Original article

Reliability of cone beam computed tomography in locating and measuring the mandibular canal for planning of surgical techniques in the mandibular body

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A B S T R A C T

Aim: The aim of this study was to determine the reliability of cone beam computed tomography to locate and take measurements of the mandibular canal, as well as the vestibular bone wall, in the planning of bone graft surgery in the mandibular body.

Material and methods: A total of 11 mandibles from fresh cadavers were studied (22 hemimandibles, half of them with teeth). A CBCT and a surgical procedure for the lateralization of the lower dental nerve were performed with the aim of measuring the thickness of the vestibular table and the mandibular canal (MC) or lower dental nerve at 5, 15, and 25 mm from the most posterior position of the mentonian hole.

Results: The results obtained in the study indicate that CBCT, being the best diagnostic tool currently available, still appears to be unreliable when compared to actual results. This discrepancy is a mean of 1.15 mm as regards the thickness of the vestibular bone wall that covers the MC, and a mean of 0.3 mm in relation to the thickness of the lower dental nerve.

Discussion: It is important to know and assess these discrepancies in view of the multitude of surgical procedures that can be performed in this area, and in the vicinity of the lower dental nerve.

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Fiabilidad del uso de la tomografía computarizada de haz cónico en la localización y medida del conducto mandibular en la planificación de técnicas quirúrgicas en el cuerpo mandibular

**Resumen**

**Objetivo:** El objetivo de nuestro estudio fue determinar la fiabilidad del estudio tomográfico para localizar el conducto mandibular y tomar mediciones exactas del diámetro de dicho conducto y de la pared ósea vestibular, como mediciones principales en la planificación del toma de injerto óseo de cuerpo mandibular.

**Materiales y método:** Se estudiaron 11 mandíbulas (22 hemimandíbulas) de cadáver fresco, lamidad de ellas dentadas, a las cuales se les realizaron una CBTC y un procedimiento quirúrgico de localización del nervio dentario inferior con el objetivo de medir el grosor de la lámina vestibular y el grosor del conducto mandibular o dentario inferior (CDI) a los 5, 15 y 25 mm de la parte más posterior del agujero mentoniano.

**Resultados:** Los resultados obtenidos por nuestro estudio indican que el CBTC, siendo el mejor método diagnóstico disponible en la actualidad, aún presenta diferencias respecto a la realidad. Esta discrepancia es de 1,15 mm de media con relación al grosor de la tabla ósea vestibular que lo recubre y de 0,3 m de media con relación al grosor del CDI.

**Discusión:** Conocer y valorar estas discrepancias es importante dada la multitud de procedimientos quirúrgicos que se pueden realizar en esta zona, y la vecindad con el nervio dentario-inferior.

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**Introducción**

Actualmente, los avances en implantoología y su reconocimiento como uno de los medios terapéuticos más importantes en el campo de la Odontología han llevado al uso más comprobado de técnicas quirúrgicas para la implantación de elementos de soporte para la reconstrucción de los dientes faltantes.  

Hay un gran número de técnicas, algunas de las cuales se han realizado en el área anatómica de la mandíbula. Para ello, el tratamiento del rango mandibular y las técnicas de injerto han sido frecuentemente mencionadas en publicaciones recientes.

El núcleo más importante de esta área es el que debe ser cuidadosamente examinado en todos los casos, y que se refiere a la formación de la rama del primer molar de la mandíbula y del arco dental, que se encuentra en el área de la oreja (IDC).

Por lo tanto, determinar la localización de esta estructura antes de la cirugía es esencial para el plan de tratamiento de la mandíbula. Por lo tanto, es importante comprender las técnicas quirúrgicas que se pueden implementar.

En algunos casos, el IDC no puede ser identificado usando una radiografía panorámica. Además, este método no es efectivo para la planificación de la implantación de un injerto en la mandíbula. Por lo tanto, el uso de la tomografía computarizada de haz cónico (CT scan) para planificar la implantación de injertos mandibulares es un método que ha sido ampliamente utilizado y ha demostrado ser eficaz en el campo de la cirugía oral.

**Material y método**

El estudio implicó a 11 mandíbulas (8 sujetos masculinos y 3 sujetos femeninos), 22 hemimandíbulas, de las cuales se obtuvieron dientes frescos, obtenidos de cadáveres. Las mandíbulas fueron pedidas, bajo autorización por parte de la Autoridad de la Unión Europea. Se obtuvieron imágenes de CBCT utilizando un escáner CBCT (GE Locus Ultra, GE Healthcare, United Kingdom). Las imágenes obtenidas fueron base para el análisis de los resultados.
following parameters: 120 kV, 20 mA, exposure time of 16 s, and incisions of 154 μm thick. Images were subject to a three-dimensional treatment, visualisation and measurement using the software Romexis Viewer (Planmeca OY, Finland) (Fig. 1).

The buccal distance was measured from the most lateral area of the IDC towards the vestibular area up to the bone buccal margin. This measurement was based on an incision perpendicular to the basal plane of the mandible in the following points: at 5, 15 and 25 mm from the most rear part of the mandibular mental foramen (Fig. 1). The distance was always measured by the same person. The coronal-caudal diameter of the inferior dental canal was measured in the same way.

After the radiological measurement, the following protocol was carried out on the heads of the corpses to obtain the actual measurement of the distances between the most outer part of the IDC and the limit of the vestibular cortical bone of the mandible. After a surgical approach to this anatomical location, the mental foramen was identified and, on its rear part, at 5, 15 and 25 mm, subsequent osteotomies were conducted (with a handpiece and a fissure drill under irrigation) to access the area to be measured (a fenestration was performed until nerve exposure, and the walls and the canal were subsequently measured using a gauge). Measurements were taken using a manual gauge, and one tenth of a millimetre was established as the base unit (Figs. 2 and 3).

As happened with the radiological measurements, only one independent observer, after the surgical preparation, measured each of the distances: the width of the vestibular bone wall of the IDC and the coronal-caudal diameter of the IDC.

Apart from these main measurements or variables, other measurements were collected in relation to the part of the mandible from which measurements were taken (right or left) and to the gender of the patient.

Finally, the data collected were included in a spreadsheet that was exported to SPSS v.14 (IBM Corp., USA) for their statistical analysis. The Mann–Whitney U statistical test was applied.

**Results**

The thickness of the vestibular wall of the IDC amounted to 4.73 ± 0.95 mm when radiographically measured and to 3.91 ± 1.62 mm when directly measured, at 5 mm from the mental foramen. At 15 and 25 mm from this point, on a radiographic level, the measurements were 7.17 ± 1.18 and 6.72 ± 0.43 mm, respectively. When directly measured, these amounted to 5.13 ± 0.18 and 6.09 ± 0.34 mm, respectively. The differences were statistically significant both at 15 and at 25 mm from the mental foramen (Table 1).

The data used for the comparison of anatomical measurements based on gender or location, as well as the data used for the comparison of radiological measurements, present no statistically significant differences (Table 1).

The diameter of the interior dental canal radiographically measured amounted to 3.94 ± 1.05, 4.06 ± 1.10 and 4.02 ± 1.14 mm, respectively, at 5, 15 and 25 mm from the mental foramen. When directly measured, these presented the following results at 5, 15 and 25 mm from the mental foramen,
Although
respective: 3.86 ± 1.10, 3.81 ± 1.11 and 4.45 ± 2.16 mm. All
the differences were statistically significant (Table 2).

The data used for the comparison of anatomical mea-
surements based on location did not present significant
differences. However, in comparisons based on gender, female
subjects did present a significantly smaller diameter of the IDC
than male subjects, on both a radiological and an anatomical
level (Table 2).

Discussion

Although the IDN presents only one sensible component,
patients and clinicians consider its damage as a failure in the
planning of a treatment. Therefore, it is necessary to conduct
a precise assessment of its anatomy and location to prevent
any damage.

Several surgical procedures, such as the placement of
implants, mandibular ramus or body block grafts, embedded
third-molar exodontia, ramus sagittal osteotomy, nerve trans-
position and the placement of miniscrews for orthodontics,
pose a risk of damage to the IDN. Currently, the planning of these surgical procedures greatly
benefits from the use of CT scans, which have been applied to
the anatomical study of these areas. However, given the importance of preserving noble struc-
tures and the aggressiveness of some of these techniques, it
is essential to understand the correlation between radiologi-
cal measurements and actual measurements, so as to avoid
planning errors.

In relation to the vestibular wall of the IDC, its radiological
thickness ranged from 4.75–5 mm from the mental foramen
to 7–25 mm from said point. When measured directly from
the corpse, said thickness ranged from 4 to 6 mm under
the same conditions. The mean difference between radiologi-
cal measurements and anatomical measurements amounted
to 1.15 mm. This difference must be taken into account upon
planning surgical interventions on this area when performing
a CBCT.

Our results from the radiological measurements were
slightly higher than those obtained in the study conducted
by Massey et al., although it is rare that, in that study,
radiographic measurements were lower than anatomical mea-
surements in the rear areas but higher than the latter in
the areas surrounding the mental foramen. It would seem

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<th>Table 1 – Measurements related to the vestibular wall of the inferior dental canal, distal to MF in mm.</th>
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NS: not statistically significant difference; MF: mental foramen.
that the magnification of the CBCT varies from one area to the other until it disappears and turns into a negative value. This effect was not observed in our study, where radiological measurements were higher than anatomical ones in all cases, regardless of their statistical significance in some situations.

In the work conducted by Kamburoglu et al.,

which showed that the mean thickness of the buccal cortical bone was similar to that obtained in other studies, such as the one performed by Levine et al. in 2007 and by Yashar et al. in 2002 (4.9 mm).20–22

The results related to the thickness of the IDC demonstrated that, in all locations, the radiologically measured thickness was greater than the anatomically measured one (mean value of 0.3 mm).

Several articles indicate that the thickness of the vestibular table is reduced if the analysed individuals are Caucasian or older in the area of the furca of the first molar.20–22

In our study, we did not find differences in relation to the thickness of the vestibular table based on gender or location. However, the thickness of the IDC is lower for female subjects (for both anatomical and radiological measurements) than for male subjects.

In conclusion, the results obtained in our study indicate that the CBCT still presents differences when compared to actual measurements, despite being the best diagnostic method currently available. This difference amounts to a mean value of 1.15 mm in relation to the thickness of the surrounding vestibular bone table and a mean value of 0.3 mm in relation to the thickness of the IDC.

It is essential to understand and assess these differences, given the wide range of surgical procedures that may be performed in this area and its closeness to the IDN.
Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflict of interest

The authors declare that there are no conflicts of interest.

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