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Diagnostic efficacy of cone-beam computed tomography for mandibular fractures

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Objective. The aim of the study was to determine the clinical efficacy of maxillofacial cone-beam computed tomography (CBCT) for the diagnosis of suspected mandibular fractures and to evaluate whether findings would lead to a change in treatment.
Study design. CBCT imaging was performed for 164 patients with suspected mandibular fractures (231 sites) but equivocal clinical and radiological findings (conventional radiography). Images were interpreted by oral and maxillofacial surgeons and treatment decisions based on pre and postimaging were compared. Linear regression analyses were performed.
Results. For 63.2% of sites ($n = 146$) the suspected diagnosis was confirmed by CBCT ($P < .0001$; $R^2 = 0.93$). For 4.33% of sites ($n = 10$) no fracture was identified. Additional fractures were identified in 17.75% ($n = 41$) and additional infractures in 14.72% ($n = 34$). The treatment plan was altered for 9.52% of sites ($n = 22$).
Conclusions. CBCT imaging of suspected mandibular fractures resulted in a change in the treatment plan in 9.52%. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116:98-104)

Despite increased availability of cone-beam computed tomography (CBCT), it has received little attention for the assessment of maxillofacial injury[1] and in particular for mandibular fractures. Patient reports involving the mandible have been limited to single case studies,[2-5] for intra-operative controls[4-6] and for postoperative inspections.[7] In some clinical circumstances the use of CBCT is now replacing multidetector computed tomography (MDCT).[8]

With regard to the mandibular fractures it has been stated that CBCT is superior to panoramic radiography as condylar and coronoid fractures and the anterior part of the mandible were more difficult to detect due to superimposition.[2,5]

Some authors demonstrated that CBCT was superior to conventional radiographs for the detection of fracture lines of patients with a maxillofacial trauma and provided more detailed information about subtle dentoalveolar fractures.[1,3]

Heiland et al.[4] stated that for intra-operative imaging of a mandibular angle fracture and a bimaxillary repositioning osteotomy CBCT offered an alternative to computed tomography (CT) related to high-contrast structures. Other authors[9] found that CBCT was useful to detect an unfavorable sagittal split osteotomy of the mandible and to have a direct visual control of the lingual cortical bone of the mandible and the screw placement.[6]

With regard to the use of MDCT for the diagnosis of mandibular fractures, numerous authors have reported increased accuracy as compared to conventional and panoramic imaging particularly for subcondylar fractures,[10] for mandible fractures,[11] for additional information regarding fracture displacement and comminution,[7,12,13] and degree of displacement.[7,14] Nevertheless some authors stated that axial CT was not recommended for angle fractures[15] and for the diagnosis of minimally displaced fractures.[13]

Sirin et al.[16] found no statistically significant difference between CBCT and multislice CT in artificially created condylar fractures of 63 sheep.

For implant planning the use of conventional tomograms increased the efficacy of periapical and panoramic images, with respect to the prediction of appropriate implant size, by a factor of 2.5.[17] With respect to a change in the treatment plan, selected implant size

Statement of Clinical Relevance

Cone-beam computed tomography imaging of mandibular fractures is a recommended procedure, as it provides additional information (additional fractures in 17.75% and additional infractures in 14.72%) and leads to a change in the treatment plan in 9.52% of sites ($n = 231$).

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differed on average in 89% of the cases[18] when comparing panoramic and conventional cross-sectional tomography for preoperative selection of implant size.

Although it is reasonable to assume that CBCT would perform similarly to MDCT in the diagnosis of mandibular fractures, it is unclear, unlike for implant imaging, that the use of CBCT in this circumstance leads to a change in clinical efficacy, more specifically treatment plan modifications which are potentially more beneficial for the patient.

In the present study, two major study hypotheses were focused on (1) to determine if CBCT imaging for patients with equivocal clinical or radiographic findings suggestive of mandibular fracture improved diagnostic performance, and (2) to evaluate whether confirmatory, exclusional, or additional findings in these patients would lead to a change in the treatment plan.

METHODS

Subject selection

This investigation was designed as an observational prospective study.

Institutional Review Board approval existed. A justification for each radiographic examination was performed according to national guidelines.[19]

The sample consisted of successive patients who presented themselves to the Clinic for Oral and Craniomaxillofacial Surgery, University of Munich, with suspected mandibular trauma. Patients were thoroughly examined by 6 oral and maxillofacial surgeons and only those who had no evidence of other maxillofacial trauma and no neurological deficiency were recruited to participate in the study. Initial radiographic examination comprised panoramic imaging (Orthophos XG Plus, Sirona, Bensheim, Germany) and a posteroanterior skull radiograph (Siemens Multix Pro/Vertix/Polydoros, Siemens, Erlangen, Germany). For those patients with uncertain clinical and/or radiological findings CBCT was performed to either confirm or rule out the suspicion of mandibular fracture.

Three-dimensional radiographic imaging

CBCT was obtained using a NewTom 3G MF12 (Quantitative Radiology, Verona, Italy) and NNT Viewer Software version 3.00 (QR srl, Verona, Italy; July 2010). Volumetric images were acquired using the large field of view (FOV; 12-in FOV, $0.38 \times 0.38 \times 0.3$ mm voxel size) and the middle FOV (9-in FOV, $0.25 \times 0.25 \times 0.2$ mm voxel size) zoom modes.

Exposure parameters for the 12-in-FOV mode were 110 kVp, 0.5-3.99 mA, and 5.4 s, and for the 9-in-FOV mode were 110 kVp, 0.5-4.4 mA, and 7.2-9 s.

At first, 2 scout images, i.e., lateral and posteroanterior views, were taken and then a 360° scan was obtained. The total scan time was 36 s and the reconstruction time of the volumetric images was approximately 3 min. The above-mentioned steps were repeated by the 12-in-FOV mode or the 9-in-FOV mode.

Interpretation

Suspicious clinical findings were defined as no displacement, no mobility, no asymmetry, no occlusal discrepancy, and mouth opening was feasible; suspicious radiological findings were situations with a fracture line being questionable or discontinuous (Figures 1 and 2).

The determination whether initial radiographic examinations (panoramic and PA images) were suspicious was made by a group of maxillofacial surgeons in the ambulance (assistant physician and 2 senior physicians) and was then discussed with senior physicians of the surgical procedure sector, totaling 6 oral and maxillofacial surgeons. An initial diagnosis, based on clinical and radiographic findings, was determined.

The group of OMFS was asked to provide a consensus on the number and location of the mandibular fracture(s) and the treatment plan.

Fractures with regard to the location were classified as (1) fractures of the mandibular symphysis, (2) paramedian fractures, (3) fractures of the mandibular body, (4) mandibular angle fractures, (5) fractures of the mandibular ramus, (6) condylar base fractures, (7) fractures of the condylar neck, (8) intra-capsular fractures, and (9) coronoid process fractures according to Loukota et al., Schiel et al., the AO-classification and Buitrago-Tellez et al.[20-22]

The treatment plan options included (1) no treatment, (2) clinical follow-up control, (3) arch bars and intermaxillary fixation (IMF), and (4) surgical procedure (plate osteosynthesis).

CBCT examination was performed for those patients with suspicious findings for further diagnosis. The process for the interpretation and assessment of number and location of fractures was the same as for the initial clinical/radiographic phase. CBCT images were assessed by the group of maxillofacial surgeons in the ambulance and the surgical procedure sector.

The group of OMFS was asked to provide a consensus on the number and location of fractures and most appropriate treatment plan according to the same classifications as for the initial clinical/radiographic assessment. The decisions derived from the initial assessment based on clinical/radiographic data were compared to those determined by the group using CBCT images.

With regard to the location of the fracture, a comparison of decisions resulted in (1) CBCT confirming or ruling out the presence of the suspected fracture, (2) CBCT providing additional findings related to the confirmed fracture (like displaced fragments and multiple fragments), and (3) CBCT demonstrating a new fracture not assumed before on conventional radiographs.