Int. J. Oral Maxillofac. Surg. 2003; 32: 548–552
doi:10.1054/ijom.2003.0413, available online at http://www.sciencedirect.com

International Journal of
Oral & Maxillofacial Surgery

Evidence Based Therapy
Oral Surgery

Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey

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S. L. Quek, C. K. Tay, K. H. Tay, S. L. Toh, K. C. Lim: Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey. Int. J. Oral Maxillofac. Surg. 2003; 32: 548–552.

Abstract. One thousand orthopantomograms (OPGs) of patients 20–40 years old were examined. Where impacted third molars were present, the angle and depth of impaction were recorded. Results were analysed using the Pearson χ^2 test. 68.6% of OPGs showed at least one impacted third molar.The frequency was three-fold higher in the mandible (1024/1079=90%) than in the maxilla (306/1077=28%), with a significantly higher frequency ($P<0.05$) in females (56%) than males (44%). The mesioangular impaction was the most common, and 80% of all impacted third molars were partially buried in bone. Of the 429 bilateral occurrence of impacted third molars, 423 were in the mandible. It was concluded that the frequency of impacted third molars in the Singapore Chinese population studied was generally two to three times that reported in races of the Caucasian stock. There was also double the frequency of impacted third molars when compared to a previous study in a Chinese population published in 1932 with females being more frequently affected than males.

Key words: molar third; retrospective studies; adults; radiography; dental.

Accepted for publication 13 March 2003

Introduction

The third molar is the most frequently impacted tooth, with a frequency of occurrence generally reported to be from 18 to 32%[2]. It is considered impacted when its eruption into normal functional occlusion has been interfered with by other teeth, overlying bone or soft tissue and it is not fully erupted by its expected age of around 20[11].

Most studies have reported no sexual predilection in Caucasian[1,4,5,17], Negro[4,14], Arab[9,10] or Chinese[17] populations. Other studies however, reported a higher frequency in female Caucasians[11,12,19]. Studies are also divided as to whether the mesioangular[14,18] or vertical impaction[9,12] is more common.

The only available data on impacted third molars in a Chinese population is to extract data from a general comparative study of impacted teeth in Caucasians and Chinese by Montelius[17] published in 1932. His data for patients with complete oral X-rays indicates a frequency of 32% in Chinese compared with 12% in Caucasians. As racial differences affect the pattern of impaction[16,23], and there is no contemporary data for Chinese populations, the aim of this retrospective radiographic study is to investigate the pattern of third molar impaction of a Chinese population in Singapore.

Materials and methods

The first 1000 orthopantomograms (OPGs), taken at the Dental Diagnostic Imaging Department of National University Hospital, Singapore from 1996 to 1997 of Chinese Singaporean patients, aged between 20 to 40 years old were used. These patients had presented to the hospital's outpatient dental centre which provides the full range of dental

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services. The OPGs of patients with any of the following conditions were excluded:

i. Any pathosis or trauma to the jaws that may disrupt the alignment of the dentition.
ii. Congenital diseases or syndromes such as Down's Syndrome, Cleidocranial Dysostosis, etc.
iii. Third molars presenting with incomplete root formation.

The data required for each subject were collected retrospectively from their clinical notes and OPG. Two pairs of examiners viewed the OPGs in a darkened room, using identical X-ray viewers. The presence, location, depth and angle of impaction of third molars were noted. For this study, the following definitions were used.

Impaction

The third molar was considered impacted when it was not fully erupted to the assumed normal functional position in the occlusal plane. Although a tooth may occasionally remain unerupted because of factors other than impaction, in this retrospective OPG study, a tooth was assumed to be impacted when it was not fully erupted.

Angulation of impaction

The angulation of impaction of the mandibular third molar was determined by the angle formed between the intersected longitudinal axes of the second and third molars. This angle was measured using an orthodontic protractor. The classification of impaction was adapted from Winter's Classification[26]. A system of measurement using a protractor was incorporated to reduce errors arising from visual impression alone, a method commonly adopted in most studies. In a pilot study of 200 OPGs, errors in classification of angulation typically arose when the angle of impaction fell between 5° to 15° and 75° to 85°. To overcome this, the following classification was adopted (Fig. 1).

i. Vertical impaction: 10° to −10°
ii. Mesioangular impaction: 11° to 79°
iii. Horizontal impaction: 80° to 100°
iv. Distoangular impaction: −11° to −79°
v. Others: 111° to −80°
vi. Buccolingual impaction

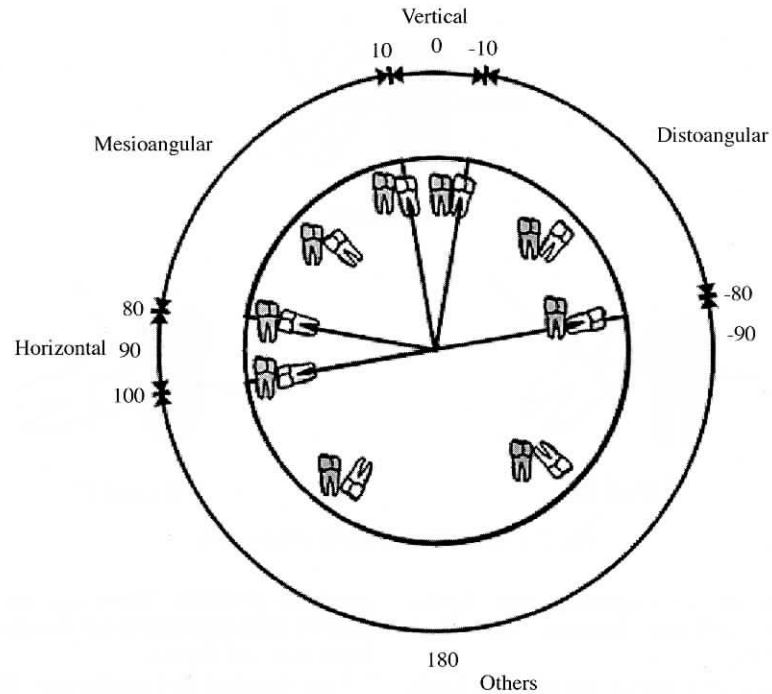

Fig. 1. Classification of angulation of impaction.

The classifications of uncommon angulations such as 'Mesio-inverted', 'Distoinverted' and 'Disto-horizontal' were combined and classified as 'Others'. In cases where the adjacent second molar was absent, the angle of impaction was recorded as nonapplicable.

Level of eruption

The level of impaction of the crown of the third molar was considered in relation to bone and the cemento-enamel junction of the impacted tooth (Fig. 2).

i. Level A: Not buried in bone.
ii. Level B: Partially buried in bone. (If any part of the cemento-enamel junction was lower then the bone level, the tooth was considered to be partially buried in bone.)
iii. Level C: Completely buried in bone.

To reduce inter-examiner error, only one examiner in each pair measured the angulation of impaction and all findings were recorded only when both examiners were agreeable. From the pilot study, the inter-examiner and intra-examiner reproducibility was found to be 91%.

The data was analysed using the Pearson χ^2 test.

Results

Of the 1000 OPGs, 686 radiographs of 302 males and 384 females presented with impacted third molars. The average age of subjects with impacted third molars was 26.5 ± 5 (Table 1). The distribution of subjects by number of impacted third molars is shown in Table 2. The commonest number of impacted third molars was two. There were significantly more females (56%) than males (44%) with at least one impacted third molar ($P<0.05$). In addition, the total number of impacted third molars in an individual was significantly different ($P<0.01$) between the sexes. Females were 1.7 times more likely to have three or more impacted teeth than males.

The distribution of impacted third molars by sex and arch is shown in Table 3. The proportion of impacted mandibular third molars was significantly more than that of the impacted maxillary third molars ($P<0.01$). Impacted third molars were 3.2 times more likely to occur in the mandible than in the maxilla. There was no significant difference ($P>0.05$) between the right and left impacted third molars within each arch, therefore their data was pooled.

The occurrence of the different angulations of impaction in the mandible is shown in Table 4. Mesioangular impaction (60%) was the most common. Again, the distribution of the different

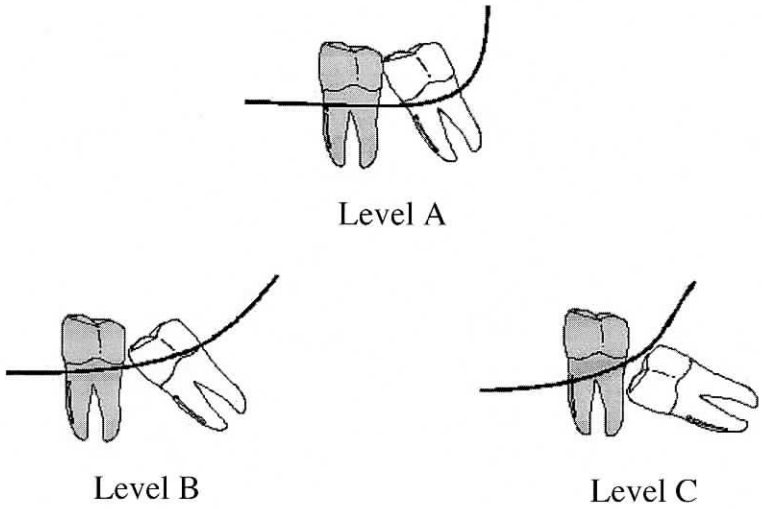

Fig. 2. Classification of depth of impaction.

angulation of impaction was significantly different between the sexes ($P<0.01$).

The occurrence of the different levels of impaction is shown in Table 5. Level B impaction was the most common (80%). The proportion of the different levels of impaction was significantly different between the two arches ($P<0.01$). There was significantly more level C impaction in the maxilla than in the mandible ($P<0.01$). There was no significant relationship between the level of impaction and the sex.

Four hundred and twenty-nine OPGs showed occurrence of bilateral impaction (Table 6), the majority of which were in the mandible (Table 7). Of those whose angulation of impaction could be classified, 209 (51%) presented with the same classification of angle and level of impaction (Table 6).

Table 1. Age distribution of sample population with impacted third molars

	No.	Mean age	Median age	Std dev.
Female	384	26.3	25	5.2
Male	302	26.7	25	5.6
Total	686	26.5	25	5.4

Table 2. Distribution of subjects by total no. of impacted third molars

No. impacted	Female	Male	Total	(%)
1	109	102	211	(31)
2	164	148	312	(45)
3	70	32	102	(15)
4	41	20	61	(9)
Total	384	302	686	(100)
(%)	(56)	(44)	(100)	

Table 3. Distribution of third molars by arch and sex

	Maxilla	Mandible	Total
Present			
Female	600	674	1274
Male	477	530	1007
Total	1077	1204	2281
Impacted			
Female	204	607	811
Male	102	472	574
Total	306	1079	1385

Discussion

The 20 to 40 year age group was used as growth is essentially completed by age 17[7], therefore by age 20 we should be able to differentiate more reliably if the third molar has insufficient space or is improperly positioned for normal eruption[11]. However, we recognize that some change in angulation even up to age of 32 years has been observed[25]. The upper limit of 40 years was used as beyond this age, it is more likely that most third molars may have been extracted[12].

A simple but effective classification system for angular measurement of impaction of the third molar was used (Fig. 1). Prior to this, a comprehensive set of criteria to enable reproducible results appeared lacking. In many studies, the angulation of impaction was usually established via visual impression, based on Winter's classification[26]. Hugoson & Kugelberg[12] proposed a set of angular guidelines, but angular distance was still estimated using visual impression.

In this study, 68.6% of the 1000 OPGs had at least one impacted third molar. This frequency is quite similar to Morris & Jerman[18], who reported a frequency of 65.6% in a study on 5000 subjects in USA. Other studies have generally reported a frequency of about a half to a third of this. Our figure is about double the frequency of 32% observed in Chinese by Montelius[17]. Montelius evaluated radiographs made between 1921 and 1931 in a hospital in China. No information was provided regarding the age group evaluated or their exclusion criteria, but it is likely that during this period, a fair proportion of their subjects would be partially edentulous. The author probably appreciated this would result in an underestimation as he noted that 'were a large group of complete oral roentgenograms taken of the younger generation of Chinese exclusively, a much higher percentage of impactions would be discovered'. It is interesting to note that a similar two fold increase in the frequency was also observed in a Finnish study where the frequency of impacted third molars in male military conscripts increased from 19% in 1949 to 38% in 1990[20].

Svendsen & Maertens[23] have reviewed in detail the aetiology of third molar impactions. Two of the causes cited are:

1. Lack of space

a) Insufficient anterior-posterior dimension.
b) Transverse distance of the alveolar process in the third molar region. Wide alveolar shelves and a greater

Table 4. Distribution of angulation of impaction in the mandibular third molar

Angulation	Female no. of impacted teeth (%)	Male no. of impacted teeth (%)	Total (%)
Horizontal	87 (14.3)	103 (21.8)	190 (17.6)
Mesioangular	356 (58.6)	286 (60.6)	642 (59.5)
Vertical	73 (12.0)	30 (6.4)	103 (9.5)
Distoangular	77 (12.7)	29 (6.1)	106 (9.8)
Buccolingual	3 (0.5)	3 (0.6)	6 (0.6)
Others	1 (0.2)	5 (1.1)	6 (0.6)
Not applicable	10 (1.6)	16 (3.4)	26 (2.4)
Total (%)	607 (100.0)	472 (100.0)	1079 (100.0)

Table 5. Distribution of level of impacted third molar in the maxilla and mandible

Level	Maxilla			Mandible			Max. and mand.
	Female (%)	Male (%)	Total (%)	Female (%)	Male (%)	Total (%)	grand total (%)
A	4 (2)	4 (4)	8 (3)	28 (5)	34 (7)	62 (6)	70 (5)
B	116 (57)	64 (63)	180 (59)	520 (86)	402 (85)	922 (85)	1102 (80)
C	84 (41)	34 (33)	118 (39)	59 (10)	36 (8)	95 (9)	213 (15)
Total	204 (100)	102 (100)	306 (100)	607 (100)	472 (100)	1079 (100)	1385 (100)

Table 6. Distribution of bilaterally impacted mandibular third molars by angulation and level

	Bilateral impaction (angulations)		
	Same (%)	Different (%)	Total (%)
Bilateral impaction (level)			
Same	209 (51)	25 (6)	234 (57)
Different	141 (34)	34 (8)	175 (43)
Total	350 (86)	59 (14)	409 (100)*

*Of the 423 cases with bilateral mandibular impaction, 14 cases with at least one tooth classified as non-applicable (NA) were excluded as it was not possible to determine whether they had the same or different angles of impaction.

mandibular width at the ramus in relation to the intermolar width is important for successful eruption of the third molar.

2. Late third molar mineralization and early physical maturation.

Some of the pertinent causes of insufficient anterior–posterior space are tooth jaw size discrepancy from evolutionary changes, and insufficient sagittal growth of the mandible as continuous elongation of the third molar region between 8 to 20 years of age is necessary. According to RICHARDSON[22], this elongation provides for forward movement of the first molar, together with ramus resorption to provide third molar space for eruption.

In the Chinese population, we postulate that two contributory factors to the high frequency of third molar impactions could be tooth jaw size discrepancy and the effect of arch shape in providing anterior-posterior space. In a morphometric study of the maxillary central incisor and dental arch length as measured from the mid-incisal edge to the molar tooth line, KENG & FOONG[13] reported that the maxillary central incisors were wider in the Chinese population sampled than that reported in a Caucasian group[15]. Further, the Chinese arch is more tapered as indicated by wider intermolar widths than Caucasians by at least 3 mm, whereas the intercanine width is wider by only 1 mm. The implication of this commonly found tapered arch form in Chinese is that although there is a wide intermolar width, it is probably at the expense of the width of the buccal alveolar shelf in the third molar region. The resulting relationship between the ascending ramus and alveolus may be less favourably disposed to resorption to provide space for the developing mandibular third molar, resulting in a lack of space. This compounds the presence of wider teeth, resulting in a higher frequency of impacted mandibular third molars. This could also be the reason for a higher frequency of impacted teeth noted in the mandible than the maxilla.

A less often discussed factor for third molar impaction is late third molar mineralization in combination with early physical maturity[23]. Late mineralization in combination with early physical maturity would have less chance to influence the remodeling processes of the overlying bone. This has been postulated to be the reason for a lower frequency of impacted lower third molars in Australian aborigines compared to Caucasian Australians[6]. However, other factors like the abrasive diet of the Australian aborigines which cause loss of proximal contact and the consequent gain in space[3] makes the contribution of each individual factor difficult to evaluate. We are unaware of any studies on the chronology of the mineralization of the third molar in Chinese in relation to physical maturity, and this factor could be explored further.

Table 7. Distribution of bilateral impaction of third molars by arch

	Bilateral impaction (%)
Maxilla only	6 (1)
Mandible only	362 (84)
Both	61 (14)
Total	429 (100)

Like HELLMAN[11], HUGOSON & KUGELBERG[12], and MURTOMAA[19], we observed a significantly greater frequency of impacted third molars in females ($P<0.01$). MONTELIUS[17] however, observed no sexual predilection in third molar impactions in either Chinese or Caucasian dentitions. HELLMAN[11] proposed that the higher frequency of impacted third molars in females is a consequence of their jaws that stop growing when the third molars just began to erupt, whereas in males, the growth of the jaws continue beyond the time of eruption of the third molars. In females, the end of the growth spurt is closely linked with the onset of menarche. In a large international comparison of menarche in 67 countries, THOMAS et al.[24] found that menarche is largely influenced by extrinsic factors like living conditions, for example, health and socioeconomic conditions and energy balance related to physical activities, rather than genetics. Thus with better diets, higher healthcare standards, and reduced excessive physical activity compared with MONTELIUS[17] era, indeed, menarche has been observed to arrive 2.8 years earlier in Chinese now than 40 years ago[8]. This could lend support to the theory of late third molar mineralization in combination with early physical maturity as an important aetiological factor.

It is difficult to compare the prevalence of the different angulations of impaction, as classification systems vary across different studies. Furthermore, most studies measured angulation of impaction by visual impression alone. Hence, results obtained from one study were not comparable to another. In our study, we found that mesioangular impaction of the mandibular third molar was the most common (60%). KRAMER & WILLIAMS[14] and MORRIS et al.[18], also observed this trend. HUGOSON & KUGELBERG[12] however, reported vertical impaction and mesioangular impactions of 50% and 30% respectively.

Table 8. Distribution of level of impacted third molar in the maxilla and mandible

Level	Maxilla			Mandible			Max. and mand.
	Female (%)	Male (%)	Total (%)	Female (%)	Male (%)	Total (%)	grand total (%)
A	4 (2)	4 (4)	8 (3)	28 (5)	34 (7)	62 (6)	70 (5)
B	116 (57)	64 (63)	180 (59)	520 (86)	402 (85)	922 (85)	1102 (80)
C	84 (41)	34 (33)	118 (39)	59 (10)	36 (8)	95 (9)	213 (15)
Total	204 (100)	102 (100)	306 (100)	607 (100)	472 (100)	1079 (100)	1385 (100)

The level of impaction with respect to bone gives a direct indication of the depth to which the tooth is buried. HUGOSON & KUGELBERG[12] reported that level of eruption A was the most common but they included all third molars, impacted or otherwise. In our study however, level B was most common. This result is not directly comparable to Hugoson and Kugelberg or to other studies as we only evaluated impacted third molars and our definition of levels refer to the amount of crown buried in bone, not the highest point of the crown with respect to the occlusal plane. Comparing the frequency of level C impactions (crown completely buried in bone), there was significantly higher frequency arising in the maxilla than in the mandible ($P<0.01$).

Studies on the bilateral occurrence of impacted third molars are scarce. DACHI & HOWELL[5] found that unilateral and bilateral impaction of third molars occurred with almost equal frequency, which they reported was contrary to their general clinical impression.

They qualified this finding with the fact that they did not provide for the recording of the severity of impaction and accepted that clinically, some of their unilateral impactions would probably not be clinically classified as impacted. Our study showed that bilateral occurrence of third molars was more common than unilateral impactions. Of the 686 radiographs with impacted third molars, 429 (63%) showed bilaterally impacted third molars, of which 423 (62%) were in the mandible. Two hundred and nine (51%) of these, with angulation of impaction that could be classified, presented with the same classification of angle and level of impaction.

Acknowledgments. Grant: Undergraduate Research Opportunities Program, Faculty of Dentistry, National University of Singapore.

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