Original Article

Clinico-radiologic correlates of oral and maxillofacial radiographs: A 3-year study of 156 patients in a Nigerian teaching hospital

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Abstract

Background: Any discrepancy between clinical and radiographic information may have dire consequences on the optimal care of patients.

Aim: The aim of this study was to determine the correlation between the clinical and radiographic findings in oral and maxillofacial surgery patients.

Materials and Methods: This was a retrospective study of all patients with plain radiographic views of the oral and maxillofacial region, seen at a Nigerian Teaching Hospital, over a 3-year study period. The radiographs and patients' case files were retrieved and demographic, clinical as well as radiographic information were obtained. Radiographic information obtained included source and types of the radiographs, patients' bio-data, side and site of the pathology, clinical indication, labeling on the radiograph as well as interpretation errors in form of missed diagnosis other than missed fractures. The data were analyzed using SPSS version 13. Cohen's kappa agreement test was done between clinical and radiographic information. $P < 0.05$ was considered significant.

Results: Radiographs from 156 patients aged 8–80 years, mean (standard deviation), 37.9 (19.22) years, were reviewed. There were 102 males and 54 females. Trauma ($n = 54$; 34.6%) was the most common indication for radiographs. "Transposition" of side of the lesions accounted for 9 (5.8%) of the cases. Radiographic "transposition" was significantly associated with facial fractures, temporomandibular joint ankylosis, and impacted mandibular third molars (likelihood ratio: $\chi^2 = 16.930$; df = 10; $P = 0.03$). There was some disagreement between clinical and radiographic information with regard to side (kappa = 0.788; $P = 0.001$).

Conclusion: Discrepancies in the side of lesions, between clinical and radiographic information, were observed in this study. Adequate care should be taken by clinicians and radiologists to minimize errors in radiographs.

Keywords: Interpretation errors, missed diagnosis, plain maxillofacial radiograph

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INTRODUCTION

One of the basic investigative tools in oral and maxillofacial surgery is the use of plain radiographs. This is usually complementary to other diagnostic modalities such as hematologic, serology, blood chemistry, histopathologic investigations as well as advanced imaging techniques. To serve its purpose, a radiograph, apart from being of high quality, should also be able to accurately depict the indicative pathology in terms of side and site of the lesion. In addition, the true identity of the patient should be correctly displayed on the radiograph for obvious medicolegal reasons.

Errors in health care have been listed as the leading cause of death and injury.[1] A major reason for accidents in medicine is that the continuum of care includes a chain of events where faults can grow and evolve.[2] One report has shown that error in radiology is seven times more than in other departments resulting in poor continuity of patient care.[2]

The maxillofacial region is one area of the body where esthetics is of utmost concern. Tumors affecting this area are easily noticed and there may be very little or no clerical errors in the radiographic film report or in the recording of clinical details such as the site and side of the pathology. However, in conditions such as trauma or ankylosis of the temporomandibular joint (TMJ), error may occasionally occur as the side and site of the indicative pathology may not be readily obvious on clinical inspection alone. Improper labeling and misdiagnosis of facial fractures constitutes the primary cause of radiological malpractice lawsuits in the developed countries and is the most common source of diagnostic error in hospital accidents.[3]

In Nigeria, not much work appeared to have been carried out on radiographic errors, especially as it relates to radiographs of the maxillofacial region. In the present study, analysis of different maxillofacial radiographs from 156 patients was undertaken with a view to highlighting the correlation between the clinical and radiographic findings.

MATERIALS AND METHODS

A retrospective analysis of all plain extraoral radiographs in the Maxillofacial Unit of Aminu Kano Teaching Hospital, Kano, Nigeria, over a 3-year period, spanning from January 2010 to December 2012, was undertaken by a senior consultant oral and maxillofacial Surgeon. The inclusion criteria were availability of previous radiologic reports and clear and undamaged radiographs. All radiographs from each of the patients, irrespective of the number of views, were counted as one. This was to allow for easy comparison with the previously available radiologic reports.

In addition, the case files of the patients were also retrieved, and the demographic information (such as patient's name, age, and gender) and clinical information (which includes presenting complaint, side of lesion, diagnosis, and indication for radiologic investigation) were obtained. The radiographic information obtained included source of the radiographs (from a private or public institution), nature of radiographs (whether digitalized or nondigitalized), patients' biodata, side and site of the pathology, clinical indication, labeling on the radiograph as well as interpretation errors in form of missed diagnosis, missed fractures, and nonexisting fractures. A fracture was said to be nonexisting where a clinically and radiographically absent fracture was reported as present. Radiographic errors or discrepancies were confirmed if there were variations between the original radiologic report and the surgeon's observation in terms of intraoperative findings, clinical information, and the surgeon's re-interpretation of the radiographs. The data were analyzed using Statistical Package for the Social Sciences (SPSS) version 13 (Chicago, Illinois, USA). Quantitative variables were presented as frequencies and percentages, while qualitative variables were presented using measures of central tendencies. Cohen's kappa agreement test between clinical and radiographic information was done for interobserver errors, between previous radiographic interpretations made by the general radiologist and that by the maxillofacial surgeon, as well as the correlation between clinical and radiographic information on each of the consecutive cases was determined. $P < 0.05$ was considered statistically significant.

RESULTS

The ages of the 156 patients ranged from 8 to 80 years, the mean (standard deviation) was 37.9 (19.22) years, and there were 102 males and 54 females, giving a male:female ratio of 2:1. Over half of the radiographs were taken in private radiological centers (n = 86; 55.1%) and the remaining 70 (44.9%) were taken at the radiology department of our institution. Eighty (51.3%) of the radiographs were digitalized, while 76 (48.7%) were nondigitalized.

The clinical indications for radiologic request are presented in Table 1. Maxillofacial trauma (n = 54; 34.6%) was the most common indication, followed by impacted mandibular third molar (n = 28; 17.9%), jaw tumors (n = 22; 14.1%), and TMJ ankylosis and fibro-osseous lesions each represented by 10 (6.4%) cases.

Combinations of posterior–anterior (PA) jaw and left and right oblique laterals of the mandible were the most common radiologic views requested and accounted for

70 (44.9%) of all maxillofacial radiographs examined. This was followed by combinations of left and right oblique laterals (n = 34; 21.8%), combinations of PA jaws and occipitomental views (n = 14; 9%), and isolated PA jaws (n = 12; 7.7%). The distribution of other types of radiologic views requested is displayed in Table 2.

Table 3 shows the different types of errors, including missed diagnosis, missed fractures, and nonexisting fracture. Clerical error involving "transposition" of side of the lesions accounted for 9 (5.8%) of the 156 radiographs reviewed. There were 5 cases of missed diagnosis, 3 of which were TMJ ankylosis, and in the remaining 2 (1.3%), bony tumors were misdiagnosed as soft-tissue swellings. There were 9 (5.8%) cases of missed fractures with 6 involving the horizontal ramus of the mandible and 3 (1.9%) were fractures of the zygomatic arch. Three (1.9%) nonexisting temporal bone fractures were reported [Table 3].

Clerical error, involving "transposition" (such that there is a mismatch of radiographic and clinical sides), was significantly associated with fractures of the facial skeleton, TMJ ankylosis, and impacted mandibular third molars (likelihood ratio: $\chi^2 = 16.930$; df = 10; $P = 0.037$) [Table 4].

Cohen's kappa agreement test between clinical and radiographic information with regard to side of the lesion indicated kappa value = 0.788 and P = 0.001 [Table 5]. Cohen's kappa agreement test between previous radiologic reports as obtained from the radiology department and that obtained by the maxillofacial surgeon indicated kappa = 0.302 and P = 0.021, which showed very high discrepancy [Table 6].

Table 1: Clinical indications for request for plain maxillofacial radiographs (n=156)

Indications	Frequency (%)
Maxillofacial trauma	54 (34.6)
Impacted lower third molar	28 (17.9)
Jaw tumors	22 (14.1)
TMJ ankylosis	10 (6.4)
Fibro-osseous lesion	10 (6.4)
Facial cellulitis	8 (5.1)
Jaw cyst	6 (3.8)
Facial gunshot injuries	6 (3.8)
Retained root	5 (3.2)
Chronic sinusitis	4 (2.6)
Alveolar cleft	3 (1.9)
Total	156 (100)

TMJ – Temporomandibular joint

Table 2: Distribution of different radiographic views requested in oral and maxillofacial unit

Types of views	Frequency (%)
Left and right oblique	34 (21.8)
Posterior-anterior jaws	12 (7.7)
Occipitomental	5 (3.2)
Reverse towns	6 (3.8)
P-A jaws, left and right oblique	70 (44.9)
P-A jaws, occipitomental	14 (9)
Left and right oblique, OMV	6 (3.8)
Anterior-posterior skull, lateral skull	9 (5.8)
Total	156 (100)

P-A – Posterior–anterior; OMV – Occipito-mental view

Table 3: Radiographic findings

Variable	Frequency (%)
Transposition error	
Yes	9 (5.8)
No	147 (94.2)
Missed diagnosis	
Yes	5 (3.2)
No	151 (96.8)
Missed fracture	
Yes	9 (5.8)
No	147 (94.2)
Nonexisting fracture	
Yes	3 (1.9)
No	152 (98.1)

DISCUSSION

Maxillofacial trauma, jaw tumor, and impacted mandibular third molar were the most common indications for request of plain radiographs of the oral and maxillofacial region. Although orthopantomograph remains the radiologic gold standard investigation for impacted mandibular third molars,[4] it is not available in our center. As an alternative, oblique laterals of the mandible are used, especially when mouth opening is limited. In addition, oblique lateral views give a very good view of the inferior neurovascular canal and its relationship to the apices of the impacted tooth compared to periapical radiographs, particularly if the intraoral film is not properly positioned.

Radiology cannot always produce infallible interpretations or reports.[5] The errors noted in this study include clerical errors (5.8%) such as mislabeling, missed diagnosis (3.2%), missed fractures (5.8%), and overdiagnosis (i.e., presence of clinically and radiographically nonexistent fractures [1.9%]). All these may lead to misinterpretation error which may be potentially harmful, depending on the case.

Interpretation error in radiology is not new. A review of the literature suggested that the level of error for clinically significant or major error in radiology is in the range 2%–20% and varies depending on the radiological investigation.[6,7] Studies with chest radiographs have shown that physicians and anesthesiologists do make inaccurate interpretations[8-10] and those faulty interpretations changed management decisions in up to 11% of cases.[7] With higher levels of training and experience, however, it was

Table 4: Distribution of clerical radiographic errors according to clinical indications

Indication	Transposition		Clerical error, total (%)
	No	Yes	
Maxillofacial trauma	51	3	54 (34.6)
Impacted lower third molar	26	2	28 (17.9)
Jaw tumors	22	-	22 (14.1)
TMJ ankylosis	6	4	10 (6.4)
Fibro-osseous lesion	10	-	10 (6.4)
Facial cellulitis	8	-	8 (5.1)
Jaw cyst	6	-	6 (3.8)
Facial gunshot injuries	6	-	6 (3.8)
Retained root	5	-	5 (3.2)
Chronic sinusitis	4	-	4 (2.6)
Alveolar Cleft	3	-	3 (1.9)
Total	147	9	156 (100)

χ^2=16.930, *P*=0.037. TMJ – Temporomandibular joint

Table 5: Kappa statistical test between clinical and radiographic information

Radiographic information	Clinical information			Total
	Patient left	Patient right	Patient bilateral	
Patient left	78	6	-	84
Patient right	3	48	-	51
Patient bilateral	-	-	21	21
Total	81	54	21	156
Measurement of agreement	**Value**	**SE**	**Approximate *T***	***P***
κ	0.788	0.047	12.9111	0.001

SE – Standard error

Table 6: Kappa statistical test between general radiologist's and surgeon' radiographic diagnosis of maxillofacial fractures

Presence of fractures General radiologist	Maxillofacial surgeon		Total	
	No	Yes		
Yes	0	16	16	
No	10	27	37	
Total	10	43	53	
Measurement of agreement	**Value**	**SE**	**Approximate *T***	***P***
κ	0.302	0.066	2.309	0.021

SE – Standard error

demonstrated that interpretation improved with greater confidence.[11,12] Literature on interpretation errors in oral and maxillofacial radiographs is however sparse. In Nigeria, Akadiri *et al*. observed that condylar fracture was easily missed by the general radiologists.[12] This is in agreement with the result of the present study which showed relatively lower diagnostic skills of maxillofacial fractures by the general radiologist compared to the maxillofacial surgeon (kappa = 0.302; *P* = 0.021). This also confirmed the results of Lee *et al*.[13] who had previously observed that clinicians with little experience in the field of maxillofacial fractures showed a relatively low diagnostic acumen in the detection of condylar fractures. It is thus logical to assume that an oral and maxillofacial surgeon or better still, a maxillofacial radiologist, because of his superior understanding of the anatomy of the region, may report radiographs of the maxillofacial area more accurately than the general radiologist.

Clerical errors (or incorrect labeling of the radiograph such that a lesion that presents clinically on the right of the patient for instance is reported in the radiologic report to occur on the left) accounted for 9 (5.8%) in the present study. The results of this study shows that certain maxillofacial conditions like facial skeletal fractures, TMJ ankylosis, and impacted mandibular third molars were more likely to be misrepresented than other lesions because these pathologies are not as prominent on clinical inspection when looking at the patient extraorally, compared to tumors in the maxillofacial region. Even though the Cohen's kappa value for agreement between clinical and radiographic location of the lesion was 0.79, signifying good agreement, this is not acceptable as perfect agreement, with kappa value of 1 being the most desirable for optimal patient care.

While this type of discrepancy may be of no significant negative effect on the outcome of patient management in certain conditions, it may present with grave consequences in others. In patients with TMJ ankylosis, for instance, surgeons rely, to a very large extent, more on radiologic than clinical findings to decipher both the side and extent of ankylosed mass. Due to wrong labeling, the operator may mistakenly open up the left TMJ for condylectomy, only to find out that the pathology was on the right side. This will obviously have a negative effect on the psyche of the surgeon as well as increased operation time. For the patient, this will mean more surgical morbidity, increased period of anesthesia, avoidable surgical scar as well as increased likelihood of re-ankylosis.

Although limited by cost, modern imaging techniques, especially three-dimensional computerized tomographic scan and cone-beam computerized tomographic scan would also help a great deal in avoiding errors in maxillofacial radiography and are supported by the results of a number of studies.[9,11] Being able to visualize oral and maxillofacial pathologic entities in three dimensions assists in diagnosing and planning the appropriate treatment for the patient and minimizes misdiagnosis in the maxillofacial region.[9,11]

One of the limitations of the study is that the working environment and conditions of the radiographers and radiologist were not taken into consideration while carrying out interpretation. It is possible that the interpreter or radiologist might have been fatigue, arising from having to cope with too many patients. Another limitation is that it is difficult to know if the clinical information in the patient case files were correctly documented.

CONCLUSION

Discrepancies (between clinical and radiographic information) such as clerical error, "transposition," missed fracture, and clinically nonexistent fracture were observed in this study. In this current litigious world, adequate care must be taken by both clinicians and radiologists/radiographers when attending to patients to minimize errors or discrepancies in radiographs. Where possible, joint clinico-radiologic meetings should be encouraged, where the need arises, between the two specialties of radiology and oral and maxillofacial surgery. It is also recommended that more residents should be encouraged to specialize in oral and maxillofacial radiology, which is still an evolving specialty in Nigeria, such that in future, all radiographs of the maxillofacial region would be handled by these groups of experts. In addition, regular refresher courses for general radiologists in the areas of maxillofacial radiology should be encouraged.

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Conflicts of interest
There are no conflicts of interest.

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