RESEARCH ARTICLE

The anomalous canal between two accessory foramina on the mandibular ramus: the temporal crest canal

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Objectives: The temporal crest canal (TCC) is a variation of the bony canal with two accessory foramina that correspond to an entrance and an exit on the mandibular ramus. This study investigated the anatomical characteristics of the TCC using CBCT.

Methods: The study population consisted 446 patients who had undergone CBCT. Sagittal, cross-sectional and three-dimensional images were evaluated for the presence of a TCC. The canals were classified into two types according to the configuration, and the location of the posterior accessory foramen of the TCC was also recorded.

Results: 6 TCCs were present in 4 of 446 patients (0.90% of the total population). All of the TCCs were observed in males, and all of the posterior foramina were located superior to the mandibular foramina on the medial aspect of the mandibular ramus. There were five noticeably curved and increasingly narrow canals (Type 1) and one slightly curved and uniformly wide canal (Type 2).

Conclusions: Precise knowledge of the TCC is clinically important for suitable local anaesthetic nerve block and the planning of surgical procedures that involve the mandibular ramus. Three-dimensional images of CBCT data are particularly effective for confirming the presence of this variation.

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Introduction

The mandibular canal originates from the mandibular foramen and transmits the inferior alveolar artery and nerve to the mental incisive region. This canal is generally a single structure, but variations in the mandibular canal, such as bifid mandibular canals, retromolar canals and temporal crest canals (TCCs), have been reported.¹⁻⁷

The TCC is an anomalous canal that runs from the posterior accessory foramen on the posterior aspect of the temporal crest to the anterior accessory foramen on the anterior aspect of the temporal crest, approximately in the retromolar fossa.^{6,7} The posterior foramen

corresponds to the accessory mandibular foramen that is near the mandibular foramen on the mandibular ramus, and the anterior accessory foramen corresponds to the retromolar foramen in the retromolar fossa.

TCCs are rare anatomical variations that have an incidence rate of 0.3–5.6%.⁵⁻⁷ Because few studies have focused on the TCCs,⁵⁻⁷ there is a paucity of information about this anomaly. Recently, three-dimensional images from CBCT data have made it easier to confirm the presence and configuration of TCCs on the mandibular ramus, and studies of TCCs using CBCT scans have also been reported.^{5,6}

TCCs are clinically significant for mandibular anaesthesia and dental surgery. To prevent nerve damage during surgical procedures, such as sagittal split ramus

osteotomy, bone block harvesting and the removal of lesions involving the mandibular ramus, the need for information about the TCCs is increasing. The aim of the present study was to evaluate the anatomical characteristics of TCCs on the mandibular ramus using CBCT.

Methods and materials

446 patients (892 sides) underwent CBCT scanning for a variety of dental problems at the Yonsei University Dental Hospital, Seoul, Republic of Korea, between December 2011 and February 2012 (males, 217 and females, 229; age range, 15–70 years). The protocol was performed in accordance with the principles of the Declaration of Helsinki, including all amendments and revisions. Only the investigator had access to the collected data.

A Rayscan Symphony[®] CBCT unit (Ray Co. Ltd, Seoul, Republic of Korea) was used. The exposure volume was set at a 142 × 97-mm field of view, and the voxel size was 0.38 mm. The CBCT scans were performed at the exposure settings recommended by the manufacturer. The patients were placed in a position in which the occlusal plane was parallel to the floor, using ear rods and a chinrest during the scans.

All CBCT images were evaluated retrospectively by a single oral and maxillofacial radiologist with more than 10 years' experience. Sagittal, cross-sectional and three-dimensional images were reconstructed from volumetric CBCT data using the image analysis software OnDemand 3D[™] (CyberMed Inc., Seoul, Republic of Korea).

The criteria for confirming the presence of a TCC were as follows:

- (1) The presence of two accessory foramina on the mandibular ramus; one foramen was the posterior foramen behind the temporal crest of the mandible and the other was the anterior foramen in front of the temporal crest of the mandible (in the retromolar fossa).
- (2) The presence of a continuing canal between two accessory foramina corresponding to an entrance and an exit.

The incidence of a TCC and the location of the posterior accessory foramen (accessory mandibular foramen) were evaluated. The TCCs were also classified into two types based on their configuration (Figure 1). Type 1 TCC was noticeably curved and increasingly narrow (Figure 2), and Type 2 TCC was slightly curved and uniformly wide (Figure 3).

Results

At least 1 TCC was identified in 4 of 446 patients (0.90% of all mandibles), and 6 TCCs were observed in

Figure 1 Classification of temporal crest canals (TCCs) according to configurations. Type 1 TCC was the noticeably curved and increasingly narrow canal, and Type 2 TCC was the slightly curved and uniformly wide canal.

a total of 892 sides (0.67% of all sides). Two of the four patients with a TCC presented with bilateral TCCs. One patient presented with a unilateral TCC in the right mandibular ramus, and the other patient presented with a TCC in the left mandibular ramus (Table 1). The TCCs were found only in males.

We observed five Type 1 TCCs and one Type 2 TCC. All of the posterior foramina of the TCCs were located vertically above the mandibular foramina (Table 2). The anterior foramina of the Type 1 TCCs were much smaller than the posterior foramina of this type, and the anterior foramen of the Type 2 TCC was approximately the same size as the posterior foramen.

Discussion

Knowledge of the mandibular canal and its variations are clinically important for dental procedures that involve the mandible. Bifid mandibular canals and retromolar canals are known variations of the mandibular canal, and information about these variations is well established.^{1–4} By contrast, there is a lack of information about TCC.

Ossenberg^{7,8} classified retromolar canals into three types and first described the Type 3 retromolar canal as a TCC. In our previous report, we also classified retromolar canals into three types according to Ossenberg's classification and reported that the Type 3 retromolar canal was associated with TCC.³

In a study of dry mandibles, Ossenberg⁷ suggested that TCCs are inherited, that the incidence of TCCs is 1.3% in Northeast Asia, that the incidence is as high as 23% in some racial groups and that TCCs are more common in males than females.

Recently, three-dimensional images from CBCT have made it possible to confirm the presence and configuration of the TCC on the mandibular ramus. Naitoh *et al*⁶ reported that TCCs were observed at three sites of two mandibles in 292 patients (0.68% of all mandibles and 0.51% of all sides) in a study using CBCT scans. By contrast, Kawai *et al*⁵ who evaluated TCCs on CBCT scans of 48 cadavers reported the relatively high incidence of 8.3% across all mandibles (5.6% of all sides). In the

(a)

(b)

Figure 2 CBCT images of Type 1 temporal crest canal (TCC). (a) Three-dimensional images and (b) cross-sectional and sagittal images. The posterior foramen (black arrowheads) is superior to the mandibular foramen and the anterior foramen (white arrowheads) is in the retromolar fossa. Type 1 TCC (white arrow) is noticeably curved and increasingly narrow.

present study, 6 TCCs were found in 4 of 446 patients (0.90% of all mandibles), and all observed TCCs were found in males.

Regarding the configurations, our classification of TCCs differs from that of Kawai *et al.*⁵ These authors defined the TCC as a bony canal that did not branch off from the mandibular canal but was independent of the mandibular canal at its beginning and classified the canals that started at the mandibular foramen and ended at an anterior foramen into Type 1 TCCs.⁵ However, TCC was defined to have the posterior accessory foramen on the mandibular ramus in other studies.⁶⁻⁸ The canal that branches just at the mandibular foramen, runs parallel to

the mandibular canal and terminates at the accessory foramen in the retromolar fossa, which is associated with another type of retromolar canal compared with TCC.^{3,8,9} This difference in definitions is likely the reason that the incidence of TCC reported by Kawai *et al.*⁵ was higher than that reported in other studies.^{6,7}

In our study, the noticeably curved and increasingly narrow TCC belongs to the Type 1 group. Because Type 1 TCC is increasingly narrow towards its anterior foramen, the anterior foramen is much smaller than the posterior foramen. In previous studies, TCCs were reported to be markedly curved canals and the smallest, with the anterior foramina noticeably smaller than the

(a)

(b)

Figure 3 CBCT images of Type 2 temporal crest canal (TCC). (a) Three-dimensional images and (b) cross-sectional and sagittal images. Type 2 TCC (white arrow), which is the slightly curved and uniformly wide canal, runs between the anterior foramen (white arrowheads) and the posterior foramen (black arrowheads). The anterior foramen is approximately the same size as the posterior foramen.

posterior foramina.⁷ In this study, five of the six TCCs belonged to this type. However, we found Type 2 TCC was a uniformly wide canal between two accessory

foramina, whose anterior foramen was nearly as large as the posterior foramen. The pattern of Type 2 TCC has not been reported in previous studies.

Table 1 The incidence of temporal crest canal

Incidence	Patients (n = 446), n (%)	Sides (n = 892), n (%)
Absence	442 (99.10)	886 (99.30)
Presence	4 (0.90)	6 (0.67)
Unilaterally	2 (0.45)	2 (0.22)
In right	1 (0.22)	1 (0.11)
In left	1 (0.22)	1 (0.11)
Bilaterally	2 (0.45)	4 (0.45)

Table 2 Distribution of temporal crest canals according to configuration

Configuration	Location of posterior foramina		
	Inferior	Superior	Total
Type 1	0	5	5
Type 2	0	1	1
Total	0	6	6

Some authors have suggested that the TCC conveys the long buccal nerve.^{5,7,8} Ossenberg⁷ hypothesized that the TCC contains a branch of the nerve that joins the main buccal nerve according to its size and position in the child's mandible. Because the course of the buccal nerve is generally near the retromolar area and the coronoid process of the mandible, Kawai *et al*⁵ agreed with Ossenberg's hypothesis. However, further studies are required to verify the relationship of the buccal nerve to the TCC.

When a TCC is present, local anaesthesia might fail during routine mandibular nerve block.^{10,11} Because the posterior foramina of the TCCs were located vertically above the mandibular foramina in this study, the contents of the TCC likely branched from the mandibular neurovascular bundle prior to entering the mandibular canal. In such cases, Gow-Gates block or another high

pterygoid entry injection should be performed for local anaesthesia.^{10,11}

TCCs are at risk of nerve damage during oral surgeries, such as dental implant, osteotomy, bone block harvesting and the removal of the lesions involving the mandibular ramus. Nerve damage to a TCC may result in unilateral paraesthesia, excessive bleeding and traumatic neuroma.^{5,12,13} Additionally, the accessory foramen of the mandible is known to provide a route that is highly permissive of the spread of tumour cells following radiotherapy.^{14,15}

In conclusion, special attention must be paid to the identification of TCC for suitable local anaesthesia and the planning of surgical procedures that involve the mandibular ramus. Three-dimensional images of CBCT data are effective for confirming the presence of this variation.

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