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The radiological assessment of ectopic lower third molars

A J MacGregor DDSC MChD FDSRCS
Department of Dental Surgery, School of Dentistry, University of Leeds

Summary

Experiments using observers ranging in experience from undergraduates to consultants showed that the orthopantomograph can be used satisfactorily to predict the time taken to remove those ectopic lower third molars capable of being put into Winter's classification. When used for this purpose this radiograph compared well with the lateral oblique view of the mandible. There were differences with the intraoral view, but it could not be certain which was superior.

The value of the orthopantomogram in predicting impaired postoperative labial sensation was tested. It became apparent that there were cases in which the nerve was clearly at risk and others in which it was clearly not at risk. Variations in the anatomy of the canal and the quality of its image could give rise to doubt, some of which could be resolved by taking intraoral views.

An unsuccessful attempt using analysis of multiple regression was made to select and quantify those features of the radiograph important for predicting the time taken for removal of the teeth. A simple points scoring method was evolved which agreed with current practice and was capable of being used effectively by undergraduates, some of whom had made inadequate assessments hitherto.

Introduction

John Hunter[1] was right when he wrote in 1771 that 'this cutting of the *dens sapientiae* is often attended with an inconvenience'. He was also aware of the problems of what is now known as pericoronitis and that 'nothing but the removal of the tooth or teeth will remove the evil in many cases'.

This procedure must have been formidable in the eighteenth century and continued to be so until the 1920s, after certain technical advances had been made. Radiographs were recognised as being particularly valuable in planning the surgery almost as soon as X rays were discovered by Roentgen in 1895, but the exact manner in which they were to be used was not codified until 1926, when Winter[2] produced his well-known classification based mainly on the position of the third molar in the jaw. Other systems followed, notably those of Pell and Gregory[3] and Thomas[4] in the USA and Warwick-James[5] and Ward[6] in the United Kingdom. All were influenced by Winter, but it should be said that Clarke[7] thought Winter's classification of academic value and that surgical planning owed most to practical experience of removing teeth.

Those who believed in the value of radiographs almost all based predictions on reading the intraoral (IO) film, claiming that only this view provided the necessary detail. Oblique lateral (OL) views of the jaws showing third molars were acceptable only in extremes such as permanent trismus. When the orthopantomogram (OPT) (Fig. 1) was introduced in the 1970s it quickly replaced the other views. This was determined by the convenience of the radiographer rather than the needs of the surgeon and it seemed possible that surgical standards were being allowed to fall because of its introduction.

The first question to decide was whether the OPT could be used to estimate the difficulty of removing wisdom teeth. The possession of 142 OPTs (Table I) for which the time taken to remove the wisdom teeth was known allowed the setting up of a series of psychological experiments based on a classical design of R A Fisher[8].

Value of OPT in predicting difficulty of removing lower wisdom teeth

The time taken from just after raising the flap to just before it being closed ('removal time') was known for each tooth; values ranged from

From a Hunterian Lecture delivered on 24th February 1978

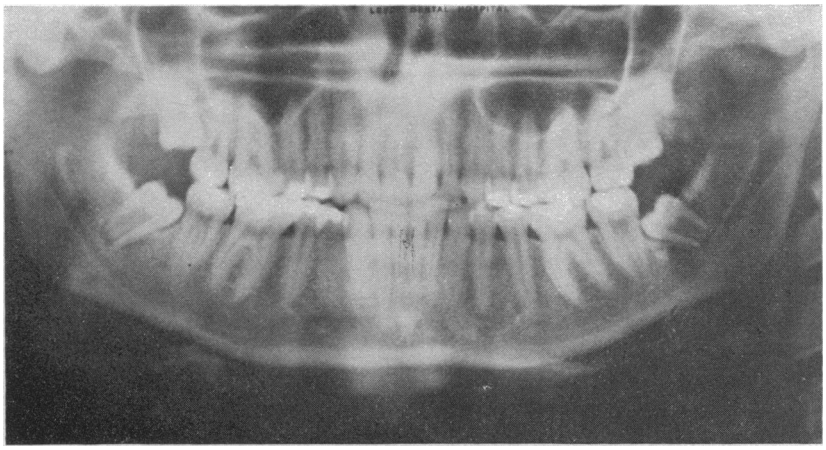

FIG. 1 *Orthopantomogram showing bilaterally impacted wisdom teeth.*

TABLE I *Distribution of 142 third molars according to time of removal and allocation into categories of difficulty*

	A (*very easy*)	*B* (*easy*)	*C* (*average*)	*D* (*difficult*)	*E* (*very difficult*)
Time	0 – 1 min 59 s	2 min – 3 min 59 s	4 min – 5 min 59 s	6 min – 7 min 59 s	8 min +
Frequency	52	42	20	12	16

a few seconds to just under 14 min. Difficulty of removal was classified in five categories, A–E, related to the time scale. As shown in Table I, teeth designated 'very easy' (category A) were removed in under 2 min, while those rated 'very difficult' (category E) took over 8 min.

Two radiographs were selected to represent each of the five categories, there being thus 10 teeth to assess, all of them having been removed by the same surgeon. These radiographs were presented in random order to observers who did not know the removal times and they were asked to estimate into which category of difficulty the tooth fell. A scoring system was devised based on the sum of the squared difference between the estimated and known degree of difficulty of the 10 teeth. Probability values were calculated for all the different possible scores. The system has general value and can be used to make a rapid and precise estimate of ability in matching any 10 pairs. A lower value was taken to mean a higher skill in assessing radiographs.

An example of the results obtained with this scoring scheme is shown in Table II. Students in the third year of study have not yet attended the oral surgery clinic and can be regarded as intelligent laymen. It is clear that some of them are quite skilful at assessing the radiographs in this regard. The table also shows that as the undergraduate course continues an increasing proportion becomes skilful, but that just before qualifying some are still unable to

TABLE II *Cross-sectional study of radiological assessment showing frequency distribution among students with different experience and consultants*

	Score			
	0–6 ($P<0.001$)	*7–11* ($P>0.001$, <0.01)	*12–17* ($P>0.01$, <0.05)	*18 +* (*NS*, $P>0.05$)
3rd year	0	3	1	6
4th year	0	3	5	2
5th year	0	4	4	2
6th year	2	1	5	2
Consultants	2	3	4	1

TABLE III *Comparison of OPTs with OL radiographs*

Observer	*Method*	*P value*			
		<0.001	*>0.001, <0.01*	*>0.01, <0.05*	*>0.05 (NS)*
Students (10)	Ranking	6	1	2	1
Consultants (14)	Category	7	4	0	3
Senior registrars (7)	Category	7	0	0	0

perform any better than by chance. Ten consultants from the academic and hospital staff of the Leeds and Sheffield Dental Hospitals accepted invitations to read the radiographs and although some achieved almost perfect matches, it was interesting to see that one could be considered inadequate.

Longitudinal studies were made in which students were followed partly through the course. In another series it was asked that the radiographs be placed in order and for this a similar scoring system was devised. Another series of radiographs was assembled relating to another surgeon's operating times. One most interesting finding was that if the groups of observers were large enough, their collective estimate could be nearly perfect even if none of them individually was very skilful. All the results confirmed the view that the OPT contained the information necessary to assess the difficulty, conceived in terms of time, of removal of lower wisdom teeth.

Comparison of OPT with OL and IO views

A direct study of the value of OL and IO views was not possible because of the shortage of material arising from the popularity of the OPT. Pairs of radiographs were assembled so that for each of 10 teeth OPT and OL views were available. Observers were presented with the 20 radiographs in random order and asked to place them in categories of difficulty. Some were also asked at different times to place each series in order of difficulty, having been presented with them in random order. It will be appreciated that the scoring systems were already available from the direct experiments with the OPT against time. Similar experiments were carried out comparing the OPT and the IO.

Table III shows that the OPT and OL views can be matched extremely well by most observers and it must be considered that they provide similar information.

Table IV shows that most observers cannot match the OPT and IO views. However 2 performed at the $P<0.01$ level and 1 at $P<0.001$, and since the total taking the test was only 20 it must be assumed that for those possessing the skill the relevant information is present on both films and moreover that it is likely that non-matching is due to the presence of confusing additional information. It may be that so far as assessing difficulty is concerned the IO provides too much information, for it has already been shown that the OPT is adequate.

Predicting impaired labial sensation

Sewill[9] reported two third molars, one grooved and the other perforated by the neurovascular bundles, to the Odontological Society of London in 1881. The patient had suffered loss of sensation in the lower lip and it is evident from the discussion on the paper that the complication was well known. La Cronique[10] in 1922 is given the credit of being the first to predict nerve damage from radiographic appearance. The relationship of nerve and impacted wisdom tooth received sporadic attention through case reports. Bowdler Henry[11] made a good review of the early literature in a Hunterian Lecture in 1935. The applied anatomy of the region was described by Miles and West in 1954[12], using specimens from the

TABLE IV *Comparison of OPTs with IO radiographs*

Observer	*Method*	*P value*			
		<0.001	*>0.001, <0.01*	*>0.01, <0.05*	*>0.05 (NS)*
Students (20)	Ranking	1	2	4	13

Odontological Museum. It was not, however, until Howe and Poyton[13] published their review in 1960 of the results of removing 1355 wisdom teeth that the problem was quantified accurately and described in terms allowing independent criticism. They developed criteria based on alteration of appearance of the tooth or inferior dental canal when they were superimposed which led to a diagnosis called true relationship. Their findings were confirmed at operation and apart from slight overdiagnosis in erring on the side of caution they were almost always correct. If a true relationship occurred a patient had a 36 in 101 (35.64%) chance of getting postoperative labial anaesthesia and if not then the chance was 34 in 1254 (2.7%).

Seward[14] later emphasised that if the canal was adjacent to the tooth the nerve was in jeopardy. Roberts and Harris[15] drew attention to the impaired labial sensation resulting from damage to the mylohyoid nerve. Neither of these possibilities is yet capable of being diagnosed using conventional two-dimensional radiographs, so Howe and Poynton's predictions must still be considered the best available.

It would have been of interest to have compared the OPT directly with the IO in regard to their usefulness in predicting impaired labial sensation, but the IO had almost gone into disuse. Another complicating problem was the low occurrence of the disorder. A retrospective study showed only 5 examples in 504 operations. This proportion was confirmed when a prospective study showed only 2 out of 398 teeth with damage to the inferior dental nerve and 1 with damage to the mylohyoid nerve. In these circumstances it was not feasible to make a meaningful study of the relationship of radiographic features to impaired sensation.

An attempt was made to predict the presence of a groove on the tooth by reading the OPT. Forty of the 398 teeth were not fully developed and therefore unsuitable. The remaining 358 were examined in random order and independently of the radiographs for the presence of grooves. Of these, 29 were considered grooved and 239 not grooved, while 90 had been so mutilated at operation as to make opinion uncertain. The radiographs were now examined and grooving of the tooth was predicted if either tooth or canal was altered just as they overlapped. Positive predictions were made in 19 cases and negative in 294, while in the remaining 45 the relationship was not discernible. Only 231 had complete data and here the important finding was that in 16 cases in which no groove was predicted a groove was found anatomically (Table V). Not all of these grooves would be due to the presence of the nerve and some were so shallow that they could not be demonstrated radiographically on the extracted tooth, but if Howe and Poyton's findings are accepted it is reasonable to suppose that the OPT is an inferior view to the IO for these purposes.

Nevertheless, there are circumstances in which the OPT gives clear indications. If the tooth is separate from the canal or if either alters in character just as they are superimposed the prediction is obvious. Where they are adjacent, and this must include all which are superimposed without alteration, Seward's injunctions must be obeyed, especially when the tooth is mesioangular and the canal is at its apex.

Where there is any doubt and the outcome is of importance to the patient then it may be considered wise to ask for an IO view.

An analysis of multiple regression

The fact that some observers could make accurate assessments of the difficulty of removal of the teeth made it seem worth while to seek measurable features of the radiograph which could be used to predict removal time.

TABLE V *Correlation of radiographic and anatomical assessments*

Anatomical assessment	*X-Ray assessment* +	−	*Not discernible*	*Total*
Grooved	7	16	6	29
Not grooved	8	200	31	239
Mutilated	4	78	8	90
Total	19	294	45	358

Records were made of 22 attributes and variables relating to the size of the jaws and teeth, their shape, and their relationship. They mainly concerned such factors as the amount of bone covering the teeth and the complexity of root form. A full account can be found elsewhere[16]. Data were subjected to stepwise multiple regression as described by Nie *et al.*[17] This programme had the facility of dealing with both metric and parametric data and had the added advantage of accepting incomplete data. The hope was to derive heuristically the minimum number of factors to be taken into consideration and to be able to construct an equation which would allow the clinician to compute accurately the time of removing a tooth by reading the radiograph.

In the event the programme selected 19 factors as being significant, and when they were used merely to compute the removal times of the 100 teeth from which the original measurements were derived the results were hopelessly inaccurate. It was perhaps just as well because if it had been otherwise dental surgeons might have been faced with finding an excuse not to make a large number of sophisticated measurements before removing such teeth.

The programme could not even predict with any accuracy the removal times of the 10 teeth used in experiments with clinical observers. This failure was thought to be due to the inadequacy of measuring lines and angles to describe shapes. It would appear that such topological problems are not yet amenable to mathematical analysis despite the ease with which they can be solved by the human brain.

The matter could have been left there, but it was so tantalising that some preclinical students could be so skilful in this matter that it seemed that a further effort ought to be made to find a solution. It was possible that despite the sophistication of the method we had tried to deal with too many data. An attempt was now made to select a few factors, easy to measure, not inter-related, and important to the regression. The factors were selected by reference to the correlation matrix. It was known, for example, that the size of the jaws was significantly related to the length of the second and third molars and to their widths, and since the OPT was being used the height of the jaw was used rather than the dimensions of the teeth. At the same time as the factors were selected a crude scoring system was devised in which increasing points were given when, for example, the jaw increased in size or root shape increased in complexity. A tedious process of trial and error eventually resulted in a system (see Appendix) which could make acceptable predictions concerning the 10 radiographs used in the first experiment.

When this process was extended to another 100 radiographs the results were found to have some clinical value. These results are shown in Table VI. It is apparent that there is a trend for the more difficult teeth to be given the higher scores. Perusal will show that a score of 5 or less is not often associated with more difficulty than average. Examination of the radiographs of 50 impacted teeth successively removed under local anaesthesia from outpatients at the Leeds Dental Hospital showed that indeed the scoring system conformed to current practice. Only one tooth had a score higher than 5.

The next question to be settled was the value to the undergraduate of the scoring system. All 32 students in the final year were asked to classify the 10 radiographs referred to in the first section. These students had almost completed their training and had some experience of third molar surgery. They were allowed to use whatever system they chose to estimate the removal time they thought necessary. They were then asked to assess the radiographs using the new system. The results shown in

TABLE VI *Frequency distribution of categories of difficulty and scores for 100 OPTs.*

Score	*Category of difficulty (see Table I)*				
	A	*B*	*C*	*D*	*E*
10	—	—	—	1	3
9	—	1	—	2	—
8	—	1	4	—	1
7	5	5	3	1	3
6	2	4	1	3	—
5	6	8	5	1	—
4	9	3	5	—	—
3	3	2	1	1	—
2	4	3	1	—	—
1	4	1	—	—	—
0	1	1	—	—	—
−1	1	—	—	—	—

TABLE VII *Comparison of results of testing by method of choice (Test 1) and new scoring system (Test 2) (32 students).*

	P value			
	<0.001	>0.001, <0.01	>0.01, <0.05	>0.05 (*NS*)
Test 1	3	8	13	8
Test 2	2	18	10	2

Table VII indicate that the method greatly reduced the number of incompetents, from 8 to 2, and also increased the number showing skill at the $P<0.01$ level, from 8 to 18. Alas, the number of really excellent assessors was reduced from 3 to 2! This falling off in standards of the brilliant when they are overcoached is a fault in many disciplines, but so far as this particular exercise was concerned it was thought to be more than compensated for by the decrease in the number of patients likely to be put to severe inconvenience. The method is one which is therefore taught to undergraduates and recommended to the admissions department of the hospital, whence patients may be referred to oral surgery departments by relatively inexperienced staff.

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APPENDIX

System of scoring for assessment of difficulty of removal

The six factors chosen have been placed in such an order as to make the acronym WHARFE. This order does not reflect the importance of the contribution of each factor to the regression. As a matter of fact W, which is first, is derived from Winter's classification, which provides an almost insignificant amount of information and was hardly worth including. It was kept not only for traditional reasons but also because if the tooth cannot be so classified this scoring system is inappropriate as it deals with impacted teeth for which the relationship of the occlusal plane is capable of being determined. Bizarre impactions and impactions in edentulous jaws are therefore among those excluded.

One further word of caution is necessary. It is clear from the factors studied that their complete manifestation is not taken into account. For example, the follicle can be obliterated by resorption of the crown and enostosis and this would make the tooth extremely difficult to remove. Extremely deep teeth, those with florid root shapes will also be excluded. Such extremes are also outside this classification. The method does not lose much in its clinical value by these reservations since such teeth are not only rare but are easy to assess as likely to be very difficult to remove.

		Category	*Score*
1)	Winter's classification	Horizontal	2
		Mesioangular	1
		Vertical	0
		Distoangular	2
2)	Height of mandible (mm) (Fig. 2)	1–30	0
		30–34	1
		35–39	2
3)	Angle of second molar (degrees) (Fig. 2)	1–59	0
		60–69	1
		70–79	2
		80–89	3
		90+	4
4)	Root shape and development		
	a) Less than $\frac{1}{3}$ complete		2
	b) $\frac{1}{3}$ to $\frac{2}{3}$ complete		1
	c) More than $\frac{2}{3}$ complete:	Complex	3
		Unfavourable curve	2
		Favourable curve	1
5)	Follicle	Normal	0
		Possibly enlarged	−1
		Enlarged	−2
		Impaction relieved	−3
6)	Exit path (Fig. 3)	Space	0
		Distal cusp covered	1
		Mesial cusp covered	2
		All covered	3

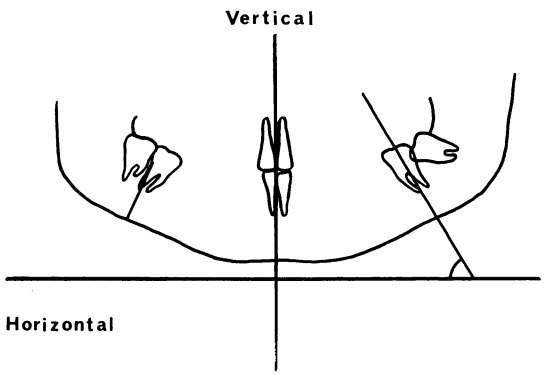

FIG. 2 *The height of the mandible is measured from the distal profile of the amelocemental junction to the nearest point on the lower border of the jaw. The angle of the second molar is that made by the long axis of that tooth to a fiducial horizontal line.*

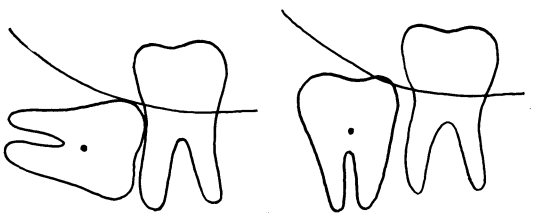

FIG. 3 *Exit path. The tooth is rotated about the midpoint of the amelocemental junction and the point at which the shadow of the coronoid process crosses the crown is noted. In the example shown a mesioangular tooth when rotated is seen to have only the distal cusp completely covered.*