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Research Article

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Difference in Root Canal Length between Populations

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Abstract

Introduction: *The objective of the study was to make the comparison of the root canal length of different types of teeth in black-Africans (Bantu) to that of Caucasians and Asians.*

Materials and Methods: *Data from a prospective cross-sectional study of Bantu (Black Africans) subjects aged from 18 to 45 years who were admitted in Service of Conservative Dentistry of Kinshasa University, root canal length were compared with already published data from studies involving Caucasians and Asians.*

Results: *This study includes 720 subjects; 480 (66%) were female and 240 (34%) were male. A total of 818 teeth were examined with 1539 root canals. The upper central incisor and the lower first molar predominated respectively in the maxilla and the mandible regions. There is a significant difference between the canal length of Bantu and Asians in the palatal canal of the upper second molar by 3.1 mm (p= 0.00). Eight different canals of Bantu were longer as compared to a single canal for Asians (p <0.05).*

This include the Vestibular (V) and palatine (P) canals of Bantu the first premolar (PM_1), palatal of the second premolar (PM_2), mesio-vestibular (MV), disto-vestibular (DV) and palatine (P) of the first molar (M_1) mesio-vestibular and palatal of the second molar (M_2). The lateral incisors (IL) (p= 0,01) and the canines (p= 0.12) of the Asians were longer than that of the Bantu. The Caucasians presented with longer canines than Bantu with a length difference of 1.7 mm (p= 0.11).

Four Caucasians also presented with longer canals of the Mesio-Vestibular (MV) and mesiolingual (ML) of the two molars (M_1 and M_2) as compared to one for Bantu are the longest (p <0.05).

Exceptionally, the distal canal (D) of the second molar (M_2) of the Bantu was longer than that of the Caucasians, with a length difference of 1.5 mm.

Conclusion: *The root canal length of Bantu is between than those of the most Asian and shortest Caucasian.*

Keywords: Canal anatomy, Canal length, Populations, Endodontics

Introduction

Root canal therapy (RCT) is a process that involves treating diseases of the pulp and periapex of a diseased tooth. The intention of RCT is to turn a pathological tooth into a healthy functional entity which is asymptomatic and in the dental arch. In most cases, this treatment is applied to the coronal and radicular pulp tissues and the periapical region of the teeth. The ultimate goal of RCT is to give a hermetic seal of root canal right up to the apical constriction and

any instrumentation and obturation beyond the apical constriction will lead to inflammatory reactions of the periapical zone.

On the other hand, the apical constriction is the limit of preparation and obturation, it offers favorable conditions for peri-apical repair. Apical constriction is the smallest diameter of the canal and is the boundary between the pulp tissues and the periodontal tissues. In most cases, it often coincides with or may be near the cemento-dentinal junction [1]. Therefore, the explicit location of the physiological apex of the root canal is a prerequisite for a successful endodontic therapy. Working length is defined in the endodontic glossary as the distance from a coronal reference point to the point at which canal preparation and obturation should terminate.

According to Kuttler, the narrowest diameter of the canal is definitely not at the site of exit of the canal from the tooth but usually occurs within the dentin, just prior to the initial layers of cementum [2]. According to Ricucci and Langeland, the apical constriction is the narrowest part of the canal with the smallest diameter of blood supply, thus creating the smallest wound site and best healing condition [3].

The canal length should be defined as being the distance between the coronary marker determined by the practitioner and the apical constriction [4]. This is because a precise knowledge of the canal length is necessary for successful endodontic treatment.

Kim, et al. 2005 showed in their study that the teeth of Caucasians are longer than those of Asians and they concluded that as previously described by with Perzigian to admit that the length of the teeth is related to the size of the individuals [5].

There is a paucity of literature concerning the measurement of root canal length among Bantu. This motivated us to carry out a study to compare the morphological similarities and differences in Bantu subjects. The objective of the study was to make the comparison of the root canal length of different types of teeth in Bantu to that of Caucasians and Asians.

Materials and Methods

A Prospective cross-sectional study of Bantu (Black Africans) subjects aged from 18 to 45 years who were admitted to the Service of Conservative Dentistry of Kinshasa University, Dental school. Patients recruited for the study included those diagnosed with pulpitis on their permanent teeth and recruited for root canal treatment, during the period from January 2014 to December 2016. Excluded in the study are patients whose main dental canals were inaccessible to apical constriction, with teeth bearing prosthetic crowns or having coronary reconstructions, teeth with gross caries with total crown destruction, abrasions, wisdom teeth, temporary, ectopic and supernumerary teeth, and teeth with periapical lesions.

After the establishment of a sterile operative field, local anesthesia was administrated and an access cavity into the pulp chamber was made with a cylindrical or round bur mounted on a fast handpiece. Localization of the pulp orifice and canal catheterization was based on the original root canal length estimated using a preliminary periapical x-ray. A K-type file place into the root canal which was also used to estimate the working length with a confirmatory x-ray. The choice of the endodontic instrument was done according to its diameter (the sufficiently fine) and that of the canals which can penetrate without dislodging on the canal wall in and which can adhere to the apical constriction. Cameral trepanation (entry into the pulp orifice) was made by means of the cylindrical probe mounted on a turbine in case of voluminous pulp, in case of pulp chamber calcification; trepanation was done using a drill mounted on steel ball using round bur and a slow speed contra-angle hand piece.

The estimation of the original length was based on the basis of the prior radiography by subtracting 2 mm from the image. The canal length was estimated using of a fine file to an estimated depth that was radiopaque, placing a rubber stop in contact with the incisal edge or occlusal surface as a reference point used as an indicator making sure that the desired length is reached.

When the measurement of the exact length of the canal on a radiograph is achieved, 4 situations can be revealed:

1. The file is located exactly at the apex or with some few millimeters from the apex.
2. The file is several millimeters away from the apex, and the length of the file on the radiographic image corresponds to the actual length, in which case the stop was moved to a few millimeters corresponding to the missing length.
3. The file exceeds the apex and the length of the file on the radiographic image is adjusted to the actual length, then the placement of the rubber stop was adjusted corresponding to the excess length.
4. If the tip of the file was farther away from the apex and the image is elongated, a simple rule of three will be used to calculate a corrected estimate length.

Results obtained were compared with a previous study carried out by Kim, et al. [5]. The root canal length of each tooth was measured to the nearest 0.5 mm.

Authorization to carry out this study was taken from the institutional review board of the Kinshasa University, Democratic Republic of Congo.

Results

The study includes 720 patients; 480 (66%) were female and 240 (34%) were male. A total of 818 teeth were examined with 1539 root canals. The upper central incisor and the lower first molar predominated respectively in the maxilla and the mandible regions. The upper canines are anterior teeth having a large root canal length followed by upper central incisors with 23.4 ± 2.3 mm and 21.8 ± 1.6 mm instead respectively. Their root canal length was compared to that of Caucasians and Asians in the tables and figures below.

Table 1: Difference in canal length between Bantu and Asians according to the typology of the upper teeth

Tooth	Canal location	Canal length Bantu (mm)	Canal length Asians (mm)	Difference in canal length	P value
Central incisor		21.8	22	-0.2	0.11
Lateral incisor		21.3	22	-0.7	0.01
Canine		23.4	24.5	-1.1	0.12
PM_1	V	20.9	19.7	1.2	0.00
	P	19.9	19.3	0.6	0.00
PM_2	V	20.4	19.5	0.8	0.00
	P	19.4	19.2	0.2	0.10
M_1	MV	19.8	18.5	1.3	0.00
	DV	19.0	18	1.0	0.00
	P	21.5	19	2.5	0.00
M_2	MV	20.0	18.2	1.8	0.01
	DV	19.1	18.2	0.9	0.10
	P	21.3	18.2	3.1	0.00

There is a significant difference between the canal length of Bantu and Asians in the palatal canal of the upper second molar by 3.1 mm (p= 0.00). Eight different canals of Bantu were longer as compared to a single canal for Asians (p <0.05). This include the Vestibular (V) and palatine (P) canals of Bantu the first premolar (PM_1), palatal of the second premolar(PM2), mesio-vestibular (MV), disto-vestibular (DV) and palatine (P) of the first molar (M_1) mesio-vestibular and palatal of the second molar (M_2). Exceptionally, the lateral incisors (IL) (p= 0,01) and the canines (p= 0.12) of the Asians were longer than that of the Bantu (Table 1).

Table 2: Canal length difference between black Africans and Asians according to the typology of the Lower teeth

Tooth	Canal type	Canal length Bantu (mm)	Canal length Asians (mm)	Canal length difference (mm)	P-value
(I C) Central		18.8	18.9	0.1	0 81
(I L) lateral		20.0	19.7	0.3	0.57
Canine		21.6	22.5	-0.9	0.33
PM_1		21.0	20.3	0.6	0.16
PM_2		21.8	20	1.8	0.00
M_1	MV	19.6	19.2	0.3	0.04
	ML	19.0	19.0	0.0	0.75
	D	20.7	19.0	1.7	0.00
M_2	MV	20.2	19	1.1	0.00
	ML	19.3	18.9	0.4	0.12
	D	21.5	18.5	3.0	0 00

A significant number (5) of the canals of the lower teeth of black Africans were longer than those of the Asians (p<0.05). These included the mesiobuccal (MV), the distal (D), all the molars (M_1 and M_2), and the canals of the lower second premolar (PM_2). The most significant difference was found in the distal canal of the second lower molar which was 3.0 mm longer Bantu (Table 2).

Table 3: Difference in canal length between Bantu and Caucasians according to typology (upper teeth)

Teeth	Canal	Length of the Canal Bantu (mm)	Canal length Caucasians (mm)	Canal length difference (mm)	P
(I C) Central		21.8	23.5	1.7	0.00
(IL) lateral		21.3	22	0.7	0.01
Canine		23.4	24.5	1.0	0.12
PM_1	V	20.9	20.3	-0.6	0.00
	P	19.9	20.2	0.3	0.78
PM_2	V	20.4	21.6	1.2	0.00

	P	19.4	20.7	1.3	0.00
M1	MV	19.8	20	0.1	0.55
	DV	19.0	20.5	1.5	0.00
	P	21.5	21	- 0.5	0.02
M2	MV	20.0	19.5	0.5	0.46
	DV	19.1	19.7	0.6	0.33
	P	21.3	20	-1.3	0.07

The biggest difference was found at the level of the upper central incisor which was 1.7mm longer in Caucasians. It was observed that five Caucasians presented with longer teeth ($p<0.05$). These included the central incisors (IC), the vestibular (V) and the palatine (P) canals of the second premolar (PM_2) disto-vestibular (DV) and palatine (P) of the first molar (M_1). Exceptionally the vestibular canal (V) of the first premolar (PM_1) and palatine canal (P) of the first molar of Bantu were longer than those of the Caucasians (Table 3).

Table 4: Canal length difference between Bantu and Caucasian according to typology (lower dental arch)

Teeth	Canal	Canal Length Bantu (mm)	Canal length Caucasians (mm)	Canal length difference (mm)	P
I C		18 , 8	19 , 9	1 , 1	0.22
I L		20 , 0	19 , 9	-0 , 1	0.85
Canine		21 , 6	23 , 3	1 , 7	0.11
PM_1		21 , 0	21 , 1	0 , 1	0.75
PM_2		21 , 8	21 , 3	-0 , 5	0.13
M_1	MV	19 , 6	21	1 , 4	0.00
	ML	19 , 1	20 , 5	1 , 4	0.00
	D	20 , 7	20 , 5	-0 , 2	0.26
M_2	MV	20 , 2	21	0 , 9	0.01
	ML	19 , 3	21 , 2	1 , 9	0.00
	D	21 , 5	20	- 1.5	0.00

The mesiolingual canal (ML) of the second lower molar (M_2) showed a significant length difference in Caucasians as compared to Bantu with a length difference of 1.9 mm. The Caucasians also presented with longer canines than Bantu with a length difference of 1.7 mm ($p=0.11$). Four Caucasians also presented with longer canals of the Mesio-vestibular (MV) and mesiolingual (ML) of the two molars (M_1 and M_2) as compared to one for Bantu are the longest ($p <0.05$). Exceptionally, the distal canal (D) of the second molar (M_2) of the Bantu was longer than that of the Caucasians, with a length difference of 1.5 mm (Table 4).

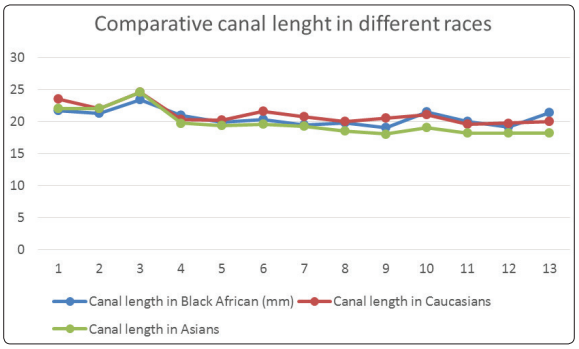

Figure 1: Length of the root canals according to maxillary teeth and three races

The root canal length of Black African (Bantu) is between than those of the most Asian and shortest Caucasian.

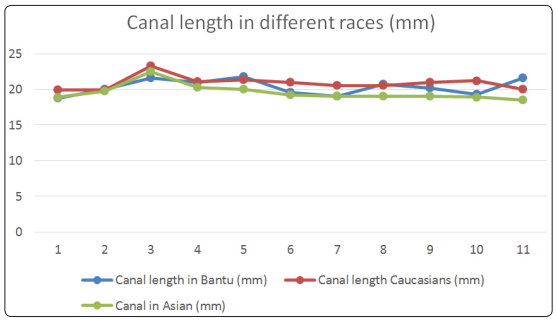

Figure 2: Canal Length root according to the mandibular teeth and three breeds

The canal length of Bantu was usually intermediate between those of Caucasians, the longest and Asian (shortest).

Discussion

Success is the expected outcome after root canal treatment (RCT), regardless of the clinical conditions. However, predicting success usually requires adopting a referential or criteria, and presupposes that the patient is healthy. It is estimated that RCT should be considered completed when the tooth is permanently restored and in function [6]. RCT clinical success can be analyzed based on different points of view, with specific values that involve the dentist, the patient or the tooth itself.

Recent studies have shown that in resource-poor settings, the measurement of root canal length where there is lack of technical and electrical infrastructure, tactile determination of the working length of root canals are used [7,8]. Within the limits of this randomized controlled trial, it was shown that tactile working length determination in RCT resulted in comparable treatment outcomes in radiographic and clinical aspects compared with standard endodontic treatment with radiographic working length determination. Tactile working length determination turned out to be an accurate method in RCT [8].

Studies on the anatomy of the root apex are an area of interest to the endodontist; they have reported that the position of the apical constriction, apical foramen, and the cemento-dentinal junction varies across the tooth types. These anatomical apical landmarks are considered extension limits for root canal instrumentation and filling. Achieving an optimum working length is thought essential for successful root canal treatment, so adopting any of these landmarks is associated with certain risks and benefits [9]. According to Laurichesse "The problem of the apical limit of canal preparations is one of the most important and complex of all. "It is accepted by many authors that the preparation must be stopped at the dentinal cementoid junction and constitutes the ideal theoretical limit of canal preparation but it is a histological structure that cannot be detected clinically [9,10] .

The generally accepted method of working length determination is the radiographic method but the apical constriction cannot be accurately determined radiographically [11]. Usually, the working length of the root canal is determined radiologically, but the radiographic image shows only the anatomical apex, not the apical constriction and depends on the dentist's ability to interpret the radiographic image [8]. On the other hand, the apical constriction is clinically detectable, either by the tactile sensation, either by apex locator, and the reliability varies respectively between one clinician to another. However, confirmation of the apex can be confirmed by a post-op radiograph with the reamer placed at the estimated apex.

An underestimation of working length decreases the chances of successful endodontic treatment [10]. Successful root canal treatment depends on adequate debridement and filling of the entire root canal system [12]. If the dentist fails to recognize the presence of an additional root canal, adequately remove the pulp tissue, and disinfect and obturate the root canals properly, it may cause the failure of the entire treatment, altogether bringing frustration to the clinician as well as the patient.

Comparison between races investigating the relationship between tooth dimensions and body size is essential in forensic odontology and paleontology. "Large teeth necessitate large jaws, large jaws a large body" [13]. This statement though sounds logical, was not yet proved over the years. However, it is rational to speculate that taller people possess longer teeth since the teeth contribute to the height of the face [14]. Several studies have been carried out to demonstrate variations in root canal length of different races and different conclusions have been made. This has been attributed to the different stature common in the three different races [15].

Significant differences had been reported between males and females of the same race. Reddy, et al. 2017, recently to determine the relationship between stature (age, sex and standing height of adults) and posterior tooth length measurement revealed that there is a positive association between stature and posterior tooth length in both males and females [16]. This contrary to a previous study carried out by, Alam, et al. (2004) in Bangladesh, where they suggested that tooth length has no significance on the sex of the people of same race [17]. To verify the results of the study, statistical tools were applied on a randomly selected sample of 100 patients and the statistical tests also support the findings of the study. The results also indicated that the tooth length of Bangladeshi people is shorter than their Caucasoid counterpart. In previous studies performed by different researcher and given in different textbook of Endodontic shows that the length of the tooth of Caucasian people is longer than this study [17]. These conclude that there are intergender, intra-race and inter-race variations which may depend on an existence of a strong genetic influence on tooth dimensions. At the same time, environmental and dietary changes could also affect tooth morphology and dimensions [16].

Comparison between Bantu and Asians

The length of the tooth also varies within the race. Though there is no specific study in this topic but the practitioners treating Negroid and Mongoloid are aware that the length found in textbooks, which are related to teeth of Caucasoid origin does not coincide with Negroes and Mongolians [13]. The current study showed that root canals of the teeth of Bantu subjects were usually longer than those of Asian. Unlike an average excess of 0, 8 mm ($p < 0.05$) and the differences in millimeters are statistically significant ($p < 0.05$) among most of the teeth except the upper incisors were longer in Asians than those of their counterpart ($P < 0.05$).

Comparison between Bantu and Caucasians

The current study showed that the root canals of Caucasians were longer than those of Bantu with a mean difference of 0, 4 millimeters ($p < 0.05$) [8]. These differences were statistically significant ($p < 0.05$) for most teeth. However, the palatal root canals of the first molar and distal of the second molar of Bantu were longer than those of Caucasians are with differences are statistically significant ($p < 0.05$).

Conclusion

The average canal lengths of the teeth of Bantu subjects are intermediate between those of Caucasians (longest) and Asians (shortest). The mean differences between Bantu and Asians and Caucasians were respectively 0.8 and 0.4 mm, as against 1.2 between Caucasians and Asians. The differences are more apparent in the posterior teeth and almost non-existent in the anterior areas. The palatal canal of the first upper molar, the distal canal of the second lower molar as well as the second lower premolars of the Bantu, were the longest (21.5mm) in all three populations.

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