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Occlusal Changes Following Posterior Tooth Loss in Adults. Part 3. A Study of Clinical Parameters Associated with the Presence of Occlusal Interferences Following Posterior Tooth Loss

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Abstract

Purpose: Tooth positional changes following posterior tooth loss may alter arch forms and occlusal planes. This may result in the development of occlusal interferences. The purpose of this study was to determine clinical parameters associated with the presence of retruded contact position (RCP) contacts and occlusal interferences associated with posterior tooth loss.

Materials and Methods: Diagnostic casts of 100 patients with at least one unopposed posterior tooth and 100 control patients were scanned and analyzed to record clinical parameters described in the earlier publications in this series. Clinical examinations identified the presence of RCP contacts and occlusal interferences. Five generalized linear models were developed to investigate the parameters associated with presence of RCP contacts, protrusive interferences, working side interferences, and nonworking side interferences.

Results: RCP contacts were associated with the degree of supraeruption of the unopposed tooth and the presence of other types of interferences. Protrusive interferences were associated with the presence and position of a tooth distal to the extraction site and the presence of other types of interference. Working side interferences were associated with tipping of the tooth mesial to the extraction site and the presence of other interferences. Nonworking side interferences were associated with the presence of other types of interference only.

Conclusions: Unopposed posterior teeth are more likely to be involved in RCP contacts or interferences than their matched controls. Many teeth were involved in multiple interferences, and there appears to be a number of interrelationships between these. Initial RCP contacts have associations with the extent of supraeruption of the unopposed teeth. The presence and position of the teeth distal to extraction sites was significant when modeling protrusive interferences. Protrusive interferences are more prevalent where the site of tooth loss was bounded. Mesial tipping of the teeth distal to extraction sites reduced this effect. Working side interferences were associated with tipping of teeth mesial to the site of tooth loss. No associations between patient or tooth factors were found for nonworking side interferences, and the only association found for these interferences were with protrusive interferences at the sites.

Earlier papers in this series have explored the clinical parameters associated with tooth positional changes following posterior tooth loss.

The changing patterns of tooth loss in the United Kingdom over the last 50 years[1,2] indicate that many patients will remain largely dentate for their entire lives. The most common missing permanent teeth are the first permanent molars,[3] often lost in childhood or young adulthood. If not replaced with fixed or removable prostheses, the postextraction movements of teeth adjacent to the edentulous spaces may be associated with dynamic tooth contacts.

From figures supplied by the Dental Practice Board, in England and Wales, almost three million molars and premolars are extracted annually (figures supplied directly to the authors by the Dental Practice Board); however, figures for the replacement of these teeth showed that 26,316 were replaced with fixed partial dentures, and 874,720 were replaced with removable dentures. This represents only 30% of the extracted teeth in the General Dental Services. It is possible that a number of these teeth may have been replaced privately or may have been extracted as part of orthodontic treatment. There are potentially two million unrestored edentulous spaces created annually in the molar and premolar regions.

Several authors[4–9] have documented spontaneous changes in tooth position following the extraction of an adjacent tooth. The tooth positional changes encountered were supraeruption, tilting, rotation, and lateral movement. Separately and in combination, these movements were found to alter archforms and occlusal planes.

Part 1 of this series discussed and attempted to model the clinical parameters associated with the extent and type of supraeruption following posterior tooth loss. Part 2 discussed and quantified nonvertical tooth movement associated with posterior tooth loss.

A stable occlusion was described by Smith[10] as "one in which overeruption, tilting, and drifting of teeth cannot occur and therefore cause new occlusal interferences to develop." Occlusal stability therefore relies on the maintenance of stable relative tooth positions over a prolonged period.

An occlusal interference may occur in protrusion or lateral excursion and on initial contact in retruded contact position (RCP). It may be associated with the working or nonworking (balancing) side of the dentition. Nonworking side contacts are regarded by many authors to be destructive in terms of damage to the teeth, their supporting structures, and the musculo-skeletal apparatus.[11] Agerberg and Sandstrom[12] confirmed this, stating that the most harmful contacts occurred between retruded position and intercuspal position (ICP) and nonworking side interferences. Their study recognized that the occlusal contacts that occurred outside the normal functional occlusal range were less relevant than those found during function and attempted to identify where in the occlusal range contacts occurred.

Many authors have investigated the incidence of occlusal interferences on different populations. By looking at the incidence in younger populations, the effects of tooth wear, tooth loss, and restorative intervention may be minimized. Agerberg and Sandstrom[12] recruited teenagers and young adults as their subject group. Unilateral tooth contacts in retruded position were found in 75% of both subject groups. Nonworking side contacts were found in 6 to 13% of the teenagers and 9 to 25% of the young adults. In total, 89% of all subjects showed at least one occlusal interference.

There are many schools of thought on the likely effects of the presence of occlusal interferences on the masticatory system; however, not all are backed by scientific research. Incidence studies show that there is a high incidence of occlusal interferences in the populations studied, but clinical experience shows that not all interferences will generate symptoms. In a study in Finland by Heikinheimo et al[13] on a group of adolescents aged 12 to 15 years, few subjects had what would be considered a functionally optimal occlusion, but there was a low incidence of temporomandibular disorder (TMD). The authors concluded that TMD is of multifactorial aetiology, of which the presence of occlusal interferences is only one feature; however, it is probably the easiest of all factors for the dentist to control.

Most recently, Koh and Robinson[14] undertook a systematic review of TMD management and found no evidence to support occlusal adjustment as an effective treatment or preventive strategy for TMD.

There may be consequences for the structural integrity of teeth involved in occlusal interferences. Ratcliffe et al[15] found a statistical association between the presence of lateral excursive interferences and cusp fracture. To confirm these findings, further research needs to be undertaken to assess the association between nonworking side interferences and cusp fracture.

The purpose of this study was to determine clinical parameters associated with the presence of RCP contacts and occlusal interferences associated with posterior tooth loss.

Materials and methods

In order to analyze the parameters associated with occlusal contacts and interferences, it was necessary to

- identify the presence of RCP contacts and occlusal interferences and
- explore patient and dental factors associated with each type of contact and interference.

The subject group for this study was the same group used to investigate tooth positional changes in Parts 1 and 2 of this series.

Briefly, there were 100 patients with an unopposed posterior tooth, with 100 age, sex, and bone level matched controls, drawn from patients undergoing routine restorative care at Leeds Dental Institute. Informed consent and Ethics Committee approval were obtained.

The unopposed teeth under investigation were assessed visually for occlusal interferences by the same examiner. The involvement of the unopposed tooth in initial RCP contact and the presence of occlusal interferences in protrusion and on both working and nonworking excursions were observed and identified using 8 μ Hanel occlusal marking foils (Roeko, Langenau/Ulm, Germany) in different colors to identify contacts in different excursions. These markings were removed, and the procedure repeated to confirm findings. Where necessary, a Lucia Jig was used as a muscular deprogramming device to facilitate RCP manipulation, and all recordings were made with the patient in a supine position, using bimanual manipulation. The findings were recorded on the data capture form. Alginate impressions were made of the maxillary and mandibular dentitions. Following disinfection, these were cast immediately.

Diagnostic casts were scanned and analyzed using the methods previously described, thereby recording the extent of eruption, type of eruption of the unopposed tooth, the overbite, overjet, buccal occlusion and degree of crowding in the dentition, tipping, rotation, and buccal movement of the teeth associated with the edentulous sites.

Data analysis

Data analysis was divided into two parts:

1. *Basic data screening:* Exploratory data analysis was undertaken using a number of statistical methods, including examination of means and distributions, scatterplots, boxplots, and relative risk tables, to examine trends and associations within the dataset.
2. *Generalized linear modeling:* Using generalized linear modeling, models were developed to examine associations between each type of interference and patient or dental factors.

Examiner reliability

Intraexaminer reliability was assessed using Bland–Altman plots for continuous data and Kappa scores for nominal and categorical data.

Results

Occlusal contacts and interferences

The presence of RCP initial contacts and excursive interferences for the teeth under investigation are shown in Table 1. Some patients displayed more than one type of contact or interference, and the frequency of initial RCP contacts and excursive interference is shown in Table 2.

Statistical modeling

Each type of contact or interference was modeled using generalized linear modeling. Five models were produced in answer to the question: *Is there an association between tooth movements and the presence of occlusal interferences?*

The models were for RCP contact, protrusive interference (general and bounded models), and working and nonworking side interference.

RCP contact model

Using generalized linear modeling techniques, a model of the covariates associated with the presence of RCP contacts was produced. The linear predictor of the presence of an RCP contact, μ, is shown in Table 3. The standardized residuals and leverages, together with the residual deviance (96 on 95 degrees of freedom) indicated an acceptable fit of the model to the data.

Table 1 Incidence of occlusal contacts and interferences

Group	Contact or interference on unopposed tooth (%)	No contact or interference on unopposed tooth (%)
Subjects	53	47
Controls	12	88

Table 2 Frequency of each type of contact or interference

Group	RCP initial contact	protrusive	Working side	Nonworking side
Subjects	30	22	19	11
Controls	2	3	1	7

Table 3 RCP contact model

$$RCP_i \sim N(u_i, \sigma)$$
$$\mu_i = -3.03 + 0.55\,OE_i - 1.81\,PRO_i + 1.64\,WS_i + 1.59\,BN_i$$

RCP contact	Value	95% CI
Intercept	−3.03	−4.64, −1.42
Supraeruption	0.55	0, 1.10
Protrusive interference	−1.81	−3.28, −0.34
Working side interference	1.64	0.48, 2.80
Bounded site	1.59	0.35, 2.83

Residual deviance 96 on 95 degrees of freedom.
Where RCP_i is the outcome for an individual (the presence of an RCP contact), N is the normal distribution, OE_i is the degree of supraeruption of the unopposed tooth, PRO_i is the presence of a protrusive interference, WS_i is the presence of a working side interference, and BN_i indicates whether the site of tooth loss is bounded.

Protrusive interference model

The presence of a tooth distal to the site of tooth loss and its angulation were found to be key features when modeling this outcome. As these two covariates were mutually exclusive, two models were therefore created—a general model and one specifically for bounded extraction sites.

Protrusive interference—general model: Using generalized linear modeling techniques, a general model of the covariates associated with the presence of protrusive interference contacts was produced. The linear predictor of the presence of protrusive interference, μ, is shown in Table 4. The residual deviance (93 on 97 degrees of freedom) and the residuals/leverages plot demonstrated that this model was an adequate fit of the data.

Protrusive interference—bounded site model: Using generalized linear modeling techniques, a model of the covariates associated with the presence of protrusive interference contacts at bounded extraction sites was produced. The linear predictor of the presence of protrusive interference, μ, is shown in Table 5. Again, assessing the residuals, leverages, and the residual deviance (72 on 69 degrees of freedom), this model can be said to fit the data adequately.

Table 4 Protrusive interference model (general)

$$PRO_i \sim N(u_i, \sigma)$$
$$\mu_i = -2.16 - 1.56RCP_i + 1.69BN_i$$

Protrusive interference	Value	95% CI
Intercept	−2.16	−3.36, −0.96
RCP contact	−1.56	−2.89, −0.23
Bounded	1.69	0.36, 3.02

Residual deviance 93 on 97 degrees of freedom.
Where PRO_i is the outcome for an individual, N is the normal distribution, RCP_i is the presence of an RCP contact, and BN_i indicates whether the site of tooth loss is bounded.

Table 5 Protrusive interference model (bounded site)

$$PRO_i \sim N(u_i, \sigma)$$
$$\mu_i = 0.22 - 0.06TIPB_i - 1.37RCP_i + 1.86NWS$$

Protrusive interference (bounded site)	Value	95% CI
Intercept	0.22	−1.01 to 1.45
Tip B	−0.06	0 to −0.12
RCP contact	−1.37	−2.78 to 0.04
Nonworking side interference	1.86	0.19 to 3.53

Residual deviance 72 on 69 degrees of freedom.
Where PRO_i is the outcome for an individual, N is the normal distribution, $TIPB_i$ is the degree of tipping of the tooth distal to the site of tooth loss, RCP_i is the presence of an RCP contact, and NWS_i is the presence of a nonworking side interference.

Table 7 Nonworking side interference model

$$NWS_i \sim N(u_i, \sigma)$$
$$\mu_i = -2.04 + 1.26PRO_i$$

Nonworking side interference	Value	Std. error	95% CI
Intercept	−2.04	0.46	−2.95 to −1.15
Protrusive interference	1.26	0.66	−0.03 to 2.55

Residual deviance 65 on 98 degrees of freedom.
Where NWS_i is the outcome for an individual, N is the normal distribution, and PRO_i is the presence of a protrusive interference.

Working side interference model

Using generalized linear modeling techniques, a model of the covariates associated with the presence of working side interferences was produced. The linear predictor of the presence of a working side interference, μ, is shown in Table 6. The fit of this model is acceptable, both in terms of the standardized residuals and leverages and its residual deviance (75 on 93 degrees of freedom).

Nonworking side interference model

Using generalized linear modeling techniques, a model of the covariates associated with the presence of nonworking side interferences was produced. The linear predictor of the presence of a nonworking side interference, μ, is shown in Table 7. The fit of this single covariate model to the data was good, as evidenced by the plot of the standardized residual/leverages and the residual deviance (65 on 98 degrees of freedom). The estimates for the model are shown in Table 7.

Discussion

The incidence of RCP contact or excursive interference in this population was 53% and is consistent with the findings of an earlier study by Craddock and Youngson,[6] which found that 51.6% of unopposed teeth had either initial RCP contacts or excursive interferences. This high incidence of interference is likely to be of interest to restorative dentists when restoring unopposed teeth or replacing the missing antagonist. The teeth mesial and distal to the edentulous space may play a part in occlusal interferences, and their restoration may be therefore complicated.

Clinically the presence of multiple interferences is significant in occlusal stability, direct occlusal trauma, and the complexity of restoring both the unopposed tooth and other teeth that may occlude with them. The preparation of teeth for prosthetic treatments involved in protrusive interferences, 22 subjects in this study, will affect the anterior path of guidance.

What is of additional interest in this investigation is the use of controls to show the difference in frequency of an interference for a given tooth between patients who had unopposed teeth and those who did not. Agerberg and Sandstrom[12] studied the presence of occlusal interferences and found the incidence to be between 75% and 89%. The use of matched controls in this study allowed valid assumptions to be made about the increased likelihood of an interference being present when a tooth had been unopposed for 5 years or more.

Table 6 Working side interference model

$$WS_i \sim N(u_i, \sigma)$$
$$\mu_i = -2.53 + 0.08TIPA_i + 2.18RCP_i$$

Working side interference	Value	95% CI
Intercept	−2.53	−3.45, −1.6
Tip anterior tooth	0.08	0, 0.16
RCP contact	2.18	0.98, 3.38

Residual deviance 75 on 93 degrees of freedom.
Where WS_i is the outcome for an individual, N is the normal distribution, $TIPA_i$ is the tip of the tooth anterior to the extraction site, and RCP_i is the presence of an RCP contact.

RCP contact model

As might be expected, the extent of supraeruption was found to be one of the covariates that displayed a correlation with the presence of an RCP contact. An inverse correlation with the presence of a protrusive interference was also easily accepted, as the mandibular movement from ICP to RCP is in the opposite direction to that found during protrusive movement. A correlation with the presence of a working side interference may be more difficult to understand; however, there may be a wide and complex range of movements of the condyle prior to and during rotation on the working side, and a distal component of this movement may be more common than was previously thought, reflecting the association found in this model. What seems completely at variance with the distal movement of the mandible to achieve an RCP contact is the association between the unopposed tooth involved in the RCP contact and the presence of a bounded site of tooth loss. One might expect unopposed teeth to contact a tooth anterior to this site. At first the association with a bounded extraction site was difficult to understand. If the model is more closely explored, there is an "interaction" between protrusive interference and the presence of a bounded saddle area. It is the interaction between these covariates that make it important in the model. The interaction itself was not used in the model, as it did not increase the overall coefficient of the model.

Protrusive interference models

The presence of a tooth distal to the extraction site was found to be an important factor in determining the likely presence of a protrusive interference. This is included in the general model, and a further model was created to show the effect of positional changes of the tooth distal to the extraction site on the presence of this type of interference.

General model

This model showed an inverse association between the presence of an RCP contact and the presence of a protrusive interference. It had a positive correlation with the presence of a tooth distal to the extraction site. Functionally this would be expected. If there was supraeruption present in the unopposed tooth, as the mandible moves forward and downward in protrusion, the absence of a tooth distal to the extraction site would prevent the unopposed tooth from being involved in a protrusive interference. As this movement is in the opposite direction to mandibular movement to the RCP position, it is also easy to clinically accept the inverse relationship with the presence of an RCP contact.

Bounded extraction site model

The presence of a tooth distal to the site of tooth loss was relevant in the likelihood of a subject having a protrusive interference associated with the unopposed tooth.

As with the general model, this type of interference was inversely associated with the presence of an initial RCP contact, but was positively associated with the presence of nonworking side interference. This is not surprising, as the anterior component of mandibular movement is similar in both protrusion and lateral excursion on the nonworking side. The tipping of the tooth distal to the extraction site had an inverse association with the presence of a protrusive interference. As the tooth distal to the extraction site tips (all teeth tipped mesially), it is not surprising that during forward movement of the mandible it would be less likely to involve the unopposed tooth in a protrusive interference.

Working side interference model

The covariates that best explain the linear predictor of the presence of a working side interference are tipping of the tooth anterior to the extraction site and the presence of an RCP contact. Therefore, the likelihood of the presence of this type of interference increased as the tooth anterior to the extraction site tipped, and RCP interference was present. Changes in the position of the cusps during tipping of the tooth anterior to the extraction site may increase its likelihood of being involved in this type of interference. The slight distal movement of the working side of the mandible has already been discussed in terms of its relationship to RCP interference.

Nonworking side interference model

The linear predictor of the outcome (the presence of a nonworking side interference) is explained by the single binary covariate—the presence or absence of a protrusive interference. Therefore, a subject will be more likely to have nonworking side interference when a protrusive interference is present.

The fact that many subjects with unopposed posterior teeth had multiple interferences associated with these teeth is not surprising when the individual models were examined. All the outcomes had one or more covariates that were outcomes for other interference models. It was therefore disappointing that there were so few patient or tooth positional factors associated with each interference.

Conclusions

In this study, unopposed posterior teeth were more likely to be involved with functional contacts or interferences than their matched controls. Many teeth were involved with multiple interferences, and there appeared to be a number of interrelationships among them.

Initial RCP contacts had an association with the extent of supraeruption of unopposed teeth.

The presence and position of the teeth distal to the extraction sites were significant when modeling protrusive interferences. Protrusive interferences were more prevalent where the site of tooth loss was bounded. Mesial tipping of teeth distal to extraction sites reduced this effect.

Working side interferences were associated with tipping of the teeth mesial to the site of tooth loss.

No associations among patient or tooth factors were found for nonworking side interferences, and the only association found for this interference was with protrusive interference at this site.

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