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Objective

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).

Results

- For 63.2% of sites (n = 146) the suspected diagnosis was confirmed by CBCT.
- 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%.

內文:

Background

Despite increased availability of cone-beam computed tomography (CBCT), it had received little attention for the assessment of maxillofacial injury and in particularfor mandibular fractures. Patient reports involving the mandible have been limited to single case studies for intra-operative(術中)controls and for postoperative inspections(檢查). In some clinical circumstances the use of CBCT is now replacing multidetector computed tomography (MDCT).

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.

Heiland et al. 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 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.

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, for mandible fractures, for additional information regarding fracture displacement and comminution, and degree of displacement. Nevertheless some authors stated that axial CT was not recommended for angle fractures and for the diagnosis of minimally displaced fractures.

METHODS

- Subject selection

The sample consisted of successive patients 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 and a posteroanterior skull radiograph. 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

1. NewTom 3G MF12

2.NNT

At first, 2 scout images, i.e., lateral and posteroanterior views, were taken and then a 360° scan was obtained.

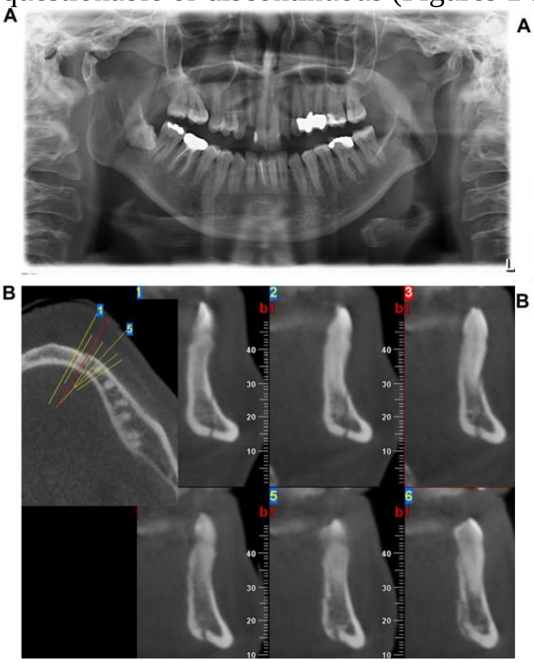
Total scan time:36 s

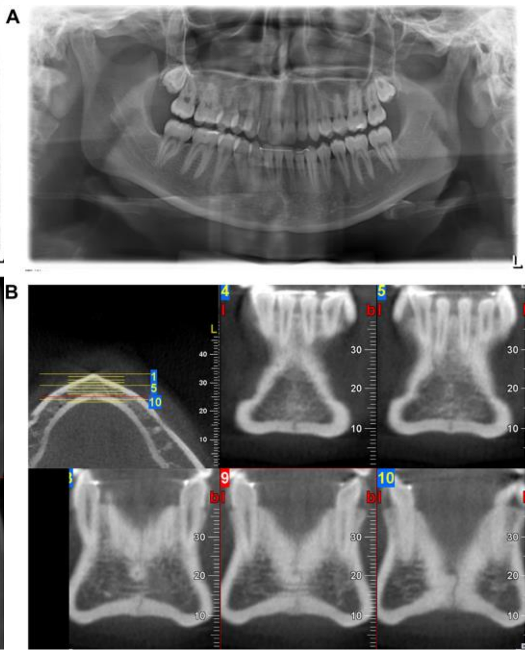
Reconstruction time of the volumetric images:approximately 3 min.

- 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
(9) Coronoid process fractures according
The treatment plan options included:
(1) No treatment
(2) Clinical follow-up control
(3) Arch bars and intermaxillary fixation (IMF)
(4) Surgical procedure (plate osteosynthesis)
The decisions derived from the initial assessment based on conventional 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)
(3) CBCT demonstrating a new fracture not assumed before on conventional radiographs.
Regarding the alteration of the proposed treatment,a comparison of decisions resulted in a definitive change in the treatment plan, defined as an additional procedure such as a surgical procedure, insertion of arch bars in either the mandible or the maxilla, IMF or withholding treatment as was be the case if CBCT ruled out the presence of a fracture.No change in the treatment plan was defined as a clinical follow-up control, prescription of a soft diet, an early functional therapy, or concurrent treatment of a fracture in another region.

- Statistics

Linear regression(線性回歸) analyses and Tukey's honestly significant difference test were performed using JMP software. The significant effects, which led to a change in treatment, were to be established. Frequency distributions comparing fracture type from initial diagnosis with CBCT supplemented diagnosis were created. The distribution of the change in treatment by the treatment modality and by the site of the mandible was to be demonstrated. The distribution and kind of supplemental information were to be presented.

- RESULTS

A total of 164 patients (231 sites totally) with suspected fractures participated in the study.The mean age was 32 years and 5 months, the oldest patient was 96 years and 5 months old, and the youngest patient was 5 years and 3 months old. Participants were 97 men (59.15% of the patients, totaln =164) and 67 women (40.85% of the patients, totaln=164).Only 21.95% of patients (n=36, total n=164) did not demonstrate a mandibular fracture. For the remaining patients (78.05%, n=128, total n=164), osteosynthesis was performed for 57 patients (34.76%,total n=164), conservative therapy was prescribed for 55 patients (33.54%, total n=164), and IMF was performed for 16 patients (9.76%, total n =164).
With regard to the sites (as 1 patient could have several sites suggestive of a mandibular fracture) CBCT confirmed the diagnosis of suspected fracture based on conventional imaging in 63.2% of the sites (n=146 sites, total n=231). For 4.33% of the sites (n=10,total n=231) CBCT could not confirm the estimated diagnosis.

Table I. Additional findings and subsequent treatment procedure (231 sites and 164 patients)

	Provisional clinical and/or radiographic diagnosis		*Additional information*			
Type of information	1 Confirmed (fracture or exclusion)	2 Not confirmed	3 Additional fracture	4 Additional infracture	5 Displaced fragments	6 Multiple fragments
			n = 231			
Sites (*n*)	146 (63.20%)	10 (4.33%)	41 (17.75%)	34 (14.72%)	55 (23.81%)	8 (3.46%)
Change in treatment	1 (IMF) (0.43%)	6 (no treatment) (2.60%)	12 (SP = 9; IMF = 3) (5.19%)	3 (IMF) (1.30%)	(*n* = 1, see in column 1)	0
Rest (without change in treatment)	149 (64.50%)		Treatment already included in treatment for fractures of columns 1 and 2: *n* = 20 (8.66%) Conservative treatment (clinical follow-up control): *n* = 40 (17.31%)			

Table I shows that for 17.75% (41 sites, total n=231), CBCT identified 41 fractures in addition to those suspected by clinical examination or observed on conventional images, for 14.72% (34 sites, total n=231) CBCT identified additional infractures.

In the group of confirmed or additional fractures supplemental information about displaced fragments was gained in 55 sites (23.81%, total n=231), and in 8 sites (3.46%, total n=231) about multiple fragments. A change in treatment was performed in the group of sites where the estimated diagnosis was not confirmed by CBCT (6 sites with a change in treatment), in the group of the additional fractures (12 sites; 3 with a surgical procedure and 9 with an IMF), in the group of the additional infractures (3 with an IMF), and in the group with the displaced fragments (1 site with an IMF).

Table II. Confirmation of the findings in conventional radiography by CBCT and change in treatment

Count Total (%)	*No change*	*Change*	*Total (%)*
No confirmation	64	21	85
	27.71	9.09	36.80
Confirmation	145	1	146
	62.77	0.43	63.20
	209	22	231
	90.48	9.52	

Table II shows that after identification of additional fractures or infractures using CBCT, the preliminary treatment plan was altered for a total of 9.52% of sites (22 sites, total n=231).For 21 sites (9.09%, total n=231) with a change in treatment there was no confirmation and the additional information was gained by CBCT. For 1 region (0.43%, total n=231) the fracture visible in conventional radiography was confirmed by CBCT, but the high level of displacement as an additional finding (Table I) led to a change in treatment (IMF). Linear regression on the additional diagnostic information obtained by using CBCT (additional fractures, infractures, exclusion, and the change in treatment) indicated significant effects ($P < .0001$; R2=0.93). The change in treatment depended on the factors of additional fractures, infractures, exclusion, confirmation, and interactions (additional fracture, exclusion). Treatment was mainly changed when additional fractures were discovered in CBCT ($P < .05$). The change in treatment for the additional infractures was not significant.

Table III. Comparison of different kinds of treatments (T0, T1, T2, and T3) by change in treatment

Kind of treatment	*No change (%)*	*Change (%)*	*Total (%)*
No treatment (T0)	57	6	63
	24.68	2.60	27.27
Clinical follow-up control (T1)	66	0	66
	28.57	0.00	28.57
Insertion of arch bars, IMF (T2)	21	7	28
	9.09	3.03	12.12
Osteosynthesis (T3)	65	9	74
	28.14	3.90	32.03
Overall	209 (90.48%)	22	231
		9.52	

Table III shows the distribution of the changes in treatment and treatment modalities undertaken. For 6 sites (2.60%, total n =231), no treatment was performed, for 7 regions (3.03%) IMF was performed, and for 9 regions (3.89%) a surgical procedure (plate osteosynthesis) was performed. So there are 22 regions
(9.52%, total n =231) where the treatment was changed.

Table IV. Frequency of change in treatment related to the fractured mandibular region

Count *Total (%)* *Region*	*No change*	*Change*	
Mandibular body	21	0	21
	9.09	0.00	9.09
Condylar base	17	2	19
	7.36	0.87	8.23
Condylar neck	39	2	41
	16.88	0.87	17.75
Intra-capsular	53	2	55
	22.94	0.87	23.81
Mandibular angle	37	4	41
	16.02	1.73	17.75
Mandibular symphysis	7	1	8
	3.03	0.43	3.46
Coronoid process	1	1	2
	0.43	0.43	0.87
Paramedian	31	10	41
	13.42	4.33	17.75
Mandibular ramus	3	0	3
	1.30	0.00	1.30
Total	209 (90.5%)	22 (9.5%)	231

Table IV shows the distribution of the change in treatment with regard to the site. There are 10 changes in treatment for the paramedian fracture, 4 changes for the mandibular angle fracture, 2 changes for intracapsular fractures, and 2 changes for fractures of the condylar neck.

Table V. Differences in the regions with regard to the change in treatment

Region	*	*	*	*Mean*
Coronoid process	A	B		0.500
Paramedian	A			0.244
Mandibular symphysis	A	B	C	0.125
Condylar base	A	B	C	0.105
Mandibular angle		B	C	0.098
Condylar neck			C	0.049
Intra-capsular			C	0.036
Mandibular body			C	0.500
Mandibular ramus	A	B	C	0.244

Table V presents the differences between the sites with regard to the change in treatment. Sites (e.g., paramedian region, condylar neck, mandibular body, and intra-capsular region) which were not connected by the same letters A, B, and C were significantly different ($P < .05$). Significant differences regarding the change in treatment exist for the paramedian region, which has only letter A, and the regions of the condylar neck, the mandibular body, and the region of the intra-capsular fractures, which have only letter C. Also the coronoid process (letters A and B) is significantly different from the group with letter C.

- DISCUSSION

The results of this study suggest that the use of CBCT affects the management of suspected mandibular fractures. In the first situation the use of CBCT provides no differences in management. This can occur if no additional fractures are identified (64.50%, Table I), if additional fractures or infractures are identified using CBCT but do not affect treatment (8.66%) as they are treated together with the previously noted fracture or if additional non-displaced fractures or infractures are identified requiring conservative treatment only (17.31%, Table I). In these situations there are no differences in treatment with or without CBCT.