Research Article

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Comparative evaluation of various contrast media in visualizing Root Canal Morphology

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ABSTRACT

Background: This in-vitro study aimed to evaluate the efficacy of three distinct contrast media in visualizing the intricate root canal morphology of maxillary posterior teeth.

Materials and Methods: Samples comprising 45 maxillary permanent premolar teeth were utilized for this investigation. Following access cavity preparation and initial cleaning and shaping of the root canals, radiographic visualization was performed using three contrast media: UROGRAFIN 76%, ULTAVIST 300 MG, and OMNIPAQUE 350 MG. Statistical analyses, including the Mann-Whitney U test and Kruskal-Wallis test, were applied to compare the groups, with significance set at $p<0.05$.

Results: Significantly superior visualization was achieved with the combination of UROGRAFIN 76% and 3% NaOCl ($p < 0.05$), followed by OMNIPAQUE 350 MG and ULTAVIST 300 MG. Notably, maxillary premolars exhibited a notably higher degree of contrast media penetration compared to molars.

Conclusion: The findings suggest that radiopaque solutions, particularly UROGRAFIN 76% in combination with 3% NaOCl, hold promise as effective root canal irrigants in therapeutic applications. They facilitate comprehensive assessment of root anatomy, identification of irregularities, and evaluation of penetration and distribution of irrigation solutions, thereby enhancing clinical outcomes.

Keywords: Contrast media, Root canal morphology, lateral canals, internal canal anatomy.

INTRODUCTION

The success of endodontic treatment over the long term hinges on clinicians' comprehensive understanding of the anatomical diversities of the root canal system, emphasizing the importance of proper access to the entire root canal system.[1]A wide range of complex variations in root canal anatomy exists, including root canal configuration type, developmental anomalies and minor canal morphology such as accessory canals and apical deltas. Accessory canals and apical deltas have been associated with pulp disease, primary canal infection, canal reinfection and post-treatment disease.[2] An effective root canal therapy requires precise understanding of the root canal morphology, a thorough evaluation of radiograph images, appropriate access to the canal orifices, extensive chemo-mechanical instrumentation, and three-dimensional (3D) obturation. There has been

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a great deal of discussion on the rather typical genetic and ethnic differences in the structure of the root canal. As a result, the internal root canal anatomy must be identified since it serves as the foundation for the endodontic therapy procedure.[3-4]

Various methods are available for analyzing the root canal morphology such as intraoral radiographs, and radiographic assessment with contrast, cone beam computerized tomography (CBCT). With the introduction of cone-beam computerized tomography (CBCT) in the field of endodontics, the root canal anatomy could be more accurately analyzed.[5] While it does not provide 3D visualisation, conventional radiography is an invaluable tool for quickly visualising the root canal architecture at the chairside. Therefore, techniques that can improve visualisation are needed. Barker *et al*. first attempted to use an endogram to enhance the radiographic visualization of the root canals using contrast media but, the toxic lead-based elastomeric contrast media was difficult to remove from the root canals[6].

Contrast media are a group of chemical agents developed to aid in the characterization of pathology by improving the contrast resolution of an imaging modality.[7] The two types of contrast media are non-ionic (monomers: iohexol, iopamidol, iobitridol, ioversol, iopromide, and iopentol and dimers: iotrol, iotrolan, and iodixanol) and ionic (monomers: diatrizoic acid, iodic acid, and ioglicic acid and dimers: ioxaglic acid and iocarmic acid).[6]

Ultravist is an intravascular injection of the non-ionic, water-soluble x-ray contrast agent iopromide, used as a contrast material for intravenous techniques such computed tomography, urography, arteriography, and angiogram.

Iohexol injection, or **Omnipaque**, (non-ionic) is a radiographic contrast agent that may be administered intrathecally to adults for myelography and contrast enhancement on computerized tomography.

A ionic contrast agent called **Urografin** (Diatrizoate) is utilized in X-ray imaging. This involves computer tomography visualization of the spleen, joints, veins, and urinary system. It can be administered orally, via a nasogastric tube, intravenously, intraperitoneally, or rectally.

The aim of this study was to investigate the efficacy of ionic and non-ionic-based contrast media for enhanced visualization of the root canal anatomy.

MATERIAL AND METHOD

The contrast media that were used for this study were: **Ultravist 300 MG (**Bayer Zydus Pharma Pvt Ltd, India), **Urografin 75**(ionic; Bayer, Madrid, Spain) and **Omnipaque 350 MG** (non-ionic; GE Healthcare, Bengaluru, India),

Sample size calculation

The study was approved by the Ahmedabad Dental College's ethical committee in Ahmedabad, India. The in vitro investigation took place over the course of one month. The study included 45 extracted maxillary posterior teeth (premolars and molars). Teeth without dental caries, teeth with distinct roots, and teeth with good tooth structure were the requirements for inclusion in the sample collection. Among the exclusion criteria were teeth with fused roots, any prior endodontic therapy, any internal or exterior root resorption, any root fracture and calcifications.

The total of 45 teeth were divided into 3 groups (15 each) as per the contrast media that were being used (**G1**: **Omnipaque 350**, **G2:Urografin 76** and **G3:Ultravist 300)**. Human maxillary premolars and molars with intact roots and developed apices were collected from the department of oral surgery at the college. The teeth were stored in a 0.2% thymol solution until use and then cleaned by submerging them in a 5.25% NaOCl (sodium hypochlorite) solution for 30 minutes. The teeth were subsequently placed on wax sheets, and radiographic imaging was carried out in the buccolingual and mesio-distal planes by utilizing a digital radiovisiography (RVG) device that lasted for 0.1 second at 7 mA and 70 kv preoperatively to verify the canal anatomy and its variations.

Application and evaluation of the contrast media

Every single procedure was carried out at a using a dental loupes. Access opening and access cavity preparation was done in each sample using a round bur and Endo-Z bur respectively. Using a no. 8 K-file (MANI, Utsunomiya, Japan), the canal patency was ascertained. RVGs were taken to measure the working length. The working length (WL) was

calculated by deducting 0.5 mm from the radiographic apex. K-file (MANI) sizes #8, #10, #15, and #20 were used in succession for canal preparation upto the WL. With each increasing file size, two milliliters (mL) of 3% NaOCl was used as an irrigant. Absorbent paper points were used to dry the canals. Stirring was used for mixing 1 mL of each contrast solution with 0.5 mL of 5.25% NaOCl. Using a double side-vented 30-gauge endodontic irrigation needle under positive pressure, 0.5 mL of contrast media was inserted into each canal, followed by sequential RVG. RVGs were used to evaluate the depth of the contrast media access in the buccolingual & mesio-distal planes.

Scoring criteria for contrast media ingress in the root canals was as follows:

0: No radiopacity

1: Radiopacity up to the middle third.

2: Radiopacity up to the apical third.

3: Radiopacity of the apical part of the root canal along with the accessory canals.

Statistical analysis

With IBM SPSS statistics 25.0, SPSS South Asia Pvt. Ltd., statistical analysis was carried out. A Kappa analysis of agreement of 0.7–0.8 was used to evaluate the degree of interobserver reliability, and the dependability of Cronbach's alpha between observers was 0.60. To assess the depth of entrance of the three-contrast media in the in vitro investigation on maxillary premolars and molars, the Kruskal-Wallis test was applied. The degree of significance was compared between the groups using the Mann-Whitney U test. At a value of p 0.05, the significance level was established.

RESULTS

Table 1: Comparative scores of contrast media in posterior teeth

Ranks			
GROUP	Number	Mean rank	P value
G1: OMIPAQUE 350MG	15	22.67	**0.022**
G2: UROGRAFIN 76%	15	29.30	
G3: UTRAVIST 300 MG	15	17.03	
Total 45			

* Kruskal-Wallis test

Table 2: Comparative scores between OMIPAQUE 350 MG and UROGRAFIN 76%

Ranks				
GROUP	Number	Mean rank	Sum of ranks	P value
G1: OMIPAQUE 350 MG	15	13.30	199.50	0.129
G2: UROGRAFIN 76%	15	17.70	265.50	
Total 30				

*Mann-Whitney test

Table 3: Comparative scores between UROGRAFIN 76% and ULTAVIST 300 MG.

Ranks				
GROUP	Number	Mean rank	Sum of ranks	P value
G2: UROGRAFIN 76%	15	19.60	294.50	**0.006**
G3: ULTAVIST 300 MG	15	11.40	171.00	
Total 30				

*Mann-Whitney test

Table 4: Comparative scores between OMIPAQUE 350 MG and ULTAVIST 300 MG.

Ranks				
GROUP	Number	Mean rank	Sum of ranks	P value
G1: OMIPAQUE 350 MG	15	17.37	260.50	**0.219**
G3:ULTAVIST 300 MG	15	13.63	204.50	
Total 30				

*Mann-Whitney test

According to the results, it was seen that UROGRAFIN 76% gave much better results during the radiological investigation, followed by OMIPAQUE 350 MG and ULTAVIST 300 MG subsequently (Table 1). And within the intergroup comparison with the three different contrast media, it was seen that there was statistically significant results between UROGRAFIN 76% and OMIPAQUE 350 MG more when compared to UROGRAFIN 76%to ULTAVIST 300 MG and lastly OMIPAQUE 350 MG to ULTAVIST 300 MG. It was observed that ULTAVIST 300 MG did not give significant canal anatomy visualization on the radiograph when compared to the other two contrast media.

DISCUSSION

Understanding the intricacies of the root canal system is paramount for the success of root canal therapy. The complexity of these canals varies based on factors like ethnicity, gender, age, and the presence of anatomical variations like lateral/accessory canals or dental anomalies such as dens invaginatus, dens evaginatus, fusion, gemination, and dens in dente. Moreover, age-related physiological changes in enamel and dentin, like increased mineralization leading to dentinal tubule calcification, create challenges during treatment. Leveraging advanced tools like dental microscopes, loupes, radiographic systems, and cone beam computed tomography (CBCT) improves visualization and magnification, thereby enhancing treatment outcomes in endodontics. However use of such techniques are not always possible due to increased chair side time and availability of such equipments.

Conventional and digital periapical radiographs becomes the most valuable diagnostic tools for assessing root canal morphology in vivo. Nevertheless, these radiographs are not reliable because of inherent limitations, such as the distortion and superimposition of bony and dental structures[8]. To overcome this disadvantage contrast media and radio opaque solution is used as an adjunct. Contrast media (CM) enhance the quality of images, revolutionizing the radiologist's ability to differentiate soft-tissue densities.[9] Because of their high atomic numbers, positive contrast agents cause an increase in the attenuation of x-rays and are considered to be **radiopaque**. They produce an area of decreased radiographic density on the image receptor. Contrast agents that are radiopaque contain elements with high atomic numbers such as iodine, bromine, and barium. When these substances are used to fill area, they essentially make the area radiopaque, and the image appears clear or white on the radiograph.[10] Both ionic and non-ionic contrast media can be used, as contrast media solution can enter the pulp chamber and root canal in vitro due to the lack of pulpal tissues in these areas.

In the current in-vitro study, both ionic (UROGRAFIN 76) and non ionic contrast (omnipaque and ultravist) media are used. The results in this study showed that UROGRAFIN 76 + 3% NaOCl ($p < 0.05$) had the greatest efficacy and the flow within the roots and lateral canals of the molars and premolars, followed by OMNIPAQUE 350, ULTAVIST 300. Compared to the maxillary molars, the maxillary premolars' root canals exhibited a much larger ingress of contrast media penetration due to is uncomplicated root canal anatomy. In some similarly conducted studies, it was found that 5.25% NaOCl aids in the removal of both organic and inorganic debris from the root canal.[3,11] Owing to the lower viscosity of ionic media (omnipaque and ultravist) compared to the non-ionic media UROGRAFIN 76, it was found that that UROGRAFIN 76 + 3% NaOCl ($p < 0.05$) had the greatest flow within the lateral canals of roots of the molars and premolars, followed by OMNIPAQUE 350, ULTAVIST 300.Urograffin, an iodinated ionic radiocontrast agent characterized by its high osmolarity, achieves increased radiopacity due to increased diffusion of ions like barium, bromine. Ionic contrast media has drawbacks such as pain and heat feeling during injection because of the agent's high cytotoxicity, and higher injection pressure needed.[12]

According to a study done by S Govind et al, Xenetix 350, which is an ionic dye, + 5.25% NaOCL had greatest efficacy followed by Urografin 76, Omnipaque 350, Iopamidol. A study done by J.M. BEFORD et al has contrasting results, where ultravist (non-ionic dye) was used as an contrast medium did not show better results in diagnosis of root canal anatomy when used as an adjunct compared to plain radiography.[7]

Clinical settings should consider factors that might limit solution ingress, such as calcifications in the

pulp chamber and root canals, constriction of the root canals, and increased volume of pulp tissues in the chamber. The direction of the roots, the overlapping of the roots, the superimposition of the maxillary sinus/zygoma, and the retention period of the solution in the pulpal chamber against gravity forces were all implicated in the impaired visualization of the root canals in the maxillary molar teeth.

CONCLUSION

Radiopaque solutions can be used to ascertain the clinical occurrence of auxiliary and/or lateral canals on a regular basis. Further research should be done in the future. for detecting any perforations, ledge, or canal transportation focusing on the cleaning efficiency, effectiveness, and visualization of the organic and inorganic contrasting media.

REFERENCES

1. Nabavi S, Rezaei M, Rahbaryfar S. A Maxillary Lateral Incisor with Type V Canal Morphology: A Case Report. Iran Endod J. 2022.

2. H. M. A. Ahmed, P. Neelakantan, P. M. H. Dummer. A new system for classifying accessory canal morphology. International endodontic journal, feb 2018.

3. Boutsioukis C, Arias-Moliz MT, Chávez de Paz LE. A critical analysis of research methods and experimental models to study irrigants and irrigation systems. Int Endod J. 2022 Apr;55 Suppl 2(Suppl 2):295-329.

4. Cleghorn BM, Christie WH, Dong CC. The root and root canal morphology of the human mandibular first premolar: a literature review. J Endod 2007;33:509-516.

5. Rosaline, Hannah; Kanagasabai, Arivunithi; Shaji, Athira; Bose, Shreya; Saeralaathan, Sindhu; Ganesh, Arathi. Analysis of root and canal morphologies of maxillary second molars in a South Indian population using cone-beam computed tomography: A retrospective study. Endodontology.

6. Barker BC, Parsons KC, Mills PR, Williams GL. Anatomy of root canals. I. Permanent incisors, canines and premolars. *Aust Dent J.* 1973

7. Bedford JM, Martin DM, Youngson CC. Assessment of a contrast medium as an adjunct to endodontic radiography. Int Endod J. 2004

8. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG. Endodontic applications of cone-beam volumetric tomography. *J Endod.* 2007;**33**(9):1121–1132.

9. Aspelin P, Bellin MF, Jakobsen JA, Webb JAW. Classification and terminology. In: Thomsen HS, editor. *Contrast media. Safety issues and ESUR guidelines.* Berlin: Springer; 2006. pp. 1–4.

10. Lusic H, Grinstaff MW. X-ray-computed tomography contrast agents. Chem Rev. 2013 Mar 13

11. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod. 2004 Aug;30(8):559-67.

12. Chávez de Paz, L.E. & Ordinola Zapata, R. (2019) Challenges for root canal irrigation: microbial biofilms and root canal anatomy. *ENDO-Endodontic Practice Today*, 13, 91–100.