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The mandibular permanent second molars and their risk of impaction: a retrospective study

ABSTRACT

Aim *The aim of this retrospective study is promote a better understanding of the impaction of teeth 37 and 47 by means of clinical and statistical data from the point of view of early interceptive treatment.*
Materials and methods *Study Design: 478 patients of the Orthodontic School of "La Sapienza" University of Rome (Italy) were studied to assess the eruption of teeth 37 and 47 on at least two good-quality panorex using angular measurements and Nolla's index from January 2008 to December 2013. Data were analysed using ANOVA and Tukey HSD test ($P < 0.05$).*
Results *The data obtained on the possible correlations between the examined teeth and the four reference angles show that at t0, the angular variation of teeth 36 or 46 is constant when the teeth are at the end of their eruptive process, while for teeth 37 and 47, this variation is always constant. At t0, the first and the second molars of both quadrants, during eruption showed a similar behaviour. At t1, the four teeth examined in the patients sample showed a model of development analogous to that exhibited at t0. Statistics: a constant variation (t0-t1) is present among the differences in the development of the 36 and the two angular values, while difference in development of the 37 and that of the angular value is constant only in relationship to the difference in development of the mandibular first molar of the same quadrant. The variations between the difference in development of the 47 and in angular value (t0-t1) are constant only when related to the developing 46. The analytic variance of gradience (vargrad) data confirm peculiar behaviour of the first one, according to both mandibular molars, during their eruptive development.*
Conclusions *Adoption of universally recognised radiographic predictive methods allows assessment of the case and allows the specialist to plan a suitable treatment to prevent or intercept the molar impaction, with a perspective of a less invasive and shorter therapy. Although rare, impaction of teeth 37 and 47 often requires a complex, multidisciplinary approach.*

Keywords *Impaction; Interception; Predictive methods; Second mandibular molars.*

Introduction

Disturbances of eruption can arise from general, structural, or local factors [Proff et al., 2006; Suri et al., 2004]. Dental impaction is the noneruption of a tooth due to a physical blockage or to an anomalous position taken up by that tooth. This condition can be seen both clinically and radiographically. The causative factors are: unusual orientation of the dental germ followed by an abnormal eruptive path, inadequate length of the mandibular body, presence of supernumerary teeth or odontogenic neoformations such as follicular cysts and odontomas, root resorption of an adjoining tooth, delayed eruption of teeth 35 and 45 or presence of ankylosed deciduous molars and idiopatic factors [Carroccio et al., 2012]. The permanent teeth most frequently affected are: third molars (representing almost 80% of all impacted teeth), followed by teeth 13 and 23 and second premolars, and, rarely, second molars (teeth 37 and 47 are more frequently involved than teeth 17 and 27) [Johnson, 1977; Magnusson and Kjellberg, 2009]. Impaction of second molars has an estimated incidence of 0.03-0.04% with similar gender distribution [Magnusson and Kjellberg, 2009]. The impaction is almost always unilateral with mesial inclination [Johnson, 1977; Carroccio et al., 2012] (Fig. 1). Intervention treatment of the impacted second molar, partially erupted or completely unerupted [Raghoebar et al., 1990], often requires the collaboration of orthodontist, endodontist, oral surgeon, and periodontist. The preferred age for intervention is

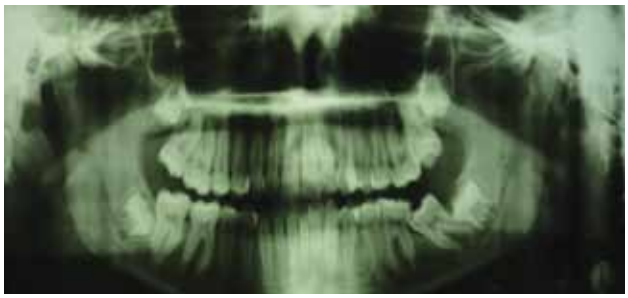

FIG. 3 Frontal view of the dental arches.

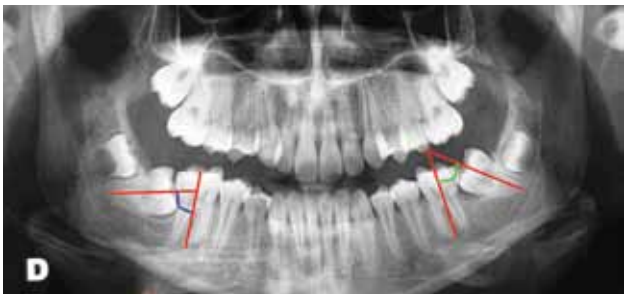

FIG. 2

FIG. 3

generally between 11 and 14 years, before completion of root development [Cho et al., 2008]. The therapeutic choices depend, in turn, on the degree of inclination of the impacted molar, varying from techniques designed to favour spontaneous eruption [Shapira et al., 1998] to a combined surgical-orthodontic approach or a purely surgical treatment [Baccetti, 2000]. Titanium miniscrews as anchorage for orthodontic forces have also found some application [Miyahira et al., 2008]. The surgical treatment consists essentially of uprighting and repositioning of the second molar, eventually including extraction of the third molar [Baccetti, 2000]. Because of the possibility to choose between orthodontic, surgical, or surgical-orthodontic recovery of tooth 37 or 47, the criteria of choice should take into account accessibility and inclination of the tooth in question [Calasso et al., 2008; Carroccio et al., 2012; Cho et al., 2008; Shapira et al., 1998]. Therefore, the purpose of the present study is to assess the eruptive route of teeth 37 and 47, their risk of impaction, and the inclination assumed by these teeth during eruption, especially considering the need of a therapeutic approach as soon as possible.

Materials and methods

This retrospective study of the orthopantomographs of 478 patients (aged 15 to 22) treated at the Orthodontic Unit of "La Sapienza" University of Rome was undertaken to assess the eruptive route of lower permanent second molars and their risk of impaction. At least two good-quality orthopantomographs were taken at intervals of 12 to 18 months. All radiographs were taken with a model No. OP100 machine (V.S. DENTAL S.p.A., Verona, Italy), the images were developed on CP-G Plus film (Agfa-Gevaert group, Mortsel,Belgium) using X ray Dürr-Automat solution (Dürr Dental AG, Bietigheim, Germany) and automatically dried (Dent-X Excel, Elmsford, NY, USA). The first orthopantomographs were used as the reference data for the group named t0 (due to the orthopantomographs taken at t0), while the remaining films served as the source of data for the t1 group (orthopantomographs taken after 12-18 months). To determine the development of teeth 36, 37, 46, and 47, we used the last 4 (of 10) stages of Nolla's tooth development index [Nolla, 1960]:

1. presence of 1/3 of the root (stage 7);
2. presence of 2/3 of the root (stage 8);
3. root almost entirely formed but with open apex (stage 9);
4. completely formed root (stage 10).

Angular values were also considered; these were determined by the intersections of the following axes and planes (Fig. 2, 3):

1. long axis of tooth 36 with the long axis of tooth 37;
2. long axis of tooth 46 with the long axis of tooth 47;
3. long axis of tooth 37 with the antegonial plane;
4. long axis of tooth 47 with the antegonial plane.

Every angle has been traced on the reference orthopantomographs, with lines perpendicular to the tangents of the cusps, passing through the median point of the crown and the furcation. The angular values obtained represent the degree of inclination of the second molars compared with the first image. The antegonial plane taken as a reference is individualised, as the line passing through the two antegonial incisures are perpendicular to the chin symphysis. We compared the angular values of the first and second orthopantomograph.

Statistical analysis

Data were analysed using ANOVA and Tukey HSD tests, with $P < 0.05$. The two tests permit comparing the inside variability, in the first case, of data from two or more groups with the single groups and the variability among groups and, in the second case, comparing a good number of groups among them that have been used for both t0 and t1. We

evaluated the correlations between the four stages of Nolla and the measured angles, the differences between the angular values of each tooth in the examined patients, and, finally, the differences in the stages of each tooth, always in comparison with the two analyses. By determining these correlations, we attempted to individualise the tendency of one of the examined variables to vary in relation to another, keeping in mind that this must not be interpreted as an attempt to track down and therefore individualise a cause-and-effect relationship.

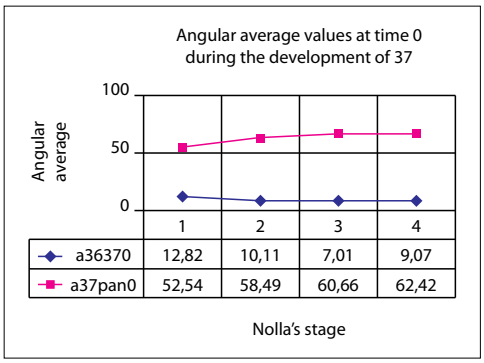

FIG. 4A

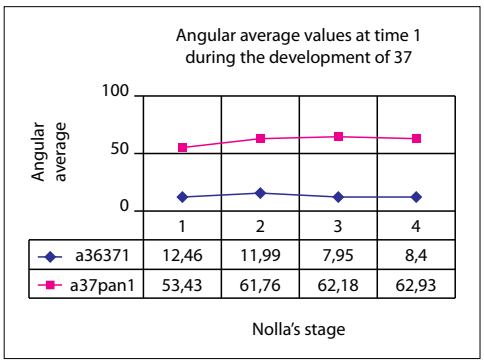

FIG. 4B

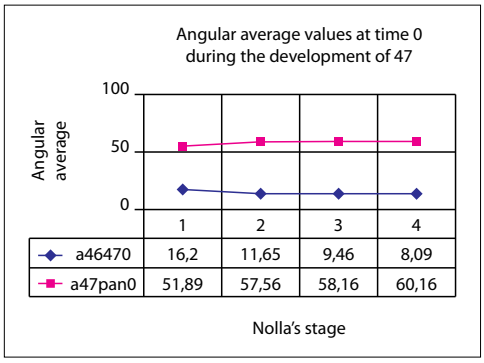

FIG. 5A

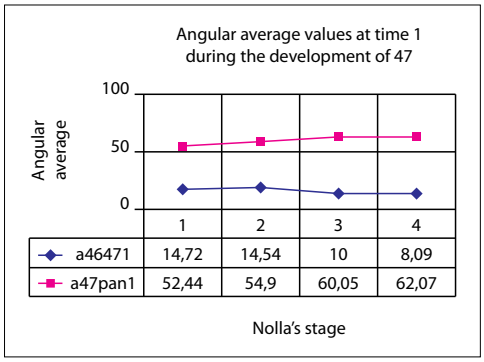

FIG. 5B

Results

Results are displayed in the respective graphic representations (Fig. 4, 5). The results obtained by ANOVA at t0 (ANOVA 0) show a constant angle between teeth 36 and 37, as well as between teeth 46 and 47, in the different patients only when the 36, or 46, is in Nolla stages 1, 3, and 4, respectively. Regarding the inclination of teeth 37 and 47, with respect to the antegonial plane, this angle is constant when tooth 36 is in stage 3, 4, or 5 of Nolla and tooth 46 is in stage 1, 3, or 4.

Appraising the significance of the four stages of Nolla, we observed that for every examined angle during the development of tooth 37, the angle between it and the 36 is constant only if the 37 is found in the 1 or 3 stage. The angle between teeth 47 and 46 is constant when 47 is in 1, 3, or 4 stage. The angle between tooth 47 and the antegonial plane and tooth 37 is always constant. The results obtained by ANOVA at t1 (ANOVA 1) show that, from a clinical point of view, there is no significant correlation when comparing the relationship of the 36 with the planes of reference from which derive the traced angles, according to the anticipated criterion of the study, in the affiliated quadrant. In terms of the phase of development of tooth 37, or 47, it affects the angle between the tooth and the first molar of the same quadrant, it is constant only when the 37, or 47, is in 1 or 3 stage of Nolla. However, during development of the 37, we were unable to state that the angular variation between this tooth and the antegonial plane remains constant. The results relative to the angular values of the 47 in relation to the antegonial plane show that the inclination is constant for all the Nolla stages. As regards on the possible correlations among the teeth examined and the four reference angles, it has been observed that, in t0, the angular variation of the 36, or 46, is constant when the teeth are at the end of their eruptive path, while for teeth 37, or 47, such variation is always constant. Then, in t0, the first and the second molars of both quadrants, during eruption, have shown a similar behaviour. In t1, the four teeth examined in the patients sample have illustrated a model of development analogous to that shown in t0. Clinically, from the analytic variance of gradience (vargrad) analysis, the variation among differences in the development of the 36 and the two angular values (variance 1 and 3), at t0 and t1, is constant, while the difference in development of the 37 and that of the angular value variance 1, at t0 and t1, is constant only in relationship to the difference in development of the first molar of the same quadrant. Appraising vargrads 3 and 4 of the 46, we have found instead that in all patients and the four stages of Nolla, there is no correlation in the vargrads because of the size of the sample. In other words, a constant clinical variation is not detectable between the

difference in development of the 46 and the difference between the two angles of interest in the time groups t0 and t1. In the evaluation of the 47, we observed that the variation between the difference in its development and the difference in angular value variance 2, to the times 0 and 1, are constant only when related to the developing 46. In conclusion, the analytic vargrad data confirm the peculiarity in the behaviour of the first one and, according to both mandibular molars, during the eruptive development of these teeth.

Discussion

This phenomenon has been attributed to systemic, local, even iatrogenic causes [Reddy et al., 2008; Sawicka et al., 2007; Vedtofte et al., 1999], underlining the need of a deeper research on its etipathogenetic aspects [Shapira et al., 1998]. An early diagnosis can lead to a total recovery of the tooth and its function [Bereket et al., 2011; Palma et al., 2003; Proff et al., 2006]. The diagnostic delay is related to the fact that the condition is asymptomatic and discovered when the impaction is already established. Extraction of the impacted tooth is equivalent to a failure imputable to either the diagnostic delay or to the irretrievability of the tooth. The substitution of the third molar in place of the impacted - and eventually removed second molar - raises more than few prognostic doubts [Proff et al., 2006]. If the second molar is extracted at age 12 or 14 years while awaiting the eruption of the third molar at about 17 years, impaction of the latter can be expected [Shapira et al., 1998]. It is known that surgical reposition of teeth 38 and 48 might be a rapid, certain, and effective method of resolving the impaction. However, this solution exposes the tooth to the possibility of complications such as pulp necrosis, root resorption, and ankylosis, compared with transplantation [García-Calderón et al., 2005; Shapira et al.,1998; McAboy et al., 2003]. The best choice of treatment is by means of surgical-orthodontic or purely orthodontic techniques [Miyahira et al., 2008]. The reports on of treating with orthodontic devices shows a degree of feasibility, practicality, predictability, and success in the pursuit of a therapeutic objective that cannot stay unnoticed [Calasso et al., 2008; Carroccio et al., 2012; García-Calderón et al., 2005; Miyahira et al., 2008]. There is the lack of a clear and unequivocal diagnostic protocol to which refer for differentiating frankly surgical cases from orthodontic or combined cases [Proff et al., 2006; García-Calderón et al., 2005]. The radiographic evaluation by means of orthopantomograph helps to assess the severity of impaction [Bereket et al., 2011; Fardi et al., 2011; Vedtofte et al., 1999]; tooth's inclination can be esteemed according to different methods named by their authors:Winter, Fonseca, Evans, [Fonseca, 2000].. Others classify the inclination of the tooth with respect to the adjacent molar, its phase of radicular-crown development, or its relationship to the development of the third molar. The prognosis of an impacted second lower molar is poor if the inclination is greater than 90° or if the tooth is severely tilted buccally or lingually so as to deviate from the planes considered to lack primary stability, wich is crucial for the success of surgical repositioning. After having surgically exposed the crown, the possibility of applying a bracket and using forces to bring the tooth into the arch calls for simpler surgical-orthodontic treatment, even if extraoral anchorage must be used [Miyahira et al., 2008]. If the tooth is only slightly impacted, it can instead be entirely repositioned by simply applying a separation ring or a wire ligature that acts as a separator [García-Calderón et al., 2005]. In the wake of reports by different authors on investigating radiographic images of patients with impacted 37 or 47, the intent of this study has been to obtain meaningful statistical results of clinical value and, therefore, of diagnostic and therapeutic utility, by devising a method for reading the orthopantomograph. This retrospective study aimed more at combining diagnostic parameters: the inclination and, therefore, the angular measurement, of the long axis of the tooth compared with that of the homolateral first molar; the inclination of the long axis of the 37 and 47 compared with the homolateral mandibular plane; and the stage of development of the impacted tooth according to Nolla's classification. The inclination of the long axis of the impacted tooth compared with that of the adjacent tooth is considered important today [Lai, 2009; Miyahira et al., 2008; Vedtofte et al., 1999], the molar's position relatively to the mandibular plane has never been used to study this problem. As for the contribution of cephalometric measurements to determine the type of impaction, we have found few studies that assessed the morphological characteristics and development of the jaws' as connected with this disorder [Cho et al., 2008, Vedtofte et al., 1999]. As previously discussed, the 37 of both t0 and t1 have shown only a mildly constant angulation with the 36 when it was in Nolla's 1 or 3 stage. While in t0, the angulation of 37 was always constant with respect to the the antegonial plane, in t1 the same angulation was not so constant. In reference to the right quadrant, tooth 47 maintained, in group t0, a constant angulation with respect to the 46 of the same quadrant and with the antegonial plane when in Nolla stages 1, 3, or 4. In t1, tooth 47 maintained a constant angulation to the 46 and to the antegonial plane in all Nolla's stages. The correlation data of groups t0 and t1 have prompted us to speculate that in the first group, according to the eruptive development of the molars, the 37 or 47 preclude a meaningful correlation with the four angular values, particularly for a3637 and a37pan, and a constant angular variation (Fig. 4). The same conclusion can be drawn for the 47, particularly for angles a4647 and a47pan (Fig. 5). In the normal situation, as the teeth develop, the values of angle 36^37 and angle 46^47 tend to decrease while the values of angle 37^antegonial plane, then angle 47^antegonial plane, tend to increase. In a small percentage of cases (0.1%) found in the literature,

also in our own study, a difference was found in the mean angular values, referable to the impaction of one or both second molars.

Conclusions

It is important to carefully monitor the eruption of teeth 37 and 47 in adolescent subjects. If these teeth erupt normally on one side but fail to erupt on the other side for a period of 6 months, then radiographs must be taken to determine whether there is an impaction. In the mandibular arch, where impaction of 37 and 47 is relatively more frequent, these teeth usually erupt within a few months of their contralateral counterpart. A delay in eruption of about one year after the contralateral tooth should prompt the dentist to take a radiograph. If the x-ray reveals that the 37 and 47 have an anomalous inclination axis compared with that of the homolateral first molar (that is, an increased angle) and with the antegonial plane (that is, if contrary to the norm, such angle has the tendency to decrease), Nolla's stage of development should be monitored (worsening can lead to impaction) so that intervention can be properly timed. Monitoring with follow-up radiographs would allow timely interception of the problem and implementation of a suitable treatment or, better, preventive plan. By examination of the most recent scientific contributions [Calasso et al., 2008; Carroccio et al., 2012; Cassetta et al., 2013], we have concluded that the age of the patient is extremely important, as timing can affect the possibility of recovering the tooth. Treatment must correlate with the evolutionary stage of the dentoskeletal apparatus [Miyahira et al., 2008] because adult patients unfortunately do not respond well to treatment, especially when it is of long duration and is perceived as too restrictive and uncomfortable.

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