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Case Series

Dentistry Section

CBCT Assisted Endodontic Management of Teeth for Aberrant Roots: Case Series

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ABSTRACT

Cone Beam Computed Tomography (CBCT) is a radiographic imaging technique which provides accurate, high-quality, three-Dimensional (3D) images of various parts of head and neck. They deliver images with a spatial resolution of teeth required for diagnosis, treatment planning and postoperative evaluation. The aim of this case series is to describe the importance of determining the root canal morphology with the help of CBCT. This case series presents the endodontic management of a three rooted maxillary first premolar, maxillary first molar with single palatal root and three canals and mandibular first molar with five canals using CBCT. The axial images from CBCT show Gulabivwala K Type I (3-1) canal pattern in distal root of mandibular first molar (36) and palatal root of maxillary first molar (26) according to Al-Quadah Awawdeh showed Type XXII (3-2-1) canal configuration. Biomechanical preparations of all the teeth were done with hand as well as rotary file systems and lateral compaction obturation technique was used. With the advancing technology in imaging, there are possibilities to detect and treat a number of variations particularly in posterior teeth leading to successful endodontic treatment.

Keywords: Mandibular first molar, Maxillary first premolar, Maxillary first molar three canals, Palatal root, Three roots

INTRODUCTION

The prognosis of root canal therapy depends on three dimensional hermetic seal and biomechanical preparation. Inability to locate root canal results in recurrent infection leading to failure of root canal therapy [1].

In a review of literature, it is stated that maxillary first premolars comprised of single root in 41.7% or two rooted in 56.6% and three rooted in 1.7%. Irrespective of number of roots, two root canals are presented in 86.6% and root canal configuration comprises of type IV (64.8%), type II (13.5%) and type I (11.4%) [2].

In a similar literature quoting clinical considerations in maxillary first molar stated the presence of three roots in 95.9%, two roots in 3.9%, fused two or three roots in 5.2% and rarely c-shaped roots (0.12%) [3]. Presence of variations in each root is also published as in mesiobucccal roots two canals in 56.8% and single canal in 43.1%, one distobuccal canal was contained in one root in 98.3% and palatal root has one canal in 99% cases [3].

Thews ME et al., reported two cases of two canal two roots, one root two canals fusing to a common foramina configuration [4]. Some of the authors also reported a single palatal root containing two separate orifices and root canals and also one orifice, a bifurcated canal, and two foramina [5,6]. Very few clinicians have reported presence of three palatal canals and its occurrence seems too rare [7,8].

Normal anatomy of mandibular first molar constitutes two roots with either three or four root canals [9]. Number of root canals are mostly three canals in 61.3%, four canals in 35.7%, and five canals in 1%. Canal configuration of the mesial root configuration showed two canals in 94.4%, three canals in 2.3% and comprised of Vertucci type IV (52.3%) and type II 35%) configuration. Distal Root canal configuration consisted of type I in 62.7%, types II (14.5%) and IV (12.4%) [9].

Because of the two dimensional nature of conventional radiography, it does not consistently reveal the actual number of canals present in teeth [10]. Root architecture and morphology can be visualised by three dimensional CBCT imaging in cases where conventional radiography fails to provide enough data [11].

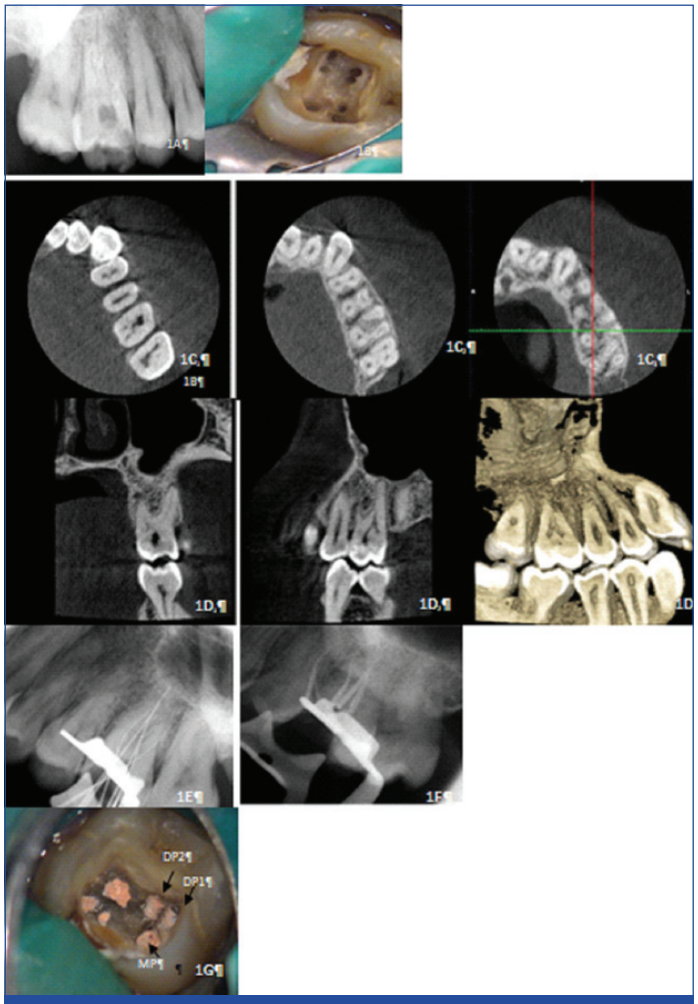
This case series reports successful, non-surgical management of maxillary first premolar with three roots, and three root canals, three palatal canals in single palatal root canal anatomy of a maxillary molar, a mandibular first molar with three canals in distal root using CBCT.

CASE REPORT 1

A 25-year-old male patient of Indian origin reported to the Department of Dentistry with a chief complaint of pain in left upper back tooth since few months. Pain was spontaneous, throbbing, localised, radiating pain aggravated on taking hot, cold and on sleeping, relieved after few hours automatically or on medication. It was not associated with any systemic signs and symptoms. Patient's medical history, family history was non-contributory. There was no significant past dental history. Clinically, there was visible discoloration and deep cavity seen on the mesial surface of 26. Intraoral periapical radiograph revealed radiolucency on mesio-occlusal aspect of tooth involving pulp and there were no signs of periapical involvement suggestive of irreversible pulpitis in relation to 26 [Table/Fig-1a]. There was an exaggerated response to cold (ice piece), heat (gutta-percha stick), and electric pulp testing (Parkell Electronics Division, Farmingdale, NY) suggestive of acute pulpitis. Hence, it was diagnosed with acute irreversible pulpitis requiring endodontic therapy.

The patient was prepared for endodontic treatment of left maxillary first molar and received local anaesthesia of 2% lidocaine with 1:80,000 epinephrine. Rubber dam was used for isolation and a conventional endodontic access cavity opening was prepared. After extirpation of the coronal pulp, probing was done with a DG16 endodontic explorer. Three principal root canal orifices-mesiobuccal, distobuccal and palatal and also a small haemorrhagic point was noted adjacent to the large palatal orifice. The conventional access was slightly gauged palatally to additional canals, to get access to distopalatal 1 (DP1) and distopalatal 2 (DP2) [Table/Fig-1b]. The presence of extra canal in palatal root was suspected and hence CBCT was advised for confirmation. The CBCT confirmed the presence of extra canals in palatal root of Al-Quadah Awawdeh Type XXII canal configuration (3-2-1) [Table/Fig-1c,d]. The working length of each canal was estimated by using apex locator (Root ZX Mini, JMorita, Japan), and confirmed with intraoral periapical radiograph [Table/Fig-1e]. The canals were initially instrumented

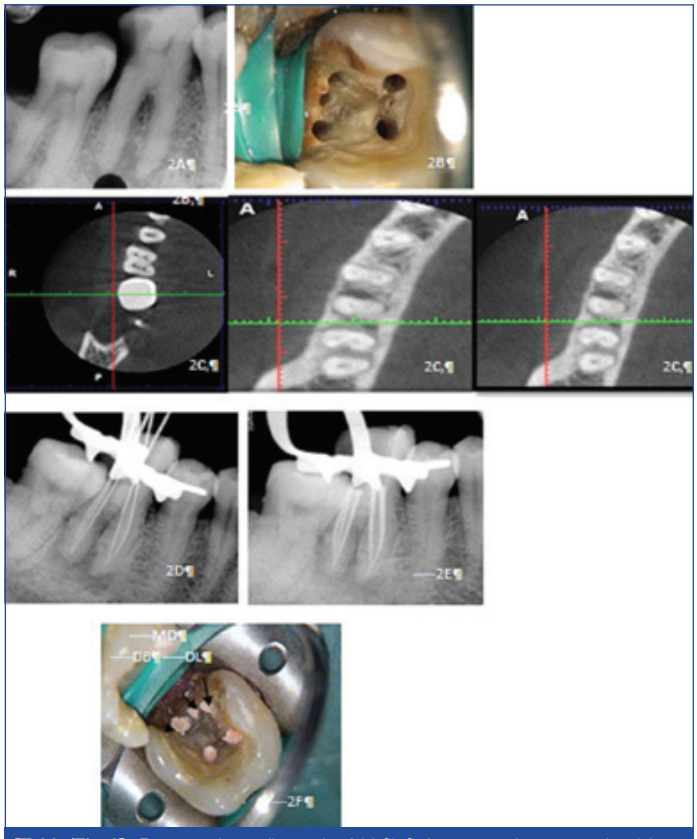
with #15 nickel-titanium files (Dentsply Maillefer) under irrigation with 5.25% sodium hypochlorite. Biomechanical preparation was performed using the crown-down technique with nickel-titanium rotary instruments (Protaper, Dentsply India Pvt., Ltd., Bengaluru, Karnataka, India). The mesiopalatal canal was enlarged till F2, 25.08% file. DP1, DP2, mesiobuccal, MB2 and, distobuccal enlarged till F1, 20.07%. Master cones were confirmed, sealing of root canal space was done with gutta-percha and AH plus resin sealer using lateral condensation technique and tooth was restored with a posterior composite filling [Table/Fig-1f,g]. Crown was placed within three days. The patient was asymptomatic when reviewed three months later. Pulp vitality tests were repeated at the review appointment, there was no response to it.



[Table/Fig-1]: Preoperative radiograph of 26 [1a]; Modification of access cavity preparation 26 [1b]; CBCT image of 26 [1c] $1C_1$: Axial view -Cervical section, $1C_2$:Axial view -Middle section,$1C_3$:Axial view -Apical section; CBCT image of 26 [1d]$1D_1$: Coronal section,$1D_2$: Saggital section,$1D_3$: 3D-view; Radiograph of 26 for determination of working length showing 3 canals [1e]; Obturation radiograph of 26 [1f]; Postobturation clinical image of 26 [1g].

CASE REPORT 2

A 34-year-old female patient with a chief complaint of pain and swelling in her lower left back region of the jaw since few months, reported to Department of Conservative Dentistry and Endodontics. Pain was spontaneous, throbbing, localised, radiating pain aggravated on taking hot, cold and on sleeping, relieved after few hours automatically or on medication. Medical and family history was non-contributory. On clinical examination, a deep carious lesion associated with the mandibular left first molar 36 was found. On evaluation of the pulp status, tooth showed no response with cold (ice piece), heat (gutta-percha stick), and electric pulp testing (Parkell Electronics Division, Farmingdale, NY) revealed non-vital tooth with respect to 36 [Table/Fig-2a]. The patient was prepared for endodontic treatment of left mandibular first molar and received local anaesthesia of 2% lidocaine with 1:80,000 epinephrine. The tooth was isolated by rubber dam and a conventional endodontic access opening was made. After removing the coronal pulp and probing with a DG16 endodontic explorer, four principal root canal orifices-mesiobuccal, mesiolingual, distobuccal and distolingual and also a small haemorrhagic point was noted in between the two distal canals called to be middle distal canal. No modification was done to the conventional access cavity [Table/Fig-2b]. The presence of extra canal between two distal canals was confirmed by using CBCT and Gulabivwala k Type I (3-1) canal pattern was seen [Table/Fig-2c]. The working length of each canal was estimated by using apex locator (Root ZX Mini, JMorita, Japan), and confirmed with intraoral periapical radiograph [Table/Fig-2d]. The canals were initially instrumented with #15 nickel-titanium files (Dentsply Maillefer) under irrigation with 5.25% sodium hypochlorite. Biomechanical preparation was performed using the crown-down technique with nickel-titanium rotary instruments (Protaper, Dentsply India Pvt., Ltd., Bengaluru, Karnataka, India). The mesiobuccal, mesiolingual, distobuccal and distolingual till enlarged till F2, 25.08% file, and middle distal canal enlarged till F1 20.07%. Master cones were confirmed, sealing of root canal space was done with gutta-percha and AH plus resin sealer using lateral condensation technique and tooth was restored with a posterior composite filling [Table/Fig-2e,f]. Metal ceramic crown was placed to 36 after a week.

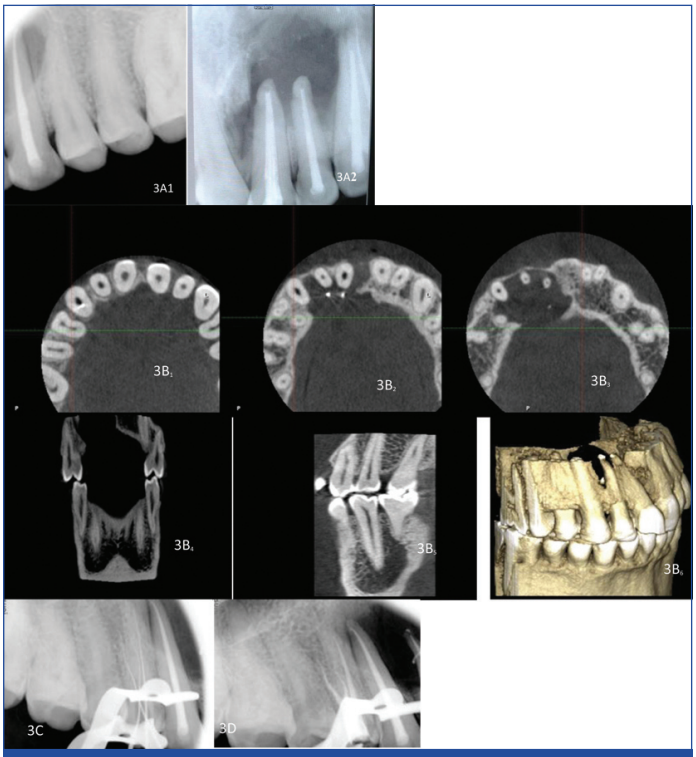


[Table/Fig-2]: Preoperative radiograph of 36 [2a]; Access cavity preparation 36 [2b]; CBCT image of 36 [2c]; $2C_1$: Axial View-Cervical Section; $2c_2$: Axial View-Middle Section; $2c_3$: Axial View-Apical Section; Radiograph of 36 for determination of working length showing 3 canals [2d]; Postobturation radiograph of 36 [2e]; Postobturation image of 36 [2f]

CASE REPORT 3

A 28-year-old male patient with a chief complaint of pain and swelling in his upper front right region of the jaw since one week reported to Department of Conservative Dentistry and Endodontics. Medical and family history was non-contributory. He had met with a road traffic accident few years back. Severe pain in 11, 12 was started seven months back forcing him to visit dentist. He was advised root canal treatment for 11, 12, and 13. He didn't undergo any treatment as pain subsided with medication. Occasionally, he experienced dull localised pain in the same region making him to visit dentist. He reported to us in the Department of

Dentistry. Thermal and electric pulp testing revealed no response with 11,12,13 and 14, radiographic examination showed large periapical radiolucency involving root apex of 11, 12, 13 and palatal 14 [Table/Fig-3a]. To determine extent of lesion, the patient was advised three dimensional radiographs. CBCT showed presence of three roots and three canals with tooth number 14 (vertucci type VIII) [Table/Fig-3b]. Patient was prepared for endodontic treatment of all the infected teeth and review for surgical excision of lesion.



[Table/Fig-3]: Preoperative radiograph of 11, 12, 13, 14 [3a]; CBCT images of 14 [3b]; ($3B_1$: Axial View -Cervical Section; $3B_2$: Axial View -Middle Section; $3B_3$: Axial View -Apical Section; $3B_4$: Coronal Section; $3B_5$: Saggital Section; $3B_6$: 3D VIEW); Radiograph of 14 for determination of working length showing 3 canals [3c]; Postobturation radiograph of 14 [3d].

The patient was prepared for endodontic treatment of left maxillary first premolar and received local anaesthesia of 2% lidocaine with 1:80,000 epinephrine. A rubber dam was placed and a conventional endodontic access opening made. After removing the coronal pulp and probing with a DG16 endodontic explorer, two principal root canal orifices-buccal, palatal and; in addition, a small haemorrhagic point were noted adjacent to the buccal orifice. The conventional access was modified to a T-shape to improve access to additional canal. The working length of each canal was estimated by means of an apex locator (Root ZX Mini, J Morita, Japan), and confirmed with intraoral periapical radiograph [Table/Fig-3c]. The canals were initially instrumented with #15 nickel titanium files (Dentsply Maillefer) under irrigation with 5.25% sodium hypochlorite. Biomechanical preparation was performed using the crown-down technique with nickel-titanium rotary instruments (Protaper, Dentsply India Pvt., Ltd., Bengaluru, Karnataka, India). The palatal canal was enlarged till F2, 25.08% file, mesiobucal and, distobucal enlarged till F1, 20.07%. Master cones were confirmed, sealing of root canal space was done with gutta-percha and AH plus resin sealer using lateral condensation technique and tooth was restored with a posterior composite filling [Table/Fig-3d]. Patient was asked for review after one month or if he is symptomatic. After one month, patient was found to be asymptomatic hence, crowns were placed and patient was called after three months.

In all the three cases, patients were comfortable, well-tolerated the long procedure and there were no complications related to CBCT or the root canal treatment. No genetic analysis or significant genetic history was elucidated.

DISCUSSION

Effective management of endodontic therapy requires good understanding, perceiving and recognising the morphology, anatomy of roots and root canal. The diagnosis and management of extra roots or root canals pose an endodontic challenge. Missing a canal and obturating it is the main cause for failure of endodontic treatment. It aggregates to 42% in the endodontic failure teeth [12]. Thus, a careful understanding and diagnosis of canal anatomy are of utmost importance for the successful management of such cases.

The management of these should start sequentially from preoperative clinical assessment, radiography and advanced radiography.

Clinical Assessment

Preoperative clinical assessment of the crown structure can hint the variations in root canal system. If the mesiodistal width of crown is more compared to buccolingual width; it may indicate presence of extra roots or root canals because dentinogenesis occurs around the canal [13]. If the tooth is carious and its structure is damaged the contralateral tooth might hint you the structure. Assessing the dentinal map, use of DG 16 in locating the orifice, laws of symmetry in canal orifice location and checking for sodium hypochlorite effervescence at the canal orifice are other clinical methods to check extra canals [1].

Radiographic Assessment

Preoperative radiographic evaluation is an important adjuvant to determine the number of roots and root canals. Preoperative intraoral periapical radiographs taken in paralleling technique with angulated radiographs mesial and distal can identify the number of roots.

According to Sieraski SM et al., if in a radiograph image mesiodistal dimension at the mid-root is more than mesiodistal dimensions of crown there can be a possibility of three-roots in maxillary premolars [14]. Researchers also stated that if in two consecutive X-rays a well-defined broad image of root canal fades off or narrows, it can be considered as a sign that there is deviation from normal anatomy and could be division of root [15,16]. Hence, accurate preoperative radiographs can hint the presence of variations.

If in a working length radiographic image with a smaller file and in distal projection taken after initial negotiation, if an endodontic file deviates from the centre of the root, an extra canal can be suspected [1].

Advanced Radiographic Imaging

Advanced radiography such as CT, Spiral CT, CBCT are of great importance in endodontics. CBCT imaging could be a part of daily endodontic practice starting from diagnosis to the management of endodontic lesions and its importance in determining the morphology and configuration of roots is invaluable [17,18].

In a conventional radiography, a three-dimensional structure is converted into two dimensional image leading to loss of information. CBCT overcomes the limitations of two-dimensional imaging by limiting unwanted shadows, geometric distortions, and superimpositions and also creating high-resolution 3D images root canal systems.

CBCT has a distinct advantage over conventional CT scans in limiting X-ray beam, rapid scan time and reduction of dose [18,19].

In an in-vitro study evaluating the efficacy of CBCT, spiral CT, peripheral Quantitative CT (pQCT) peripheral quantitative CT and digital radiographs were identification of root canal configuration, the percentage of evaluators failing to identify highest in digital radiography (23.8%) followed by contrast medium-enhanced digital radiographs (14.8%), spiral CT (15.58%), pQCT in (2.05%) and least was CBCT (0.29%.). It was concluded that the difference is mainly attributed to the slice thickness in CBCT which was least in CBCT followed by pQCT and spiral CT [20].

With all the advantages CBCT also has its limitations. Metallic restorations can create artifact-like images [21]. The duration of imaging is significantly more compared to the conventionally periapical radiography which could be difficult in geriatric, pediatric and patients with nervous disorders [22]. The dose of radiation is a concern addressed by The European Society of Endodontology stating the use of it only when additional information is required [23]. The cost is much more expensive compared to the conventional radiograph. Reliability of diagnostic value of CBCT is questioned by few researchers mainly in differentiating periapical pathologies comparing to histopathology [24]. Others stated it can differentiated based on positive and negative grey scale. However, it was questioned whether all CBCT can scan these as true lesions [24].

In the present case, CBCT scanning was used for a better understanding of the complex root canal anatomy. CBCT axial images confirmed the Gulabivwala k Type I (3-1) canal pattern in distal root of 36 and in palatal root of maxillary first molar Al- Quadah Awawdeh Type XXII (3-2-1) canal configuration [25,26]. CBCT axial images also confirmed three roots in maxillary first premolar with vertucci type VIII canal configuration. Tabulation of similar cases reported in the literature is presented in [Table/Fig-4-6] [7,8,27-35].

Author	Side	No. of roots	Number of palatal canals	Canals	Apical foramina
Wong M [7]	Right	1	3	DP1, DP2, MP	3
Maggiore F et al., [8]	Left	1	3	DP1, DP2, MP	3
Present case series	Left	1	3	DP1, DP2, MP	3

[Table/Fig-4]: Review of case reports with three palatal canals in maxillary first molar in a single root [7,8].

Author	Side	No. of roots	Number of distal canals	Distal root configuration
Reeh ES [27]	Left	1	3	MD, DL, DB
Chandra SS et al., [28]	Right	1	3	MD, DL, DB
Jain S [29]	Right	1	3	MD, DL, DB
Kottoor J et al., [30]	Right	1	3	MD, DL, DB
Present case series	Left	1	3	MD, DL, DB

[Table/Fig-5]: Review of case reports with three distal canals in mandibular first molar in a single root [27-30].

Author	Tooth number	No. of roots	Canal configuration	Population
Praveen R et al., [31]	14	3	MB, DB, P	Indian
Mathew J et al., [32]	14	3	MB, DB, P	Indian
Sathyanarayana K et al., [33]	14	3	MB, DB, P	Indian
Theruvil R et al., [34]	24	3	MB, D, MP	Indian
Agarwal PM and Taneja S [35]	14	3	MB, DB, P	Indian
Present case series	14	3	MB, DB, P	Indian

[Table/Fig-6]: Review of case reports with three roots and three canals in maxillary first premolar [31-35].

This case series describes and strengthens the role of CBCT in patients where 2D radiographs questions or doesn't clearly demarcate the association of lesion with the tooth just as in case report three. It also stresses on importance of CBCT not only in detection of variations in root canal architecture and but also to track down the anatomy from cervical to apical in various sections [36]. But, it has its own limitations such as the final outcome of treatment should be assessed for at least four years, meaningfully disappearance of lesion completely [37]. Though CBCT has help in determination, buying the equipment and its maintenance is too expensive at the clinical level. Hence, patient is referred to a diagnostic centre which is time-consuming. The radiation dose is less compared to conventional CT but it is higher than periapical radiograph. Hence, the guidelines states that it should be used in cases where only benefits overweigh risks. Therefore, alternative to CBCT in terms of dose has to be focused [23].

CONCLUSION(S)

Precise diagnosis, treatment planning, and knowledge of the root canal anatomy aids in successful endodontic treatment. Advanced imaging techniques such as CBCT is a valuable adjuvant diagnostic, imaging, in managing cases with variations. The present case series re-emphasises the role of CBCT in treating variations in root canal anatomy. Hence, it should recommended according to the literature CBCT studies and guidelines, cost aspects to restrict its use in cases where there is a deviation from the normal anatomy.

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