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Case Report

Unique anomalous in the main mental foramen opening, mandibular canal pathway, and size and shape of genial tubercles: A case report☆,☆☆

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ABSTRACT

This clinical report presents a unique and previously unreported case of anatomical variations in the mandible, specifically involving the main mental foramen (MF), the mandibular canal (MC), and genial tubercles (GTs). The case involves a 21-year-old male seeking dental implant rehabilitation. The patient exhibited an unusual lingual exit path of the main left MF through the lingual cortical bone, with the MC following an anterior lingual direction along a lingual groove before exiting through the labial cortical bone between the apexes of the left canine and first premolar. Additionally, the patient displayed excessive enlargement and rare shape of the GTs. These rare anatomical findings presented challenges in dental implant planning. This case report emphasizes the importance of advanced imaging techniques like cone-beam computed tomography (CBCT) in evaluating mandibular structures for precise treatment planning and highlights the significance of understanding anatomical variations to prevent complications in dental procedures.

Abbreviation: AL, Anterior loop; CBCT, Cone-beam computed tomography; GTs, Genial tubercles; IAN, Inferior alveolar nerve; MC, Mandibular canal; MF, Mental foramen.

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Introduction

The mandibular canal (MC) is a bilateral bony channel that extends longitudinally from the mandibular foramen to the mental foramen (MF). This canal serves as a pathway for the inferior alveolar nerve (IAN) and vessels to traverse the mandible, supplying the mandibular teeth, alveolar bone, and associated soft tissues, including the gingiva and lower lip [1,2]. The IAN branches into 2 divisions, namely the incisive nerve and the mental nerve. The mental nerve, together with the mental artery and vein, passes through the MF [3,4]. The segment of the nerve located anterior to the MF, just before its division into the incisive nerve, is referred to as the anterior loop (AL) of the IAN [5–8]. The presence and extent of the AL may vary among different populations [9,10].

The MC exhibits a consistent trajectory adjacent to the lingual surface of the mandible until it reaches the mesial surface of the mandibular first molar, subsequently transitioning gradually towards a more buccal position until its culmination at the MF [11]. Although the MC commonly takes the form of a singular passage with a symmetrical arrangement on both sides of the mandible, there can be deviations in its positioning in relation to the lower border of the mandible and tooth apex [12].

The anatomical variations in the MC can be classified based on the number of additional branches it has, such as bifid and trifid types. The bifid type also has subtypes, with the retromolar MC variant being the most common [13]. The bifid MC is a variation where the MC divides into 2 branches, each containing a distinct neurovascular bundle [14]. The reported prevalence of bifid MCs varies considerably across different systematic reviews and meta-analyses with prevalence estimates of 38% [15], 57% [13], and 16.25% [16] reported in separate reviews. According to 1 literature review, the prevalence of bifid MCs can range between 0.05% and 69% in the population [1].

The trifid MC is a rare variant, accounting for less than 6% of all bifid mandibular canals [17]. In some cases, these bifid and trifid MCs are associated with an even rarer anatomical variant - the double mandibular foramen [17], with incidence of 1.35% on CBCT images [18]. These anatomical variations can complicate mandibular nerve block anesthesia and increase surgical risks in the mandibular ramus. The double mandibular foramen also provides an easy path for tumor cells spread after radiotherapy. Therefore, careful CBCT evaluation of these variations is important for surgical and radiotherapy planning involving the mandible [18].

The MF is a bilateral oblique opening on the outer surface of the mandible, through which the mental nerve, artery, and vein pass, supplying the lower incisor, canine, and premolar teeth's mucosa, as well as the skin and mucosa of the lower lip, cheeks, and chin [19–21]. Typically located inferiorly between the root apexes of the mandibular premolars [22].

The MF typically appears as a single opening in the human mandible. However, in some cases, additional smaller openings called accessory mental foramina (AMFs) can be observed [23]. These AMFs are smaller than the main MF and branch off from the MC [24,25]. It is important to differentiate AMFs from nutrient foramina, which may also surround the MF but are unconnected to the IAN [26]. The MF can exist as a single opening, or it may have variations such as being double, multiple, or in rare cases, completely absent [4].

Accurate identification of the precise location and variations of the MC and MF is paramount in mandibular surgical procedures, such as implant placement, bone grafting, and extraction of third molars [2,27,28]. Neglecting to identify the usual location and variations of the MC and MF can result in several complications, including somatosensory impairment, traumatic neuroma, bleeding, bruising, and an elevated level of difficulty in administering alveolar mandibular nerve block, thereby causing patient discomfort [29–31]. Furthermore, understanding the position of the MF is beneficial in endodontic treatments for precise location, cleaning, and filling of root canals [32], as well as in orthodontics for planning tooth movement and aligner placement [33].

Genial tubercles (GTs), also referred to as mental spines, are small osseous projections situated bilaterally within the lingual cortex of the mandible, slightly superior to the mandibular base, at the midline. These projections serve as attachment points for the geniohyoid muscle below and the genioglossus muscle above, both of which play indispensable roles in tongue movement, swallowing, speech, and mastication. Excessive mobility of the tongue can result in the hypertrophy of GTs, leading to their protrusion beyond the crest of the alveolar ridges and heightening their susceptibility to spontaneous fracture [34].

The dimensions of the GTs have been found to impact the stability of complete dentures in the mandible [35,36] and can serve as a reference point for assessing mandibular asymmetry [37]. Additionally, the GTs can provide valuable guidance in identifying a safe area near the mental foramina for implant surgery and have been recognized as an important anatomical parameter in the surgical treatment of obstructive sleep apnea [38].

There are five patterns of GTs that have been described in the literature. These patterns include the classical arrangement of four spines (consisting of 2 inferior tubercles and 2 superior tubercles), 2 superior tubercles fused with 1 inferior tubercle, 2 superior tubercles with a rough impression below them, a single central projection, or the complete absence of any bony tubercle [39].

Panoramic radiographs have limitations in accurately assessing the MC and MF. In contrast, CBCT is a superior imaging modality that provides 3-dimensional images and better visualization of accessory canals, including narrow ones. CBCT is reliable for differentiating true from false mandibular accessory canals and accurately identifying the anatomical location of GTs [40].

This article presents a previously unreported rare case where the main left MF exhibited a lingual exit through the lingual cortical bone of the mandible. Additionally, after passing through the lingual MF, the MC followed an anterior lingual direction along a lingual groove and opened on the labial cortical bone between the apexes of the left canine and first premolar apically. Furthermore, the article describes, in the same patient, an uncommon occurrence of excessive enlargement of the GTs with unusual shape, which is particularly rare, especially in dentate individuals.

Case report

A 21-year-old male without any systemic disease presented at the Oral Surgery Clinic, Abulohoom Center, Ibb, Yemen, seeking dental implant rehabilitation due to a previous gunshot injury to the mandible that resulted in right mandibular reconstruction. Extraoral examination showed a scar below the inferior border of the left mandible from the previous injury, but there were no notable signs or symptoms related to the temporomandibular joints, and the patient had a normal range of mouth opening.

Intraoral examination revealed clinical signs of periodontal disease in the maxillary arch, and the patient had fixed restorations on several mandibular teeth, (#42, 41, 31, 32, 33, 34, 35, 36, 37) as well as retained roots of two teeth (#47, 48). There was also an edentulous area in the right mandibular premolar and molar regions, indicating a need for bone grafting and dental implants placement. The patient reported numbness and pain upon pressure on the inner aspect of the left mandible.

Panoramic radiographs showed an unusual opening observed on the labial surface of the alveolar bone between the root apices of the left canine and first premolar. Internal root resorption was also observed at the middle portion of the root of the left second premolar (Fig. 1).

The normal anatomy of the IAN, mandibular foramen, MC, MF, and the branches of the IAN are shown through schematic illustrations in Figure 2. Furthermore, Figures 3 and 4F present the anatomical variations described in this clinical report.

To assess the alveolar bone in the posterior region of the right mandible for bone grafting and dental implant placement, a CBCT scan was performed using i-CAT technology. The CBCT scan revealed rare anatomical variations in the mandible. The main left MF exhibited a lingual exit path through the lingual cortical bone, and the MC followed an anterior lingual direction along a lingual groove before exiting through the labial cortical bone between the apexes of the left canine and first premolar (Figs. 5-8). These anatomical variations were isolated to the left side, with no corresponding variations on the right side.

Additionally, the CBCT imaging showed unusual large dimensions of the GTs located on the lingual surface of the mandible, measuring 13.43 mm length and approximately 11.78 mm height. The GTs also exhibited atypical shape, characterized by a single central projection with 3 distinct heads (superior, middle, and inferior) (Figs. 7A, 9).

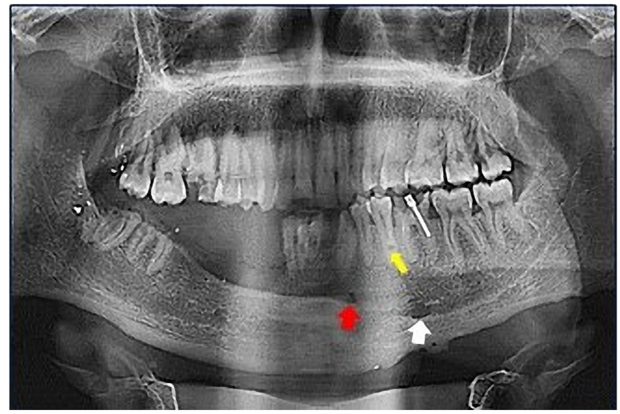

Fig. 1 – Panoramic image. Left MF apical to the roots of second premolar and first molar (white arrow), labial anterior exit of the MC (red arrow), and an internal root resorption (yellow arrow).

Discussion

This study identified a previously unreported rare anatomical variation in the mandible. Specifically, it pertains to the lingual opening of the left MF and the anterior lingual path of the MC. Furthermore, the same patient showcased an atypical observation of a larger-than-normal GTs, exceeding the conventional anatomical dimensions.

In the study conducted by Goyushov et al [41] which visualized all MF locations, it was found that the majority (49.2%) were situated between the first and second premolars, while 7.7% were distal and 39.7% coincided with the apex of the mandibular second premolar. The mean opening angle of the MFs was approximately 45.4° on the right side and 45.9° on the left side, with no significant gender differences. Ahmed

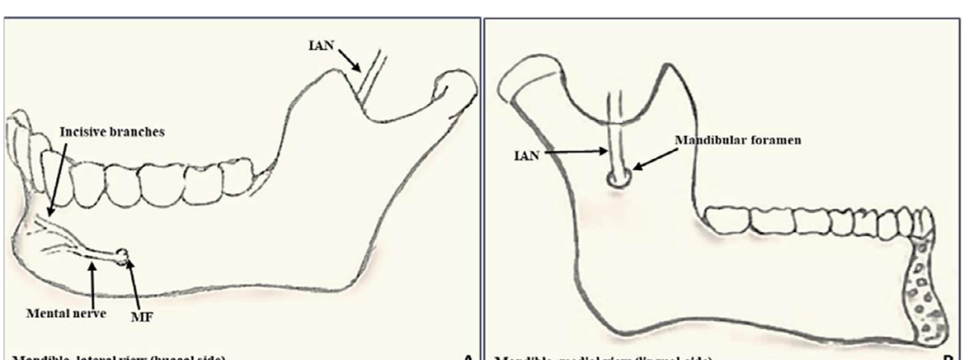

Fig. 2 – A, The normal anatomy of the inferior alveolar nerve (IAN), mental foramen (MF), and branches of the IAN. B, mandibular foramen and IAN on the medial surface of the mandible.

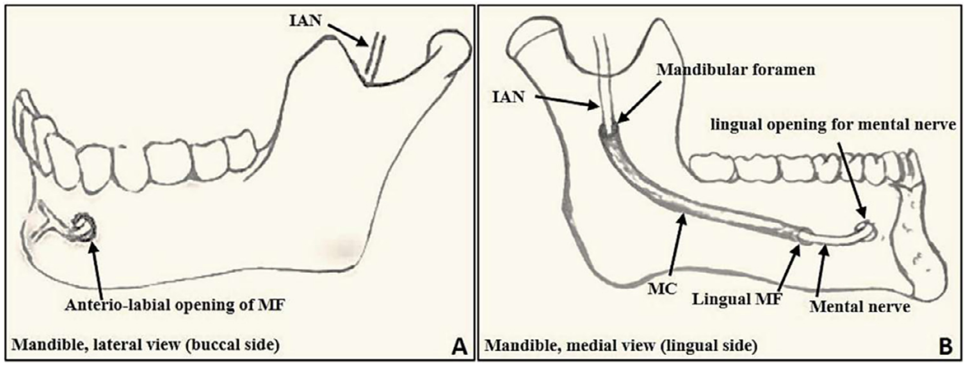

Fig. 3 – (A) The anatomical variations of the opening of the mental foramen (MF). (B) the mandibular foramen, inferior alveolar nerve (IAN), lingual MF opening and lingual opening for mental nerve on the medial surface of the mandible.

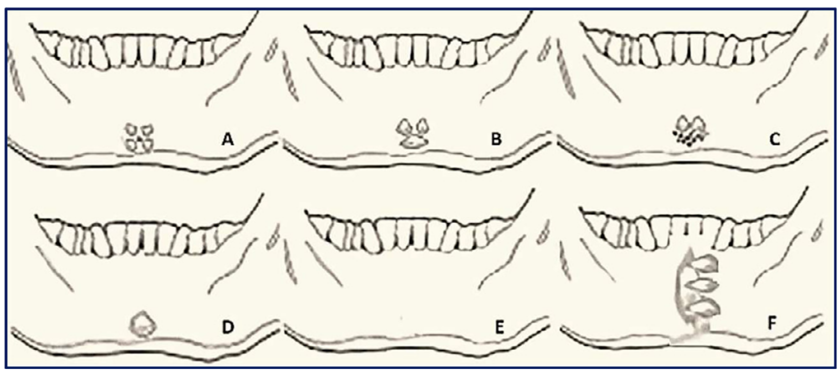

Fig. 4 – Different types of genial tubercle (GT) patterns. (A) Type 1: the classic 4 tubercles pattern. (B) Type 2: 2 superior tubercles and 1 fused inferior ridge. (C) Type 3: 2 superior tubercles with a rough impression below. (D) Type 4: a single median tubercle. (E) Type 5: absence of genial tubercles. (F) a single large median tubercle with 3 small separated heads, a variation observed in this study.

Fig. 5 – 3D view (left buccal side). Absence of the MF on the buccal cortex (red circle), left anterior opening of MC (red arrow), and remnant of bullet fragments (black arrow).

et al [42] analyzed the size and position of the MC, AL, and MF, reporting that in male patients, the MC tended to be located more coronal and medial in the jaw. The MF was commonly positioned below the second premolar with an average height of 2.94 mm and length of 3.28 mm, and its size varied with the age of individuals. Most cases showed a forward extension of the AL (66.01%), and a small percentage (2.6%) exhibited accessory mental foramina.

In this clinical report, the GTs showed larger dimensions, measuring 13.43 mm in length and 11.78 mm in height. Several studies have reported the mean width and height of GTs. One study [39] found a width of 6.23 ± 1.93 mm and a height of 6.67 ± 3.04 mm, while another study [43] reported a width range of 7.1-8.2 mm and a height range of 6.5-7.9 mm. In a different study [44], the mean width was 5.3 ± 1.2 mm, and the mean height was 5.1 ± 1.6 mm. Another study [45] reported a width of 5.24 mm and a height of 5.36 mm. In terms of GT variants, a cross-sectional study found that the two-tubercle variant was the most prevalent (57.7%), followed by a single tubercle (25.0%), 3 tubercles (16.1%), and 4 tubercles (1.2%) [46].

The significance of advanced imaging techniques, such as CBCT, in the evaluation of mandibular structures is emphasized in this case report. CBCT provides three-dimensional images and improved visualization of accessory canals, which assists in the identification of uncommon anatomical variations like lingual exits of the MF and deviations in the pathway of the MC. In addition, the rare size and shape of GTs. Consequently, CBCT should be regarded as a valuable tool for dental implant planning, bone grafting, and other surgi-

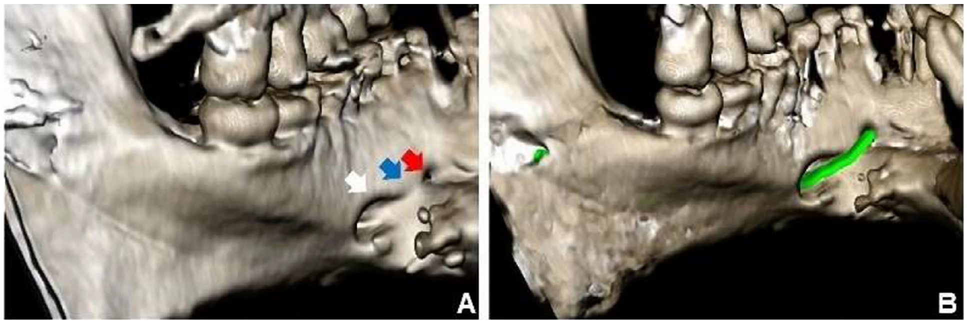

Fig. 6 – 3D views (left lingual side). (A) Lingual exit of the MF (white arrow), anterior exit of the MC (red arrow), and a groove between them (blue arrow). (B) Path of the MC (green color-coded).

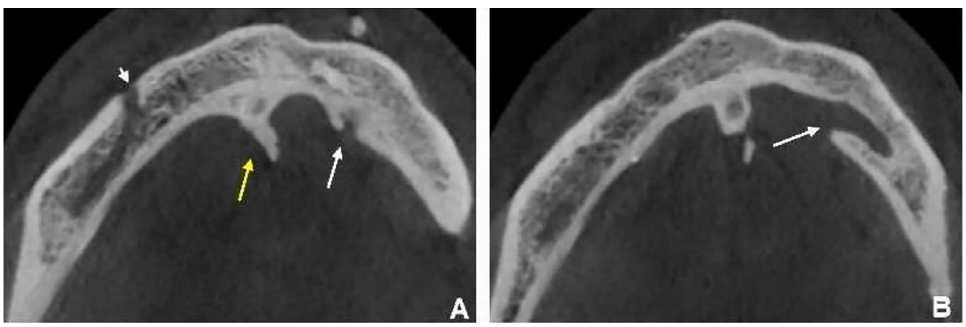

Fig. 7 – Axial CBCT views. (A) The main left MF exhibits lingual exit (white arrow), right MF (white arrow head) and excessive size GTs (yellow arrow). (B) Large opening of the lingual MF on the lingual side (white arrow).

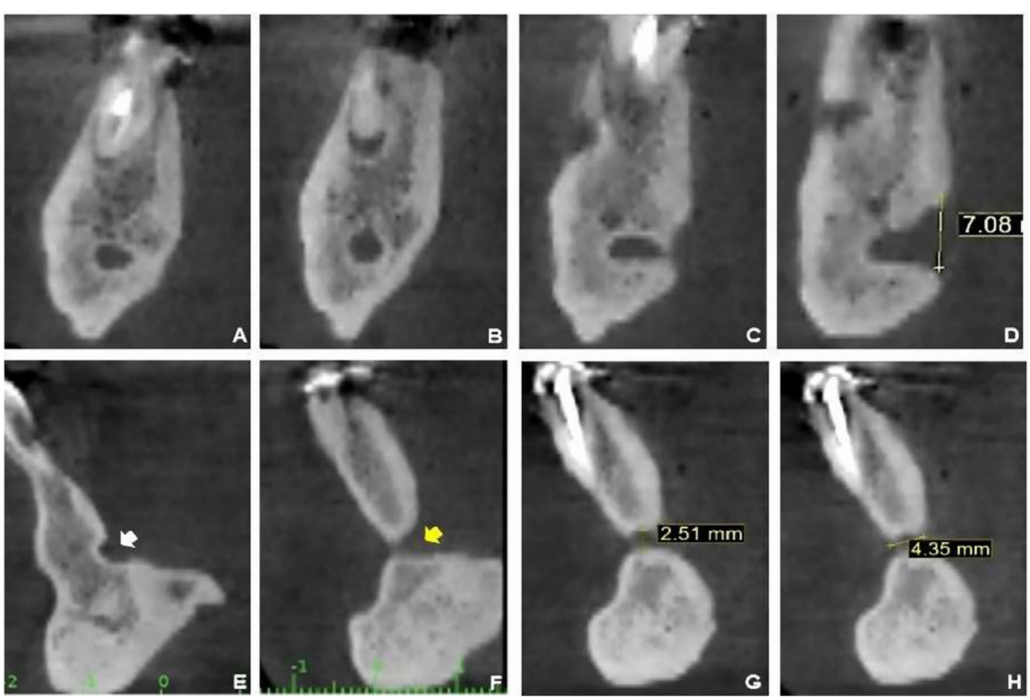

Fig. 8 – Sequential cross-sectional views in the posteroanterior direction. (A-D) display the left-side MC with measurements in millimeters of left lingual MF. (E) Lingual groove for the MC passage (white arrow). (F-H) anterior opening of the MC (yellow arrow) with measurements in millimeters.

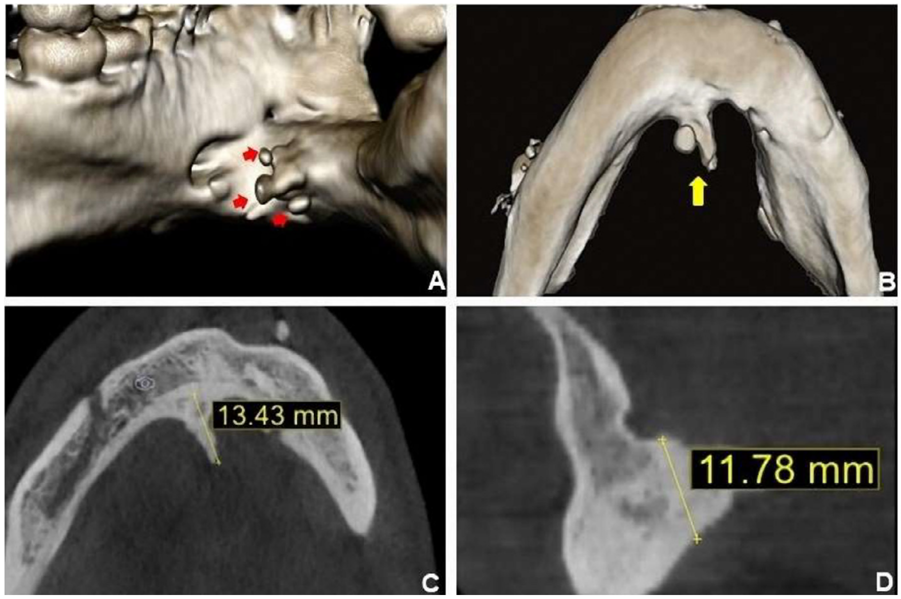

Fig. 9 – (A) 3D lingual view shows single median GT with 3 heads (red arrows). (B) 3D bottom view shows the excessive size GTs (yellow arrow). (C and D) Axial and cross sectional views, respectively, depict the length and height measurements of GTs.

cal procedures involving the mandible. Failure to recognize the standard location and variations of the MC and MF can lead to complications such as sensory impairment, traumatic neuroma, bleeding, and difficulties in administering alveolar mandibular nerve block. Therefore, clinicians should prioritize a thorough examination and the utilization of advanced imaging techniques to precisely locate these structures. Additionally, this clinical report highlights the presence of anatomical variations, such as lingual exits of the MF and deviations in the pathway of the MC. Clinicians should be aware of these variations and consider them during treatment planning.

The clinical applications derived from this case include rare anatomical findings that contribute to the complexity of dental implant planning. CBCT imaging can provide valuable guidance in identifying a safe area near the MF for implant surgery.

Understanding the morphology, position, and dimensions of the GTs can assist in determining an appropriate surgical approach. In cases where GTs are excessively enlarged, causing protrusion beyond the crest of the alveolar ridges, cautious consideration should be given to prevent their fracture during surgical interventions. The dimensions of the GTs have been found to impact the stability of complete dentures in the mandible and patient comfort.

Conclusion

In conclusion, this clinical report highlights the importance of utilizing advanced imaging techniques, such as CBCT, to accurately evaluate mandibular structures and identify anatomical variations. The MF and MC localization is crucial in various dental procedures, including dental implant planning, endodontic treatments, and orthodontics. Clinicians should know these anatomical considerations and tailor their treatment plans accordingly to achieve successful outcomes and minimize complications. Further research is warranted to investigate these variations' prevalence and clinical significance within the general population.

Patient consent

The researchers confirm that the patient featured in this case report provided written consent for the publication of this report and the associated images.

CRediT authorship contribution statement

Redhwan Al-Gabri: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Faisal Abulohoom:** Methodology, Investigation, Writing – review & editing. **Ahmed Yaseen Alqutaibi:** Writing – original draft, Writing – review & editing. **Ameera Obiad:** Methodology, Writing – original draft, Writing – review & editing.

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