination of working length from radiographs or an electronic apex locator is mandatory before introducing any rotary file to terminus. Establishing and maintaining patency are other fundamental step for excellence in apical shaping and cleaning procedures.

Instrument separation
Ni-Ti rotary instrumentation have sharply reduce iatrogenic errors such as blocks, zips, ledges and the amount of canal transportation. However, these instruments have an unpredictable, increased risk of intracanal breakage, especially when anatomy dictates high mechanical stress on the rotating file.

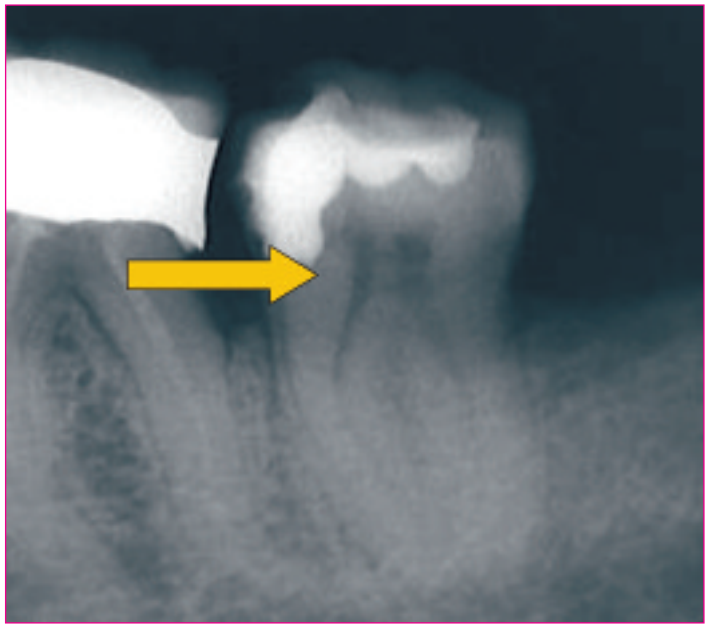

Fig. 2 - *Pre-op radiographs showing a curvature and dentinal interference in the coronal third of the mesial root.*

Radiografie pre-operatorie che mostrano una curvatura ed una interferenza dentinale nel terzo coronale della radice mesiale.

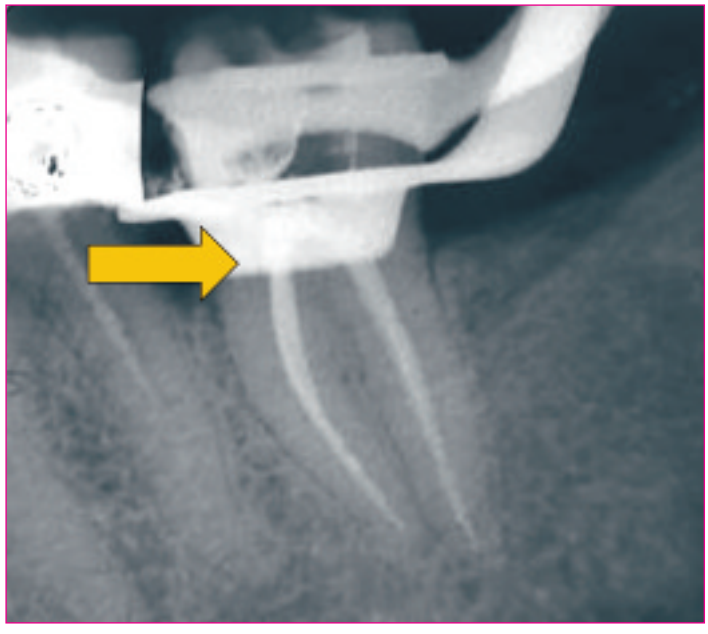

Fig. 3 - *Immediate post-op radiograph showing a more direct access to the apex, which allowed a satisfactory root canal treatment.*

Radiografia post-operatoria che mostra un accesso più diretto all'apice, che ha permesso un soddisfacente trattamento scanalare.

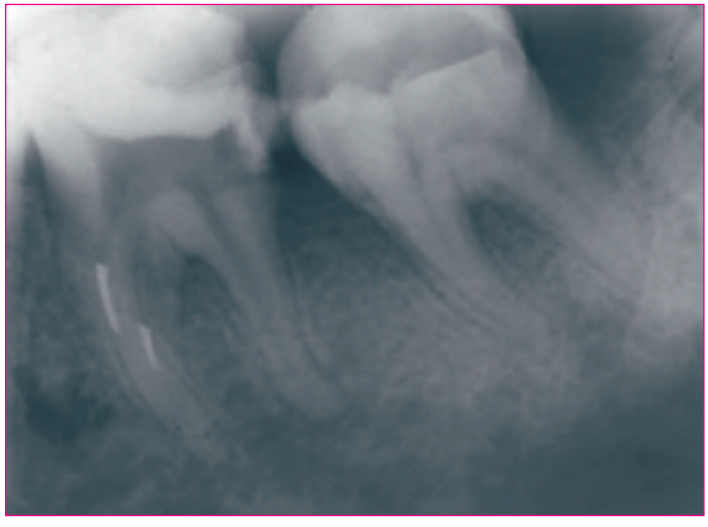

Fig. 4 - *The diagnostic radiograph shows a first lower molar with two separated Rotary Ni-Ti files inside the mesial root.*

Radiografia diagnostica che mostra un primo molare inferiore con due strumenti rotanti Ni-Ti separati nella radice mesiale.

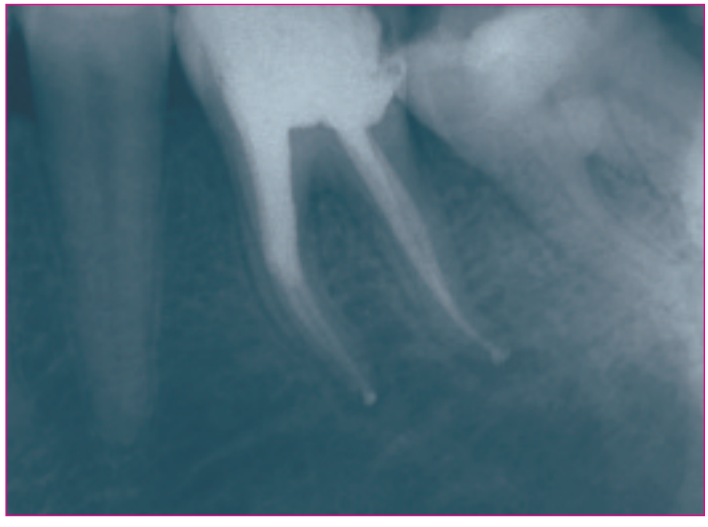

Fig. 5 - *Immediate post-op radiograph shows that the tooth was successfully treated in an orthograde manner and both separated instruments were removed.*

Radiografia post-operatoria che mostra il dente trattato con successo in maniera ortograda. Entrambi gli strumenti sono stati rimossi.

Failure to recognize these risks may easily lead to instrument's separation when severe, abrupt curvature are found, in narrow and calcified canals, and when canal length after the start of the curvatures is not small. Figure 4 shows two separated Ni-Ti files, one in each of the mesial roots of a mandibular molar. The case was treated in an orthograde manner. Instruments were removed under microscope, using ultrasonic tips and root canal cleaning and shaping procedure were completed to the full working length. Immediate post-operative radiograph shows the final results (Fig. 5).

Figure 6 shows a first lower molar with two separated Rotary Ni-Ti files inside the mesial root. There is one file in each mesial root. With the case, the retrieval of the two fragments and attempts to bypass them proved unsuccessful. As a result the case was treated surgically (Fig. 7). It is interesting to note that in

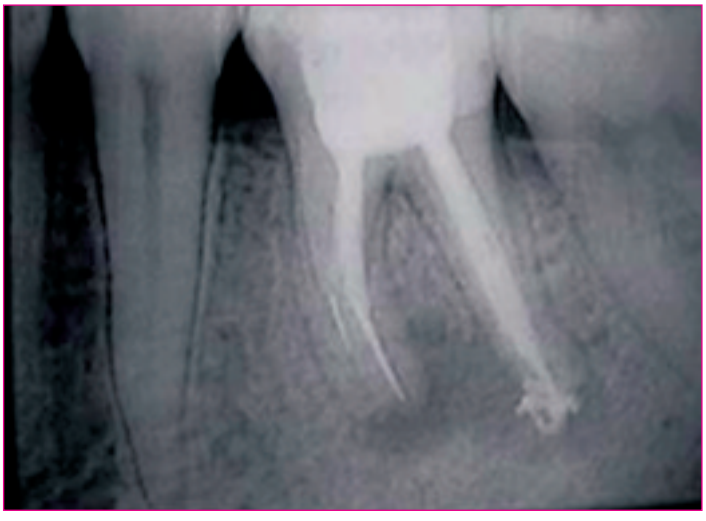

Fig. 6 - *Figure 6 shows another case with two separated Rotary Ni-Ti files, beyond the curvatures inside each mesial canal.*

Un altro caso con due strumenti rotanti Ni-Ti separati oltre le curvature in entrambi i canali mesiali.

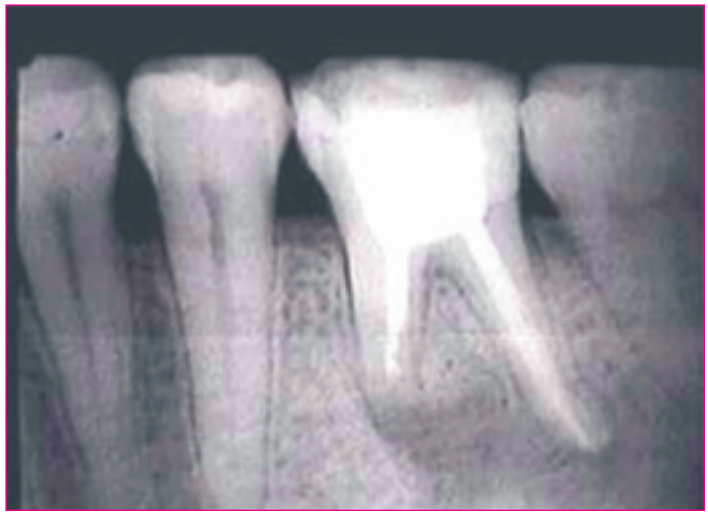

Fig. 7 - *Since the retrieval of the two fragments and attempts to bypass them proved unsuccessful, the case was treated surgically.*

Poiché i tentativi di rimuovere o bypassare i due frammenti si sono rivelati infruttuosi il caso è stato risolto chirurgicamente.

Fig. 8 - *Immediate post-op radiograph shows a "successful" root treatment of a calcified canal.*

Radiografia post-operatoria che mostra un riuscito trattamento canalare di un canale calcificato.

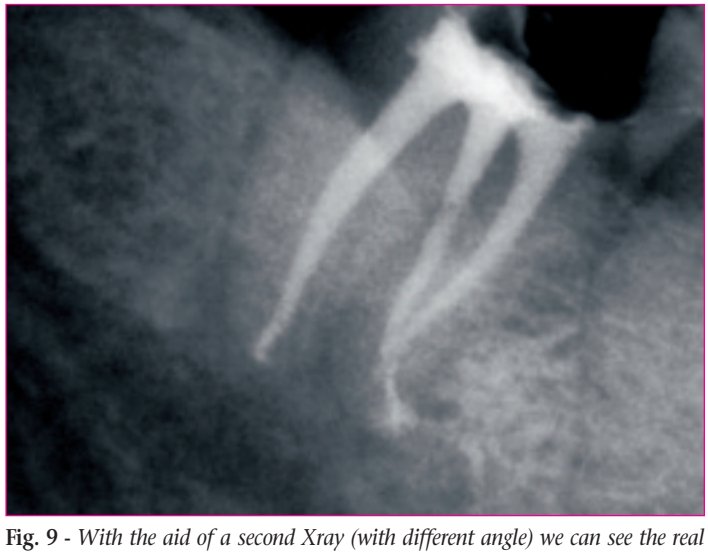

Fig. 9 - *With the aid of a second Xray (with different angle) we can see the real anatomy and how the two mesial roots are crossing in the last two mm.*

Con l'aiuto di una seconda radiografia (da una angolazione diversa) possiamo vedere la reale anatomia e come le due radici mesiali si incrocino negli ultimi due millimetri.

this case, as the two fragments were separated beyond the curvatures of the mesial roots no direct access could be established without significantly compromising the canal anatomy leading to stripping or a perforation.

Root canal preparation

It is well-known that mesial roots are usually curved, with the greatest curvature in the mesiobuccal canal. Moreover there can be significant curvatures in the buccolingual plane that may not be obvious on a radiograph. Figure 8 shows a "successful" root treatment of a calcified canal. In fact patency in the mesial roots initially couldn't be established with a 10 K-File. In order to overcome the problem a 06 K-flex file was used to support and make an impression of the canal; this allowed the operator to visualise the complexity of the internal anatomy and the localisation of any curves. A preliminary canal enlargement was performed allowing negotiation to terminus. Preparation was completed and canals obturated. As shown by Figure 9 with the aid of a second Xray (with different angle) we can have a better view of the anatomy and see how the two mesial roots are crossing in the last two mm. Therefore, it is recommended in complex cases to ha-

ve at least two different radiographs with different angles for a correct interpretation and clinical understanding of the root anatomy.
The following crown-down root canal preparation technique describes how all canals were prepared in the above illustrated cases. Firstly, "new version" OO K3 (SybronEndo, Orange, Ca) triple flutes with 25 T 12 (those instruments have a 25 mm ISO tip, 10 mm active blades in a 12% taper and a 17 mm length) were used to prepare the initial part of the roots and to establish good access to the rest of the canals. Following the use of the aforementioned instruments, a OO 25 T08 file was used as deep as it would go without applying any additional apical pressure. Some deformation at the tip of the OO 25T08 files was occasionally noticed after preparing the mesio lingual canals; this indicated instrument stress related to an anatomical consideration or a sharp curve.
Patency was then confirmed with an electronic apex locator (EAL) and working lengths established 0.5 mm shorter than the data provided by EAL. Once the working length was established, the K3 files were used in the following sequential manner, 30T06-25T06-25T04 and then 20T04. Each file was used trying to reach to full working length without apical pressure. Recapitulation was performed, when needed. When multiple curves, like those seen here, are encountered, it is important that rotary Ni-Ti files are used in a sequential manner if we want to preserve the root anatomy. If a tapered 06 file (which is quite rigid) is forced inside a curved canal, it may risk, if not separation, a certain amount of canal transportation (12). The triple flute K3 file is known to be a very safe instrument and the proposed crown-down approach decreases the chances of stripping or apical deformations (2). The canals were obturated in three dimensions by using system B and Sleiman" Hu-Friedy root canal pluggers.

DISCUSSION

As mentioned and as illustrated, the instrumentation of mesial canals of mandibular molars presenting with variable shapes, curvatures and anatomy can produce procedural errors, such as ledging (elbow formation inside the root canal wall), zip formation (external deformation of the foramen), blockages and separation of instruments (9). All of the aforementioned violate the basic principle of endodontics which is that endodontic preparation should conform as closely as possible to the general configuration of the original shape (10). Although instrumentation technique may play a role, many procedural errors are caused by the stiffness of stainless steel alloys used in the manufacturing of root canal files (8). It is well recognised that stiff files used within curved canals tend to transport out of, rather than remaining centred in, the natural canal pathway. This inherent stiffness increases with increasing instrument size (4.7) also explains why also Ni-Ti rotary instruments, if forced, can produce hiatrogenic errors, and suggest the use of smaller tapers in the most critical areas (1).
The anatomical variation seen in the mesial roots of mandibular molars makes them one of most difficult and unpredictable roots to carry out successful endodontic therapy on. It is very hard to produce a standardised technique to deal with all problems. We need a system flexible enough to deal with each variations and situation as it is encountered. We need to ensure our instruments adapt to the anatomy of the canal, we must not to adapt the canal to our instruments if we want avoid severe irreversible damage. It is important to remember that unlike Ni-Ti files root canal anatomy is not flexible. We need to understand it and build a mental image of canals before inserting any rotary instruments inside them.

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