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## Case Report

# Five-rooted permanent maxillary second molar: CBCT findings of an extremely rare anatomical variant

Andrea Borghesi, MD<sup>a,\*</sup>, Silvia Michelini, MD<sup>b</sup>, Elena Tononcelli, MD<sup>a</sup>, Roberto Maroldi, MD<sup>a</sup>

<sup>a</sup>Department of Radiology, Medical School, University of Brescia, Piazzale Spedali Civili, 1, Brescia I-25123, Italy

<sup>b</sup>Department of Radiology, Fondazione Poliambulanza Istituto Ospedaliero, Brescia, Italy

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## ABSTRACT

Permanent maxillary second molars (MSMs) are the most difficult teeth to treat endodontically because of their complex root canal system. Most MSMs have 3 roots with 3 root canals; however, variations in the root canal configuration and in the number of roots are common. The presence of extra roots in MSMs has been described by several authors, and the reported incidence of 4-rooted MSMs ranges from 0.98% to 5.6%. However, extremely few cases have been reported in the literature in which a living human subject was found to have a 5-rooted MSM. The present report describes the first case of a 5-rooted MSM in a white European subject diagnosed by cone-beam computed tomography.

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## Introduction

Permanent maxillary second molars (MSMs) are the most difficult teeth to treat endodontically because of their complex root anatomy and the high variability of the root canal system [1]. Therefore, an adequate knowledge of the complexity of their root morphology is critical to reduce the number of incomplete endodontic treatments and avoid complications.

In clinical practice, periapical radiography is commonly used to assess the root canal system before endodontic treatment; however, this radiographic technique failed to identify extra roots or canals in a significant number of cases [2]. Thus, to overcome this limitation, a preoperative cone-beam com-

puted tomography (CBCT) scan should be suggested whenever an endodontic procedure is planned on a multirrooted tooth, especially a MSM.

Most MSMs have 3 roots with 3 root canals [3,4]. These 3 roots are usually the mesiobuccal (MB) root, the distobuccal (DB) root, and the palatal root [4]. However, variations in the root canal configuration and in the number of roots are common in MSMs [3].

Variations in the MB root are not unusual, and the most common variant is the presence of a secondary MB (MB2) root canal, with an incidence ranging from 13.9% to 78.9% [1,4]. Conversely, variations in the number of root canals within the DB and palatal roots are rarely reported in the literature [5].

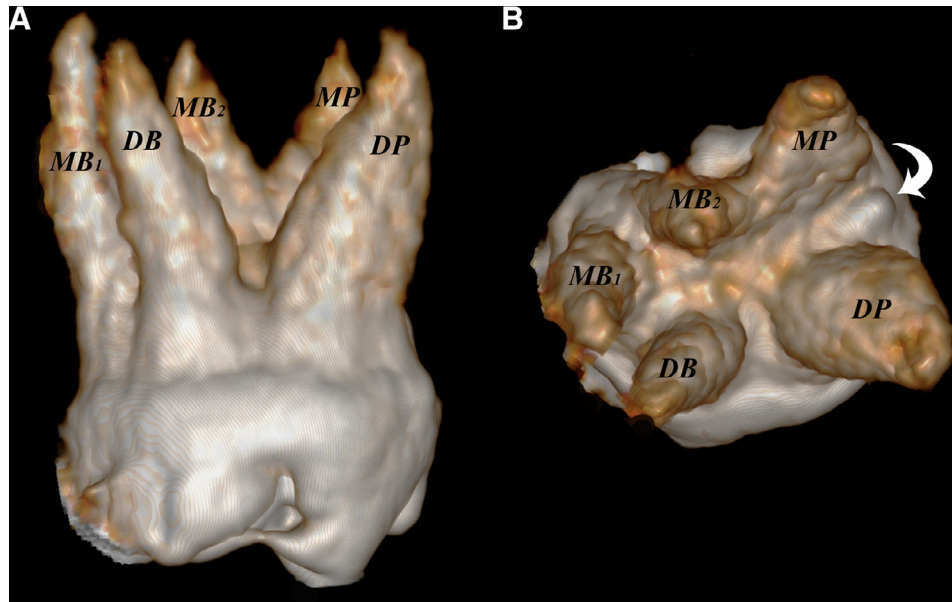
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\* Corresponding author.

E-mail address: [andrea.borghesi@unibs.it](mailto:andrea.borghesi@unibs.it) (A. Borghesi).

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**Fig. 1 – A 44-year-old woman with 5-rooted right maxillary second molar. Three-dimensional volume-rendering images showing the external root morphology of the 5-rooted maxillary second molar from distal (A) and superior views (B). A small enamel pearl is visible in the furcation area between the MP and DP roots (curved arrow). DB, distobuccal root; DP, distopalatal root; MB1, primary mesiobuccal root; MB2, secondary mesiobuccal root; MP, mesiopalatal root.**

The presence of extra roots has also been described by several authors [3,4,6]. However, to the best of our knowledge, the occurrence of 5-rooted MSMs has only been reported in the literature for 2 Asian (Indian) patients (1 male and 1 female) [7,8].

The present report describes a case involving a 44-year-old white European female who was incidentally diagnosed with 5-rooted MSM following a CBCT scan.

## Case report

A 44-year-old woman was referred to our Department of Radiology for CBCT analysis of periapical lesions in the right maxillary first molar (tooth #3 in the Universal Numbering System [9]). Informed consent for the examination and for the use of personal data was obtained from the patient. The examination was performed with a CBCT scanner (NewTom 5G, QR, Verona, Italy) with the following parameters: tube voltage, 110 kVp; tube current, 3.9 mA; exposure time, 5 s; and field of view, 12 × 8 cm. The volume obtained from the acquisition was reconstructed as axial sections with an isotropic voxel size of 200 μm.

The CBCT scan allowed the identification of an unexpected anatomical variant characterized by the presence of an MSM with 5 separate roots on the right maxilla. The 5-rooted MSM (tooth #2) exhibited 2 MB roots (MB1 and MB2), 1 DB root, 1 mesiopalatal (MP) root and 1 distopalatal (DP) root, each with its own root canal (Figs. 1 and 2). The largest root was the DP root (Figs. 1 and 2), with a maximum diameter at its cervical third of 4.8 mm. The longest roots were the MB1 and DP roots (Figs. 1 and 2), with a length from their origin of 8.8 mm.

With regard to the visibility of the root canal system of the 5-rooted MSM, we observed that the visibility of the root canals decreased from the cervical to the apical third of the root (Fig. 2). The DP root canal had the best visibility, while the worst root canal visibility was observed within the MB2 root (Fig. 2).

The CBCT scan also allowed the detection of a small enamel pearl in the furcation area between the MP and DP roots (Figs. 1 and 2).

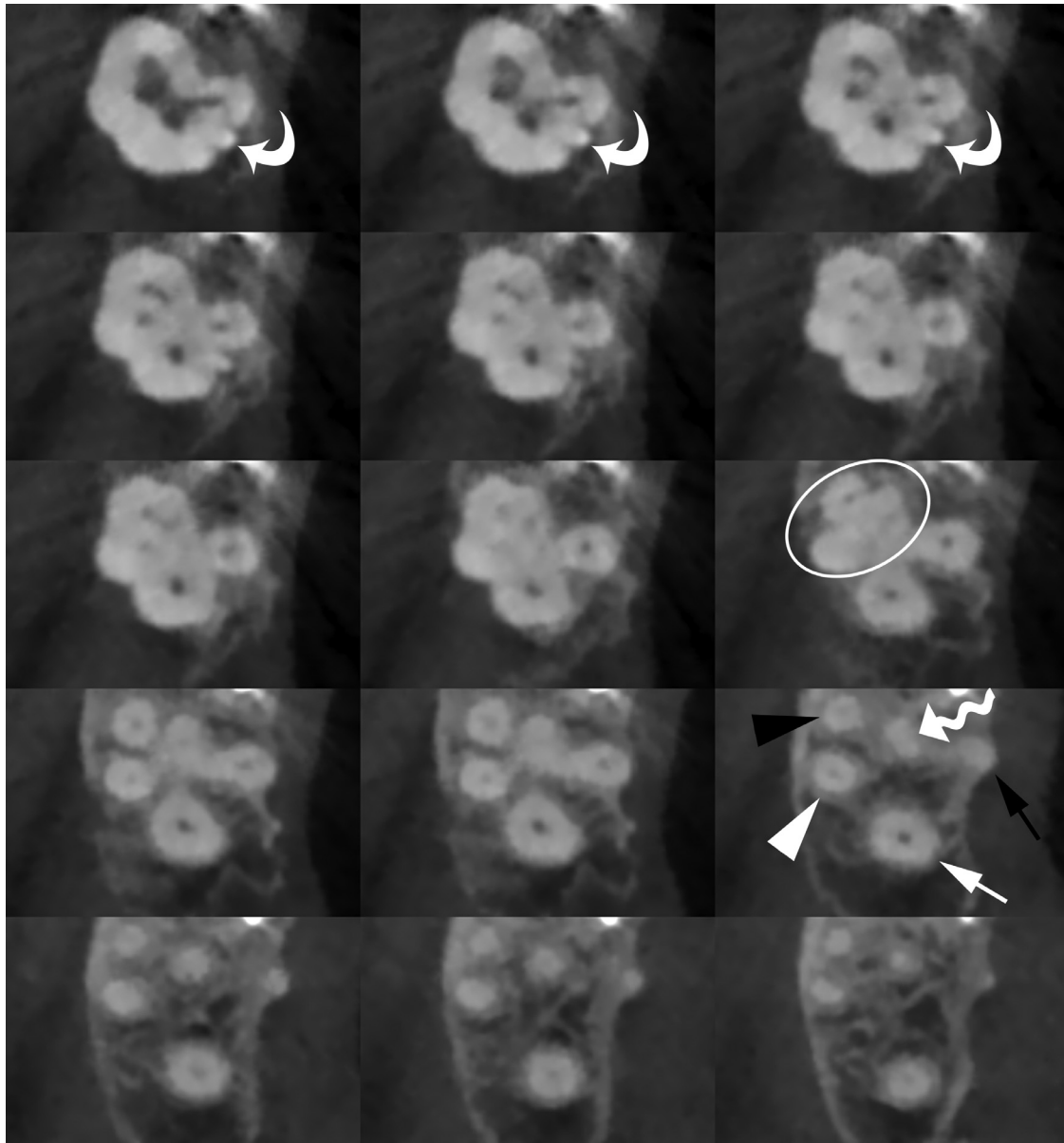
Both the 5 roots and the enamel pearl of the right MSM were not identifiable by the panoramic radiography (obtained 2 weeks before the CBCT scan) and panoramic CBCT reconstruction with 20-mm slice thickness (Fig. 3).

## Discussion

The embryological reason for which an extra root develops is not yet known. However, it seems that this anatomical variant is influenced by several factors, the main being Hertwig's epithelial root sheath, a double-layered epithelial structure between dental papilla and dental follicle that guides the formation of roots, determining their size, shape, and number [10].

The occurrence of an extra root in MSMs is not an unusual finding during CBCT exams, and the reported CBCT incidence of 4-rooted MSMs ranges from 0.98% to 5.6% [3,6].

From a clinical point of view, patients with extra roots exhibit an increased risk of incomplete endodontic treatments. Therefore, considering the non-negligible incidence of this anatomical variant in MSMs, a detailed anatomical knowledge of root variations may help endodontists increase the success rate of endodontic treatments.



**Fig. 2 – Axial CBCT images showing the internal root morphology of the 5-rooted maxillary second molar at different levels, from the cervical to the apical thirds of the roots. A small enamel pearl in the furcation area of the palatal roots is also observed (curved arrow). Ellipse, buccal root trifurcation; black arrowhead, primary mesiobuccal root; wavy arrow, secondary mesiobuccal root; white arrowhead, distobuccal root; black arrow, mesiopalatal root; white arrow, distopalatal root.**

In clinical practice, the presence of an extra root can be evaluated using different radiological techniques, including periapical radiography, multidetector computed tomography and CBCT. The main advantage that makes CBCT a particularly attractive method for obtaining a detailed assessment of root morphology is its high spatial resolution with a relatively low radiation dose. Therefore, CBCT is regarded as the best noninvasive radiological technique for assessing root morphology in daily practice [11]. In addition, CBCT has currently become the diagnostic tool of choice in the study of the anatomy and diseases of the dental arches, such as anatomical variants, periapical inflammatory lesions, cysts, and tumors [11–14].

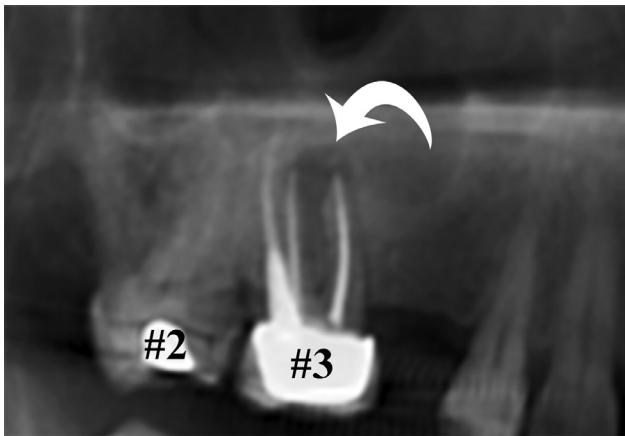
The present report describes the first case in which the occurrence of 5-rooted MSM has been observed in a white European (Italian) subject.

In a literature search of the PubMed database, we identified only 2 other case reports (published in 2010 and 2017) in which a human subject had a 5-rooted MSM [7,8]. In both cases, the patients were of Asian (Indian) origin [7,8]. In a report published in 2010, Kottoor et al [7] described a case involving a 35-year-old man who underwent CBCT exam of the maxilla to confirm an unusually complex root canal anatomy of the right MSM observed during endodontic exploration for a secondary carious lesion. In a report published in 2017, Muppa et al [8] described a case involving a 19-year-old woman who underwent

**Table 1 – Five-rooted permanent maxillary second molars reported in the literature.**

Author	Country	Gender	Analysis	Radiological technique	Side	Roots/canals
Kottoor et al [7]	India	Male	In vivo	CBCT	Right	3 B-2 P
Muppa et al [8]	India	Female	Ex vivo	MDCT	Right	2 B-3 P
Present case	Italy	Female	In vivo	CBCT	Right	3 B-2 P

B, buccal; P, palatal.



**Fig. 3 – Cropped panoramic CBCT reconstruction with 20-mm slice thickness provides a view similar to that of a panoramic radiography. Periapical inflammatory lesion around the apex of the buccal roots of the right maxillary first molar (#3) is shown (curved arrow). Neither all of the 5 roots nor the enamel pearl of the right maxillary second molar (#2) are detectable.**

extraction of the right MSM for a deep carious lesion. After extraction, the unusual root anatomy of this tooth was analyzed with a multidetector computed tomography scanner.

The similarity that unites our case to the previous cases [7,8] is the side of the 5-rooted MSM (right side). While the 5-rooted MSMs described in the present article and by Kottoor et al [7] exhibited 3 buccal and 2 palatal roots, in the case described by Muppa et al [8], the 5-rooted MSM exhibited 2 buccal and 3 palatal roots. This difference could be due to the different method of analysis (in vivo vs ex vivo); in particular, the lack of anatomical landmarks in the ex vivo analysis performed by Muppa et al [8] may have influenced the correct localization (buccal or palatal) of the 5 roots. The similarities and differences between our case and the cases described by Kottoor et al [7] and Muppa et al [8] are summarized in Table 1.

In conclusion, the present report describes the first case in the literature involving the occurrence of a 5-rooted MSM in a white European subject. Given that the occurrence of extra roots or canals is possible, especially in MSMs, endodontists should be aware of the presence of such anatomical variants to increase the success rates of root canal treatments. In addition, to prevent future incomplete endodontic procedures, the occurrence of extra roots or canals should be reported

even when the CBCT scan is performed for another clinical indication.

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