

Clinical management of confluent canals

Gianluca Gambarini¹

Ivona Bago²

Adrianna Adamek-Mrozowska³

Byron Tsivos⁴

¹ University of Rome La Sapienza, Italy

² University of Zagreb, Croatia

³ University of Lodz, Poland

⁴ Private practice, UK and Greece

Corresponding author: Gianluca Gambarini

e-mail: gianluca.gambarini@uniroma1.it

Abstract

Confluent canals are potentially dangerous for endodontic rotary instruments because they are rarely detected with periapical radiographs and they usually create an abrupt curvature, with a small radius less than two millimeters and a high degree of the curvature close up to 90 degree. The purpose of this clinical article is to show first how to manage this confluent canal according to the Vertucci technique, and also provide some clinical guidelines about determining if a confluence is present or not, at which level and which is the working length for each instrument, and which is the canal to be instrumented first. If all these recommendations are correctly followed, a very common and dangerous clinical problem for endodontists can be very easily and quickly resolved, significantly reducing the risk of intracanal failures without any additional special devices but only by using knowledge and clinical skills

Keywords: Root canal, Confluence, Nickel-titanium instruments

Introduction

The main goals of the chemio-mechanical preparation of the root canal is to reach with the instrument the working length properly and shape the canal, so that the irrigants can reach, disinfect and debride the whole root canal system and the obturation material can three-dimensionally fill and seal it (3, 7, 12, 20). In order to achieve this goal endodontic instrument must reach the working length with no iatrogenic errors. Despite improvements in materials this is still not an easy task in complex cases, especially when severe, difficult curvature are present (5, 19).

In recent years a huge amount of experimental studies has shown that abrupt curvatures can be extremely stressful for the nickel-titanium rotary instruments and may easily cause intracanal failures (5, 8, 11, 13, 19). Luckily in the majority of teeth the abrupt apical curvature is distally oriented, so it can be easily seen in a pre-operative radiograph (10, 17). Therefore the dentist can pay adequate attention in the management of this curvature from the very beginning and adopt all strategies to minimize instrumentation stress, i.e. adopting the anticurvature method for flaring, select instruments more resistant to fatigue, with smaller sizes and tapers (13).

However, a complex abrupt curvature can also occur when we have confluent canals (6), more precisely when two (or more) canals are present in the same root and then join together (usually) in the apical portion, as describe by type 2 in Weine classification. Unfortunately, this is a much more complex clinical situation to diagnose, because in the majority of cases these complex curvatures are present in the mesial roots of mandibular and maxillary molars (1). Due to the superimposition of the two mesial canals, it's very hard to establish with a pre-operative periapical radiograph whether a confluence is present or not. This is a clinically relevant issue because from anatomical study it can

Authors

Gianluca Gambarini - University of Rome La Sapienza, Italy

Ivona Bago - University of Zagreb, Croatia

Adrianna Adamek-Mrozowska - University of Lodz, Poland

Byron Tsivos - Private practice UK and Greece



License

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Authors contributing to Annali di Stomatologia agree to publish their articles under the [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/), which allows third parties to copy and redistribute the material providing appropriate credit and a link to the license but does not allow to use the material for commercial purposes and to use the material if it has been remixed, transformed or built upon.

How to Cite

Gianluca Gambarini, Ivona Bago, Adrianna, Adamek-Mrozowska, Byron Tsivos. Clinical management of confluent canals. Annali di Stomatologia, 15(4), 235-240. <https://doi.org/10.59987/ads/2024.4.235-240>

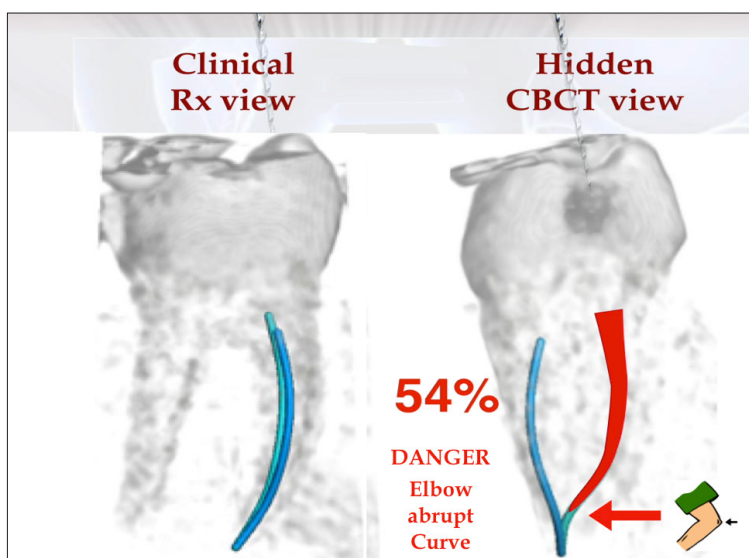


Figure 1. 2d vs 3d root canal visualization

very easily demonstrate that in molars) two confluent canals in the mesial root occurs more often than two separated canals with two apex (1,6, 10,17).

Confluent canals are potentially dangerous for endodontic instruments because they usually create an abrupt curvature, with a small radius less than two millimeters and a high degree of the curvature close up to 90 degree (Figure 1). Several studies have demonstrated that an abrupt curvature is a very stressful situation for nickel-titanium rotary instruments and may be a major cause of intracanal failure (The smaller the radius and the higher degree, the more stressful is the curvature (8,13,20).

It must be underlined that a separated instrument does not always result in a negative treatment outcome, because clinicians can bypass or remove the broken instrument (9,16), but this makes the treatment way more difficult to perform and time consuming (Figure 2). Another clinical problem related to confluent canals is that in most of the cases this hidden complexity is perceived by clinicians only when using bigger, more rigid instruments, which are also less resistant to flexural stress. The smaller and more flexible ones, which are also more resistant to cyclic fatigue, can sometimes negotiate these abrupt curvatures without providing a feedback (more difficult progression) to the dentist. Therefore it is very important that clinicians diagnoses these confluent canals before starting rotary instrumentation, because it has been shown that approximately one-third of the broken instrument in the endodontic practice is related to this anatomical complexity (4). On the other hand, if properly understood, confluence can be very easily solved in a relatively simple and efficient way, avoiding the problems related to intracanal breakage of rotary instruments (6).

The purpose of this article is to show first how to manage this confluent canal according to the Vertucci technique (18), and also provide some guidelines about determining if a confluence is present or not, at which level and which is the working length for each instrument.

The Vertucci technique

The Vertucci technique is a well-known technique and that was proposed many years ago and is a very successful one, due to its simplicity. If the Vertucci technique is correctly followed it is very unlikely to break a rotary root canal instrument inside this curvature. The basic concept of the technique is that when we have two confluent canals one canal is usually more straight than the other. Ideally the more straight canal is the only canal that we should instrument to the full working length, while the other canal should be instrumented only to the point where it merges with the easier. This is a more rationale and less stressful strategy, because clinicians avoid to instrument the very complex abrupt curvature where the instrument joins. The Vertucci technique has been suggested many years ago and, when applied, it works nicely in preventing instruments failures.

The main problem is that in some cases confluent canals can be seen radiographically, i.e. in second lower molars with mesial and distal canals joining together (Figure.3), but in the majority of cases due to the superimposition of buccal and lingual/palatal canals clinicians cannot visualize trajectories properly and do not know if the canals join or not. Obviously if they can take a CBCT pre-operative scan. It can very easily seen where the two canals merge and a proper approach and instrumentation technique can be planned accordingly (2).

Understanding the presence of confluent canals

The majority of clinicians, however, utilize a traditional two-dimensional periapical radiograph as a pre-operative radiograph. In such case they need to adopt variations in the operative technique, to precisely understand if a confluence is present and which is the canal which is easier and should be the only one instrumented to the working length. By doing so cases of confluent canals can be successfully and safely completed by using a well-defined clinical approach (Figure 3). The clinical strategy is to understand from the very beginning (before

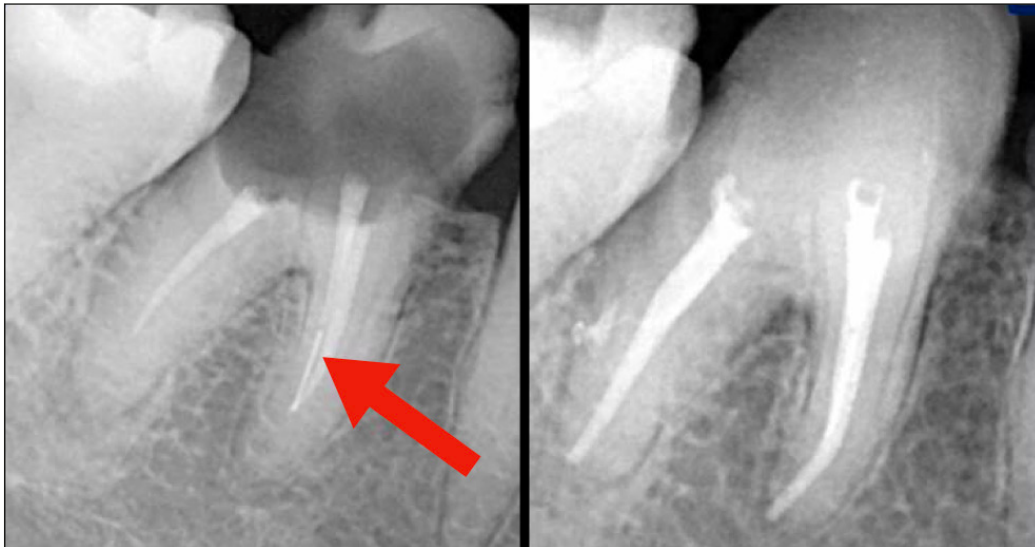


Figure 2. Intraoperative NiTi failure

using rotary instrumentation) where is the confluence, which is the canal that we should instrument to the full working length, and which is the working length of the other canals (how many mm. shorter?) Do achieve these goals a new approach is proposed. It must be underlined that there are also alternative methods, i.e. two canals with two different apex, could be detected by using a few intra-operative radiographs with both instruments at working length with different angulation of the radiographic tube to avoid superimposition, but this means more radiation dose for patients, more time and it may not always clearly show confluent canals.

The proposed technique is simple, efficient and it avoids radiations. It needs only two manual files, usually stainless steel k files size 10 or 15 and an apex locator. In the case n 2 we are treating a lower molar, which always have a mesial buccal and mesial lingual canal, but it is not possible from a periapical radiograph to

evaluate if a confluence is present or not. Therefore we start measuring the working length in both the canals in a traditional way and record both of them (14,15). In the present case the mesial lingual (ML) canal was 21 millimeter and the mesial buccal (MB) was 21,5 millimeters. If we now want to understand whether there is a confluence or there is not a confluence, what must then take another measurement in a slightly different way. We first insert one instrument in a canal (i.e. in the ML one at full working length) and leave it there. At this point we will start inserting the other instrument in the other canal (MB) attached to the apex locator. In the previously taken measurement that MB canal was 21,5 millimeters long, but now something different may happens; if there is a confluence the instrument will reach the point where they join and touch the other one left in the ML. In such a case, the contact between the two instruments will close the electric circuit of the apex locator and a 00

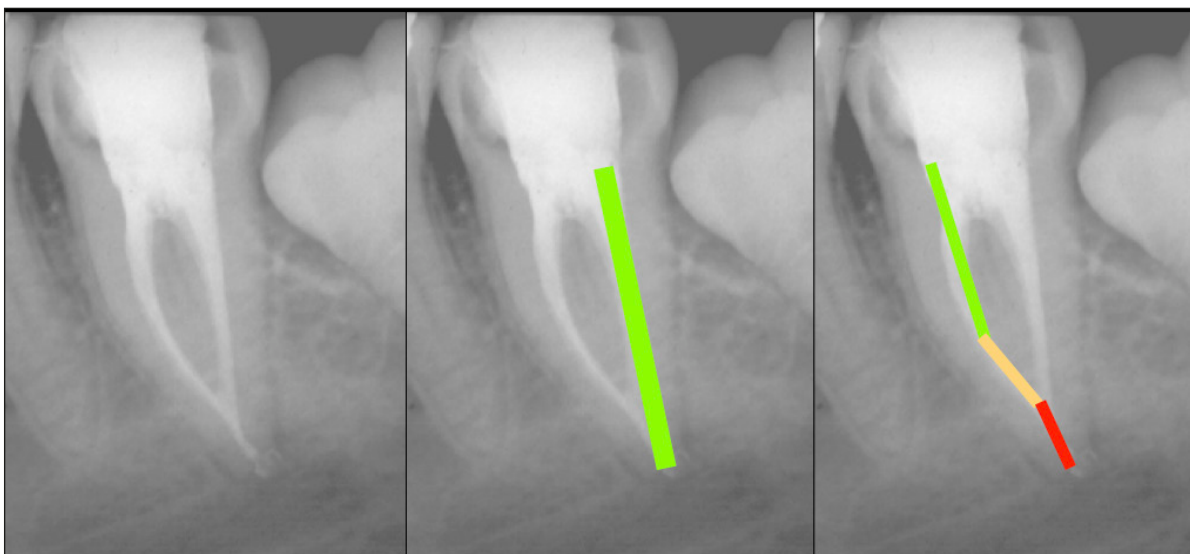


Figure 3. Complexity of curvature in different parts of the canal



Figure 4. Proper strummentation of confluent canals

(apex) measurement will be provided by the apex locator even if the file progression was only till 18,5 mm (3 mm shorter than the previous measurement), Clinician now knows that there is a confluence, the confluence is three millimeters millimeters shorter than the initial working length. Therefore, Vertucci technique can be applied with one instrument negotiating one canal at full working length (21mm) and the other one negotiation the second canal only to the merging points (18,5 mm). In the majority of cases initially understanding the presence of the confluence allows clinicians to simply and safely shape confluent canals without any heterogenic errors and instrument failure.

Which canal first?

The above mentioned tips and tricks are extremely useful but in some cases they may not solve all the clinical problems related to these complex anatomies. Even if clinicians make an initial precise determination of the confluence, they still do not know which canal you should instrument first, at the full working length, Ideally they should select the easiest one. In order to understand this concept, a case with three canals joining together in the second maxillary lower molar is presented (Figure 4). Here we can very easily see from the radiograph that the two mesial canals join together and also the distal canal join with the mesial, which is an anatomical complexity that sometimes can be found in the second lower molars (6).

In such cases if clinician does not think ahead which canal first and starts instrumenting to full working length a mesial canal, this will create unnecessary risks and stress on the rotary instruments dealing with a very complex double curvature. So even if the dentists could be able to finish the cases, the shaping procedure will be more complicated and dangerous. There will be some relevant risks of intracanal failure or other iatrogenic errors because the dentist chose to reach full working length in the most complex canal. In this present case if a clinician chooses the distal canal and stop the

preparation of the two mesial canals only to the point where they merge with the distal one, this case becomes quite simple for a good endodontist. If he does the opposite this case can be come very difficult also for a skilled endodontist.

Conclusions

We may conclude that defining which canal first or which is the easiest canal, is also another parameter that clinicians should understand before putting any rotary instrument inside canal canals. To do so, the only, slightly empirical suggestion we can provide is to gently negotiate all canal with small, manual k-files and try to feel which is the canal where the manual instrument seems to progress more easily. It is probably safer to use a smaller file (size 10), but if needed a little bit bigger file manual file (i.e. size 15 or 20) will probably give clinician a better feedback in the way they progress to working length. When clinician understands that there is a confluence and detects with the help of the manual instrumentation which is the easiest canal, then the Vertucci technique can be properly and effectively applied. Many complex cases can do become easy ones (Figure 5).

To summarize our strategies for the management of confluent canals, first of all clinicians must know to know that confluent canals are more frequent than expected and that there are some roots (especially mesial roots of molars) when a confluence is the most common canal configuration and not an exception.

The second recommendation is that clinicians must understand the Vertucci technique, know how to deal with with confluent canals. It is a very simple technique to adopt, it is very safe and very helpful in minimizing the risk of instruments' failure in confluent canals.

Another important recommendation is that clinicians must understand the variations in the anatomy and more precisely the following two parameters: if there is or a confluence or not (are two separated canals). If a confluence is present they must understand



Figure 5. Which canal first?



Figure 6. Proper treatment of hidden confluent mesial canals

confluence where is the confluence located, at what distance from the working length, so they know that that will be the critical point where they have to stop the instrumentation in one canal. This is very important because if they go deeper they will face an abrupt curve, which generates a lot of stress on instrument. The last recommendation is that clinicians must decide which canal is the most simple and consequently which canal they should treat first and reach the working length. If all these clinical guidelines are correctly followed, a very common clinical problem for endodontists can be very easily and quickly resolved, without any additional special devices but only by using knowledge and clinical skills

References

1. Al-Rammahi HM, Chai WL, Nabhan MS, Ahmed HMA. Root and canal anatomy of mandibular first molars using micro-computed tomography: a systematic review. *BMC Oral Health*. 2023 May 29;23(1):339. doi: 10.1186/s12903-023-03036-5. PMID: 37248469; PMCID: PMC10228077.
2. Connert T, Hülber-J M, Godt A, Löst C, ElAyouti A. Accuracy of endodontic working length determination using cone beam computed tomography. *Int Endod J*. 2014 Jul;47(7):698-703. doi: 10.1111/iej.12206. Epub 2013 Nov 15. PMID: 24134733.
3. Duncan HF, Kirkevang LL, Peters OA, El-Karim I, Krastl G, Del Fabbro M, Chong BS, Galler KM, Segura-Egea JJ, Kebschull M; ESE Workshop Participants and Methodological Consultant. Treatment of pulpal and apical disease: The European Society of Endodontology (ESE) S3-level clinical practice guideline. *Int Endod J*. 2023 Oct;56 Suppl 3:238-295. doi: 10.1111/iej.13974. Epub 2023 Sep 29. PMID: 37772327.
4. Feghali M, Xhajanka E, Di Nardo D, Bhandi S, Kassabian P, Seracchiani M, Gambarini G, Testarelli L. Incidence of Different Types of Intracanal Fracture of Nickel-Titanium Rotary Instruments: A Systematic Review. *J Contemp Dent*

- Pract. 2021 Apr 1;22(4):427-434. PMID: 34267014.
5. Feghali M, Al Atta AAD, Galli M. A comparative analysis of mechanical properties of different reciprocating Niti endodontic instruments. *Annali di Stomatologia I* 2023; 14(4): 9-13 ISSN 1971-1441 I DOI: 10.59987/ads/2023.4.9-13
6. Furri M. Differences in the confluence of mesial canals in mandibular molar teeth with three or four root canals. *Int Endod J*. 2008 Sep;41(9):777-80. doi: 10.1111/j.1365-2591.2008.01431.x. Epub 2008 Jul 14. PMID: 18637847.
7. Gambarini G. Shaping and cleaning the root canal system: a scanning electron microscopic evaluation of a new instrumentation and irrigation technique. *J Endod*. 1999 Dec;25(12):800-3. doi: 10.1016/S0099-2399(99)80300-8. PMID: 10726524.
8. Gambarini G, Miccoli G, Seracchiani M, Khrenova T, Donfrancesco O, D'Angelo M, Galli M, Di Nardo D, Testarelli L. Role of the Flat-Designed Surface in Improving the Cyclic Fatigue Resistance of Endodontic NiTi Rotary Instruments. *Materials (Basel)*. 2019 Aug 8;12(16):2523. doi: 10.3390/ma12162523. PMID: 31398814; PMCID: PMC6720207.
9. Madarati AA, Hunter MJ, Dummer PM. Management of intracanal separated instruments. *J Endod*. 2013 May;39(5):569-81. doi: 10.1016/j.joen.2012.12.033. Epub 2013 Mar 15. PMID: 23611371.
10. Mashyakh M, Gambarini G. Root and Root Canal Morphology Differences Between Genders: A Comprehensive *in-vivo* CBCT Study in a Saudi Population. *Acta Stomatol Croat*. 2019 Sep;53(3):213-246. doi: 10.15644/asc53/3/5. PMID: 31749454; PMCID: PMC6820446.
11. Plotino G, Grande NM, Mazza C, Petrovic R, Testarelli L, Gambarini G. Influence of size and taper of artificial canals on the trajectory of NiTi rotary instruments in cyclic fatigue studies. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010 Jan;109(1):e60-6. doi: 10.1016/j.tripleo.2009.08.009. Epub 2009 Nov 17. PMID: 19926504
12. Plotino G, Grande NM, Mercade M, Cortese T, Staffoli S, Gambarini G, Testarelli L. Efficacy of sonic and ultrasonic irrigation devices in the removal of debris from canal irregularities in artificial root canals. *J Appl Oral Sci*. 2019 Jan 7;27:e20180045. doi: 10.1590/1678-7757-2018-0045. PMID: 30624461; PMCID: PMC6322636.
13. Pruett JP, Clement DJ, Carnes DL Jr. Cyclic fatigue testing of nickel-titanium endodontic instruments. *J Endod*. 1997 Feb;23(2):77-85. doi: 10.1016/S0099-2399(97)80250-6. PMID: 9220735.
14. Simon S, Machtou P, Adams N, Tomson P, Lumley P. Apical limit and working length in endodontics. *Dent Update*. 2009 Apr;36(3):146-50, 153. doi: 10.12968/denu.2009.36.3.146. PMID: 19480102.
15. Srivastav A, Chandra R, Siddiqui S, Chowdhary D, Katiyar A, Khan RA. Evaluation of Different Techniques of Working Length Determination in Comparison with CBCT. *Indian J Dent Res*. 2023 Oct 1;34(4):405-409. doi: 10.4103/ijdr.ijdr_404_22. Epub 2024 Apr 19. PMID: 38739821.
16. Terauchi Y, Ali WT, Abielhassan MM. Present status and future directions: Removal of fractured instruments. *Int Endod J*. 2022 May;55 Suppl 3:685-709. doi: 10.1111/iej.13743. Epub 2022 Apr 18. PMID: 35377473.
17. Valenti-Obino F, Di Nardo D, Quero L, Miccoli G, Gambarini G, Testarelli L, Galli M. Symmetry of root and root canal morphology of mandibular incisors: A cone-beam computed tomography study in vivo. *J Clin Exp Dent*. 2019 Jun 1;11(6):e527-e533. doi: 10.4317/jced.55629. PMID: 31346372; PMCID: PMC6645266
18. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. *Endod Top*. 2005;10:3-29.
19. Zanza, A.; D'Angelo, M.; Reda, R.; Gambarini, G.; Testarelli, L.; Di Nardo, D. An Update on Nickel-Titanium Rotary Instruments in Endodontics: Mechanical Characteristics, Testing and Future Perspective—An Overview. *Bioengineering* 2021, 8, 218. <https://doi.org/10.3390/bioengineering81202189>
20. Zanza A, Seracchiani M, Di Nardo D, Reda R, Gambarini G, Testarelli L. A Paradigm Shift for Torsional Stiffness of Nickel-Titanium Rotary Instruments: A Finite Element Analysis. *J Endod*. 2021 Jul;47(7):1149-1156. doi: 10.101