Nat. Volatiles & Essent. Oils, 2021; 8(5): 396 – 405

NVEO Natural Volatiles & Essential Oils

Impact Of Ageing Process In The Positionof Mandibular Foramen – A Morphometric Study

Elumalai Prithiviraj[1]and Govindarajan Sumathy*

[1]Associate professor, Department of Anatomy, Sree Balaji Dental College & Hospital, BIHER, Chennai.
[2] Professor & Head, Department of Anatomy, Sree Balaji Dental College & Hospital, BIHER, Chennai.

Abstract:
The aim of this study is to compare and locate the accurate anatomical position of mandibular foramen in dentate and edentate mandibles to achieve more successful inferior alveolar nerve block. Sixty human dry mandibles were collected based on the presence or absence of a complete set of teeth and their sockets as dentate and edentulous from the Department of Anatomy and were used for the present study. The mandibles with any variations were excluded from the study. The mandibles (out of 60 dry mandibles, n=30 adult and n=30 aged) for the present study were grouped as adult (dentate) and aged (edentulous). All the measurements were repeated twice by each of three individuals (totally six times) for consistency of the data, and were subjected to further analysis such as, Vertical length of ramus from condylar tubercle, Width of the ramus, Position of the mandibular foramen and Diameter of the mandibular foramen is measured by using Vernier calliper. Our results showed a significant alteration in the position of the mandibular foramen in edentulous subjects.

Introduction:

Every human begins to undergo physical and mental weakness through the process called ageing throughout their life cycle. Ageing had started earlier in the more developed regions and was beginning to take place in some developing countries and was becoming more evident at the global scale (World Population Ageing 2013). Many conditions are associated with ageing, instigating several complex health complications that tend to cause discrete disease categories. Along with the other factors (hormonal, metabolic, life style, environmental and genetic), ageing plays a crucial role in bone remodeling.

Facial ageing is an active procedure connecting the age of soft-tissue and bony structures. The facial bones show a wide range of alterations not only in normal growth but also in ageing (Robert et al., 2011). Careful operative technique and precise prosthetic restoration and implantation are now accepted treatment options for partially dentate and completely edentulous individuals (Fanghanel et al., 2006).Reshaping of the face with age is challenging as a result of volume changes and loss of support (Levine et al., 2003). In addition to that, any kind of changes in the mandibular projection, width, or height can affect the overall aesthetics. (Shaw et al. 2011).

The mandibular foramen is located inside the mandibular ramus and serves as a passageway for blood vessels that supply nutrients to the mandible, mandibular teeth, periodontal tissues, and lower lip and for the nerves responsible for sensory perception in these regions. Thus, locating the accurate anatomical position of these regions is critical to achieving more successful inferior alveolar nerve block and preventing the complications common to orthognathic surgery (Kaffe et al., 1994).

Understanding of accurate anatomical locations of the mandibular and mental foramen is an important factor in the successful administration of mandibular analgesia while minimizing risk of injury or damage to the neurovascular bundle in the management of comprehensive restorative care (including exodontia), mandibular fractures and surgeries in children (Fontoura et al., 2002; Trost et al., 2010). Anatomical and anthropological studies have indicated that there exist anatomical variations in the growing mandible that may be influenced by gender, race and ethnicity (Kjaer 1989; Blumenfeld 2000; Williams and Krovitz 2004; Ashkenazi et al., 2011; Balcioglu et al., 2011).

In previous studies, it has been shown that the cancellous bone of the mandibular condyle is adaptive, i.e., in edentulous subjects, the apparent density and bone volume fraction were found to be lower than in dentate subjects (Hongo et al., 1989; Kawashima et al., 1997; Giesen et al., 2003). Hence, the present study provides essential data relevant to prosthodontics and orthodontics to create a better treatment strategy for the edentulous population.

The consequences of the loss of teeth on the mandibular alveolar bone are well known. However, the potential consequences on the basal bone are ambiguous. The aim of this study was therefore to compare dentate and edentate mandibles in order to define the characteristics of the mandible in edentate elderly subjects.

Materials and Methods

Sixty human dry mandibles were collected from the Department of Anatomy and were used for the present study. The mandibles with any variations were excluded from the study. The mandible was classified on the basis of the presence or absence of a complete set of teeth and their sockets as dentate and edentulous, since complete edentulousness is a characteristic feature of old age. The mandibles (out of 60 dry mandibles, n=30 adult and n=30 aged) for the present study were grouped as adult (dentate) and aged (edentulous). All the measurements were repeated twice by each of three individuals (totally six times) for consistency of the data, and were subjected to further analysis.

The mandible bones were subjected to various investigations such as, (i) Vertical length of ramus from condylar tubercle (midpoint of the posterior aspect of the condyle) to the angle of mandible; (ii)Width of the ramus at the level of mandibular foramen: the width of the ramus is taken anteriorly from lateral margin of retromolar triangle to posterior border of ramus of the mandible; (iii) Width of the ramus from retro-molar triangle to mandibular foramen: measured from the anterior margin of the retromolar triangle to the midpoint of the mandibular foramen; (iv) Position of the mandibular foramen. (v) Diameter of the mandibular foramen is measured by using Vernier caliper.

A point measured from the condylar tubercle to the angle of the mandible is taken for analysis to determine the vertical length of the ramus of the mandible. The width of the ramus is calculated from the lateral margin of the retromolar triangle and posteriorly up to the end of the ramus, and the other one from the lateral margin of the retromolar triangle to the midpoint of the mandibular foramen.

Statistical analysis

The average and the standard deviation of these measurements were calculated in the two groups (edentulous and dentate subjects). Collected data was analyzed using Microsoft Excel (Version 2003) and SPSS (SPSS, Version 25, Inc., IBM) software. The significant difference between the mean values of the control and experimental groups was determined by the Student t test. Albert et al. (2007) defined statistical significance as a P value of 0.05.

Result

A point measuring from the condylar tubercle to the angle of the mandible is taken to analyze the vertical length of the ramus of the mandible. The vertical length of the ramus from the condylar tubercle (midpoint of the posterior aspect of the condyle) to the angle of the dentate and edentulous mandibles (Fig. 1) showed a remarkable difference (Graph 1). The edentulous mandible is significantly reduced in the vertical length of the ramus (P 0.001) when compared to the dentate mandible.

The width of the ramus was measured from the medial margin of the retro-molar triangle to the midpoint of the mandibular foramen; from the lateral margin of the retro-molar triangle to the mandibular foramen; and from the mandibular foramen to the posterior border of the ramus of the mandible (Fig.1). The measurements from the medial margin of the retro-molar triangle to the mandibular foramen and from the mandibular foramen to the posterior border of the ramus, display a significant reduction (P 0.005 and P 0.001 respectively) in edentulous mandibles. But from the lateral margin of the retro-molar triangle to the mandibular foramen did not show a noticeable decrease in edentulous subjects (Graph 2).

Likewise, the width of the ramus from the medial margin of the retro-molar triangle to the posterior border and from the lateral margin of the retro-molar triangle to the posterior border (Fig. 2) exhibited considerable alteration (P 0.001) in the edentulous mandible (Graph 3).

The position of the mandibular foramen of edentulous shows obvious changes with dentate mandibles (Fig. 2 & Graph 4). The mandibular position from the condylar notch to the mandibular foramen did not change significantly, but the position from the mandibular foramen to the inferior border of the ramus did (P 0.001).Similarly, the diameter of the mandibular foramen (Fig2) is significantly decreased (P 0.001) in the edentulous mandible compared to the dentate mandible (Graph 5).

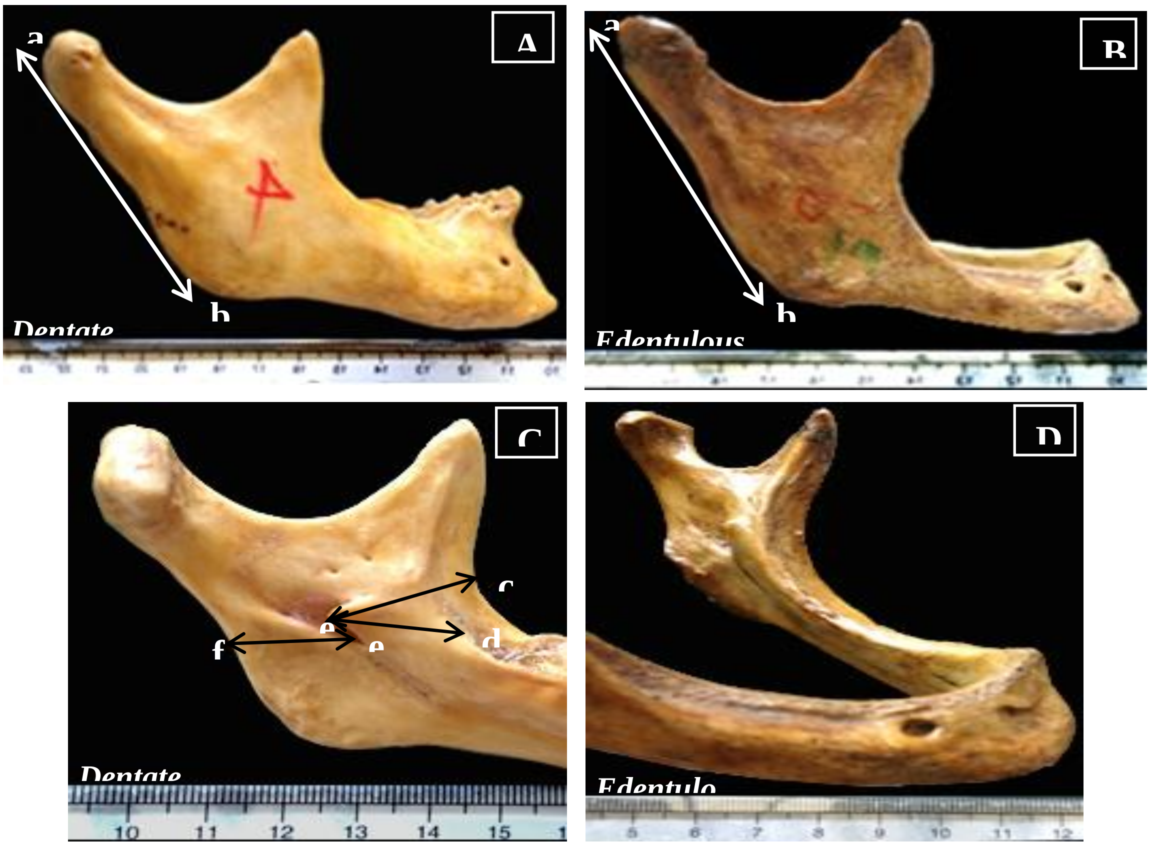


Fig. 1 Displays mandibles of dentate and edentulous subjects. Vertical length of ramus: from condylar process (a) to angle of mandible (b); Width of the ramus: from medial margin (c) & Lateral margin (d) of retromolar triangle to mandibular foramen (e); form mandibular foramen (e) to posterior border (f).

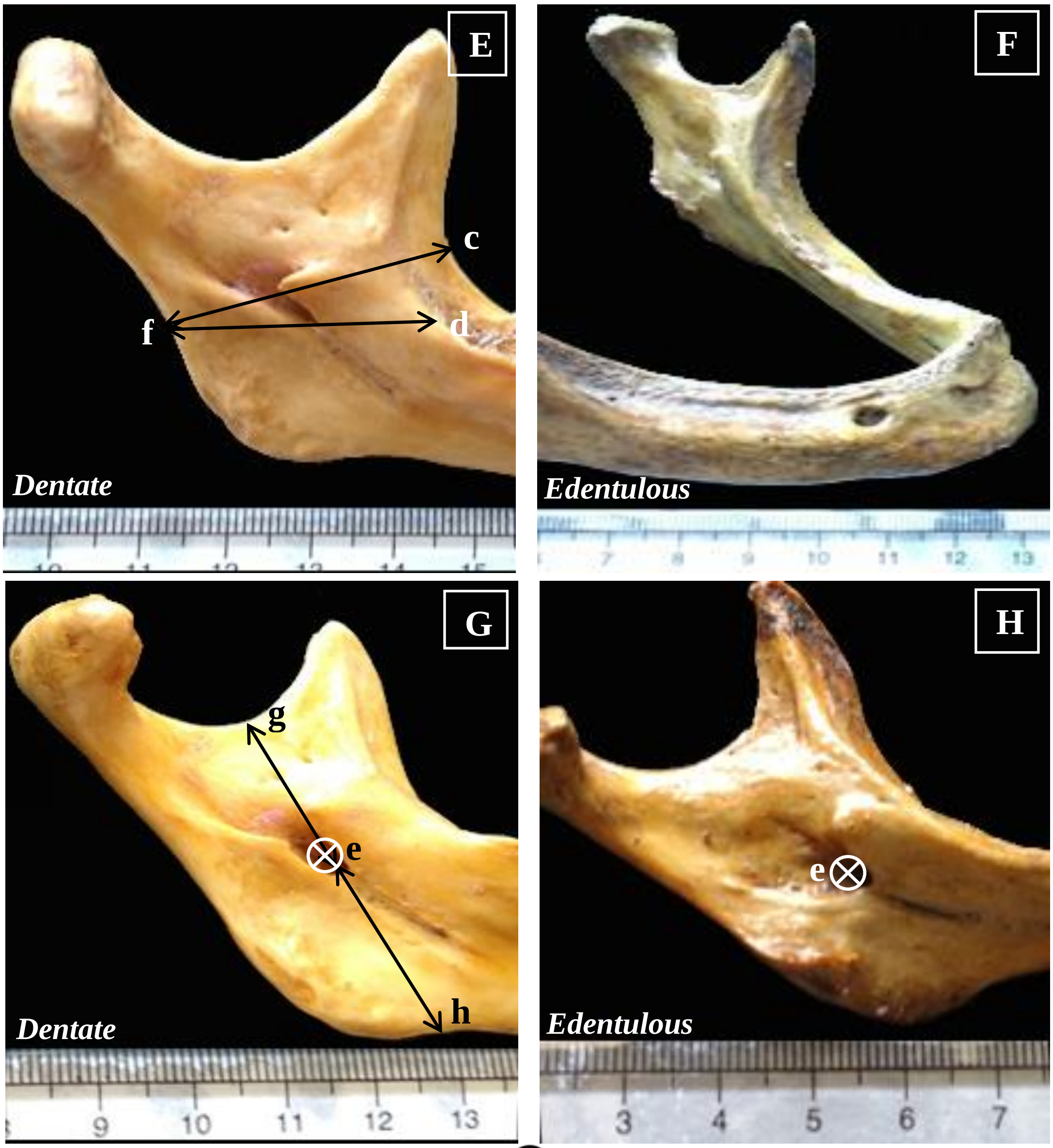
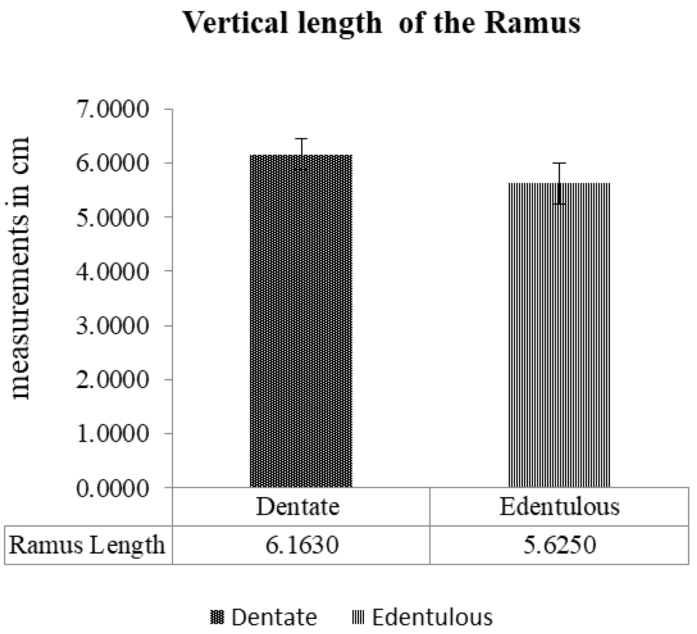
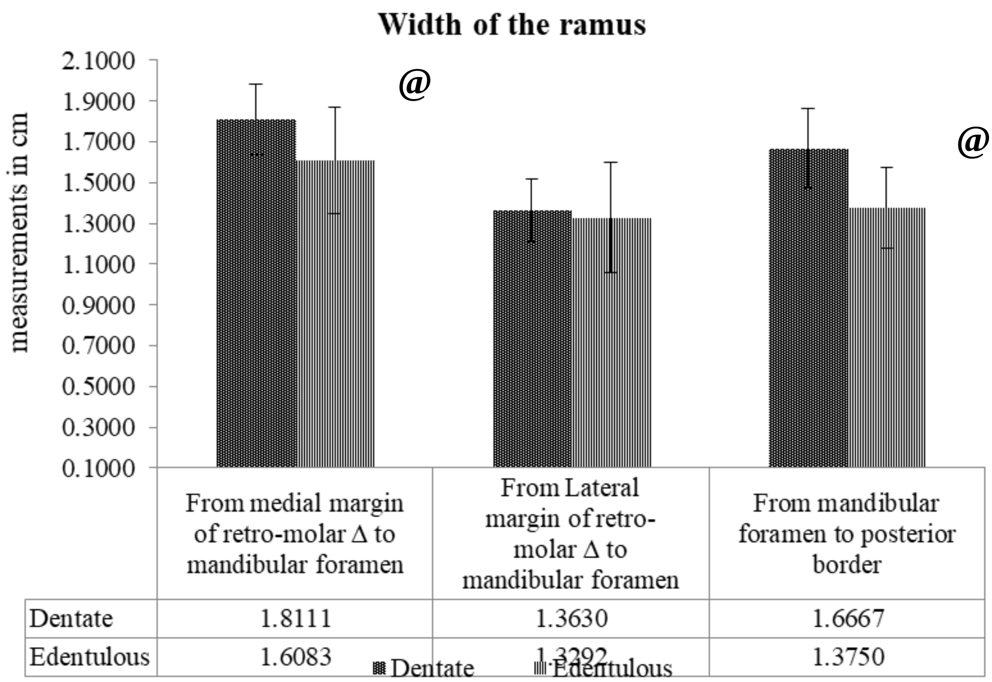


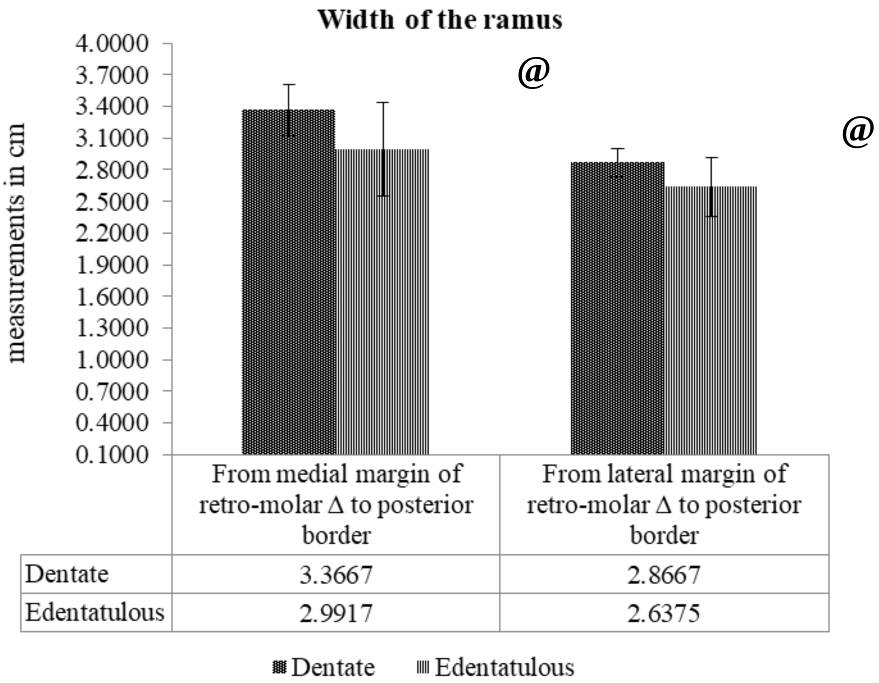
Fig.2. Shows mandibles of dentate and edentulous subjects. Width of the ramus: form medial margin (c) of retromolar triangle to posterior border (f) of the ramus; from lateral margin (d) of retromolar triangle to posterior border (f) of the ramus ; Position of the mandibular foramen: from mandibular notch (g) to mandibular foramen (e); from mandibular foramen (e) to inferior border of ramus (h); the encircled cross [⊗] marks represent Diameter of mandibular foramen.



Graph 1.The vertical length of ramus from Condylar process to angle of mandible in dentate and edentulous subjects. The column represents Mean and error bars denoting Standard deviation and the level of significance at P<0.05.

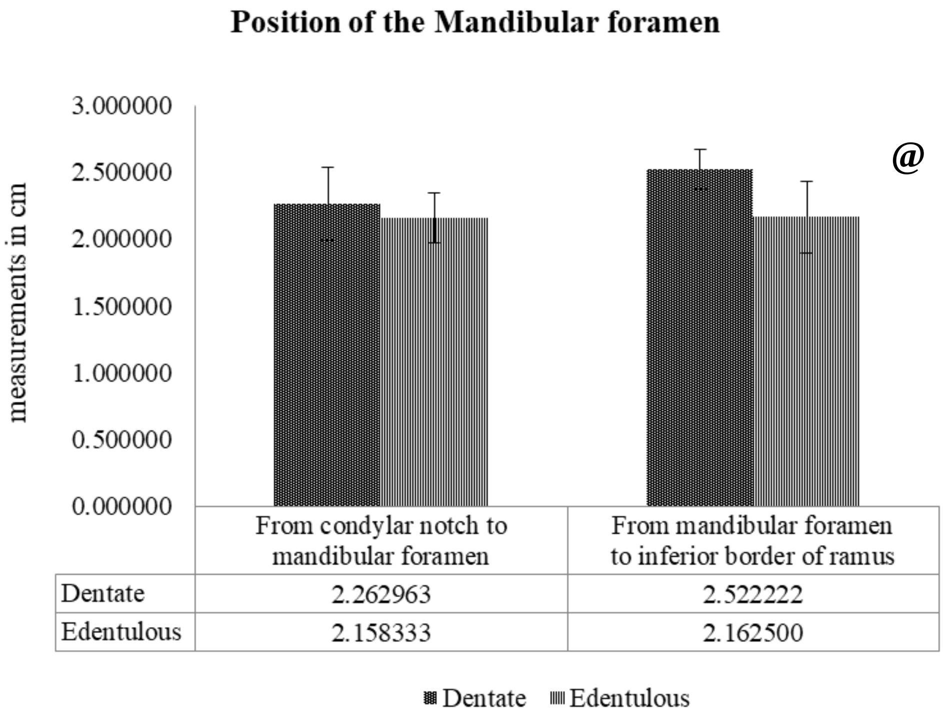


Graph 2.Width of the ramus from the medial and lateral margin of retro-molar triangle to mandibular foramen; and Width of the ramus from mandibular foramen to posterior border. The column represents Mean and error bars denoting Standard deviation and the level of significance at P<0.05.



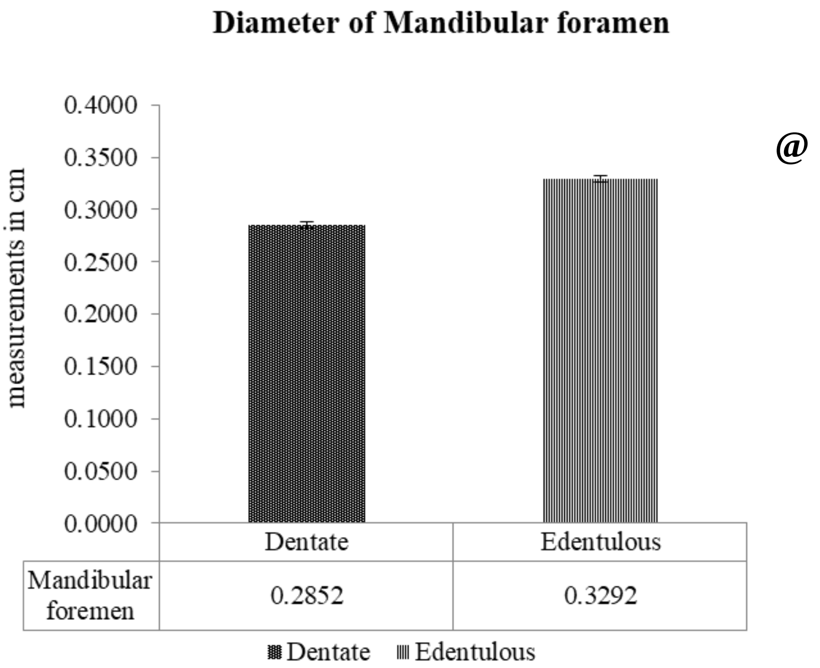
	From medial margin of retro-molar Δ to posterior border	From lateral margin of retro-molar Δ to posterior border
Dentate	3.3667	2.8667
Edentatulous	2.9917	2.6375

Graph 3.Width of the ramus from the medial and lateral margin of retro-molar triangle to posterior border. The column represents Mean and error bars denoting Standard deviation and the level of significance at P<0.05.



	From condylar notch to mandibular foramen	From mandibular foramen to inferior border of ramus
Dentate	2.262963	2.522222
Edentulous	2.158333	2.162500

Graph 4.Position of the mandibular foramen**:** from condylar notch to mandibular foramen and from mandibular foramen to inferior border of ramus. Each columns represent Mean and error bars denoting Standard deviation and the level of significance at P<0.05.



Graph 5.Diameter of the mandibular foramen**.** The columns represent Mean of dentate and edentulous subjects and error bars denoting Standard deviation. The level of significance determined at P<0.05.

Discussion:

The present study showed that ageing produce wide alterations in the mandible, which may be due to ageing-induced bone degeneration and also tooth loss. The mandible is in a constant phase of remodeling as the child grows. It shows a differential growth pattern and remodeling in different areas. The eruption and shedding process of the teeth plays an important role in bone remodeling, which may influence the position of the mandibular foramen and, hence, the inferior alveolar nerve block procedure. The mandibular foramen and the mandibular canal form during the process of intramembranous ossification of the mandibular ramus and the body of the mandible. During the 24th week of the embryonic stage, a groove forms that contains the nerves and blood vessels, and the shapes of the mandibular foramen and canal are completed as ossification progresses (Kjaer et al., 1999). Starting from the mandibular foramen within the ramus, the mandibular canal containing the inferior alveolar nerve and blood vessels descends in antero-inferior direction and then runs horizontally once it reaches the molar area of the mandible body (Carter 1971).

Although inferior alveolar nerve block is frequently used as a local anesthetic method for mandibular molar restorative treatment and surgical treatment (Madan et al., 2002; Thangavelu et al., 2012),Malamed et al. (1997) reported that this method is associated with a high clinical failure rate of up to 20%. This can be explained by the fact that the positions of the mandibular ramus and foramen vary widely from person to person (Madan et al., 2002). In addition, if the surgeon fails to identify the exact anatomical position of the mandibular foramen during orthognathic surgery, complications may ensue, such as damage to the inferior alveolar nerve or blood vessels. Thus, the position of the foramen serves as a critical anatomical reference point for reducing the risk of complications and for the success of inferior alveolar nerve block anesthesia (Yoshida et al., 1989).

Our results showed a significant alteration in the position of the mandibular foramen in edentulous subjects. The position of the mandibular may vary due to anatomical and skeletal variations. The mandibular foramen has been reported to move in a horizontal direction either anterior or posterior, or remain constant in a growing mandibular ramus (Hwang et al., 1990; Ono 2005; Ardakani et al., 2010; Kang et al., 2013) reported no age-related changes; the mandibular position remained constant despite changes in the vertical and horizontal plane and was constantly in the posterior aspect of the middle third of the ramus near the level of the alveolar crestal plane (occlusal plane). The diameter of the mandibular foramen was enlarged more in the edentulous mandible than in the dentate. This clearly indicated that degenerative changes in bone will result in a widening of the mandibular foramen.

Conclusion

In the present study, we have provided an overview of the impact of the ageing process on the position of the mandibular foramen. The mandible showed wide alterations in vertical length, width of the ramus, and diameter of the mandibular foramen in edentulous subjects. These morphological variations may be primarily the result of age-related changes. The derived information may be used to locate the mandibular foramen from the condylar tubercle to the angle of the mandible for dental surgeons to perform inferior alveolar nerve anaesthesia, dento-alveolar surgeries, orthognathic reconstruction surgeries, etc. Hence, these basic data might be helpful for the clinician or surgeon during the treatment approaches, particularly in elderly or edentulous patients.

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