Dunedin Multidisciplinary Health & Development Study

Concept Paper Form

Provisional Paper Title: Are occlusal characteristics during adolescence associated with risk for temporomandibular joint clicking and incisor relationship instability thirty years later?
Proposing Author: Simon Olliver
Author's Email: simon.olliver@postgrad.otago.co.nz
P.I. Sponsor: (if the proposing author is a student or colleague of an original PI)
Today's Date: 11.05.18

Objective of the study:

1a. To investigate the association between occlusal risk factors and subjectively measured TMD symptoms later in life.
1b. To investigate the association between occlusal risk factors and objectively measured TMD signs later in life.
2. To investigate the association between occlusal risk factors and long-term stability of the incisor relationship.

Data analysis methods:

For objective 1a, we will investigate bivariate associations between occlusal risk factors and self-perceived TMD symptoms. Following this, we will conduct multivariate regression modelling (using binary TMD symptom data from ages 38 and 45), exploring whether the exposure of interest (posterior and anterior dental cross-bite) is associated with this outcome, or whether this may be due to potential confounders or modifiers (including sex, history of orthodontic treatment, stress, missing teeth, personality traits, and other relevant health problems such as arthritic conditions). We hypothesise that we will not find an association between cross-bite and TMD, because we believe the link to be overstated in the existing literature. For objective 1b, we plan to follow the same approach as 1, but with clinically measured data from age 45 years.

Objective 2 will be investigated by measuring changes in overjet and overbite between ages 15/18 and 45 years. We want to investigate whether individuals with the 'ideal' 1-3 mm of positive overjet and overbite at age 15/18 have better stability (less change by age 45 years) in those than individuals who had zero or negative overjet/overbite, or more than 4mm of positive overjet or overbite. We will initially categorise overjet and overbite data into ≤ 0 mm, 1-3 mm, and 4+ mm groups at ages 15/18 and at age 45 and investigate differences in expected proportions within each group. We hypothesise that a positive association with incisor instability will be found in individuals who have overjet and overbites that deviate from the ideal. We will then use regression modelling, controlling for potential confounders such as tooth loss, periodontal disease, incisors replaced by fixed dental prostheses and sex).

In summary, the main outcome measures for these objectives will be:
1. Self-reported TMJ clicking at ages 38 & 45 years, as well as objectively assessed TMJ clicking at age 45 years; and
2. Incisor relationship (overjet & overbite) and Dental Aesthetic Index (DAI).

All statistical analyses will be conducted using I/C STATA 15 software (Stata, Texas, USA), with the significance level set at 0.05.

Variables needed at which ages:

A large number of variables are requested because this research project will use all of the Dunedin Study orthodontic data.

Additionally, some non-dental variables are requested to assist with the statistical analysis phase. These will include variables on personality (Multidimensional Personality Questionnaire), sex, long-term stress and other relevant health conditions that could act as potential confounders. For example, excluding those with degenerative joint conditions, such as arthritis is critical when joint clicking is the outcome.

Variables at ages 15, 18, 38 and 45.

Age 15, from **dental15** dataset

s1185	Do you think your front teeth are pleasant to look at
s1186	Do you think your front teeth are crooked?
s1187	Do you think your front teeth stick out?
s1188	How do you feel about your front teeth?
s1189	Would you like to change the way your front teeth

	look:	
s1190	in general, compared to other people your age, do you think the appearance of your teeth is:	
s1191	in general, compared to other persons your age, would you say your dental health is:	
s1192	if you have had orthodontic treatment (teeth straightened), do you think the result was:	
a1452	lower lip palatal to upper teeth	
a1453	lower lip palatal to upper teeth	
a1454	occlusal interference	
a1455	facial asymmetry	
a1456	gross facial unbalance	
a1457	definite mandibular prognathism	
a1458	definite mandibular retrognathism	
a1459	missing teeth (DAI)	
a1460	crowding of incisors (0,1,2 segments - DAI)	
a1461	incisal spacing (0,1,2 segments - DAI)	
b227	upper anterior crowding (mm)	
b228	upper anterior spacing (mm)	
b229	upper anterior central diastema (DAI-mm)	
a1462	upper anterior mid-line deviation	
b230	upper anterior largest anterior irregularity (DAI-mm)	
b231	lower anterior crowding (mm)	
b232	lower anterior spacing (mm)	
a1463	lower anterior mid-line deviation	
b233	lower anterior largest anterior irregularity (DAI-mm)	
a1464	premolars - blocked out or impacted (record number)	
b234	anterior maxillary overjet (DAI-mm)	
b235	anterior mandibular overjet (DAI-mm)	
b236	anterior overbite (mm)	
a1465	**anterior cross-bite (see forms for teeth affected)**	
b237	anterior open-bite (mm)	
a1466	**posterior cross-bite**	
a1467	posterior open-bite	
a1468	left molar relation	
a1469	right molar relation	
a1470	molar relation - largest deviation (DAI)	
dai_15	**P15: DAI score**	
a1481	have you ever had your bite checked by an orthodontist?	
a1482	have you ever had your teeth straightened?	
a1483	teeth being straightened now?	

a1484	what treatment is, or has been, done?
a1485	Do you feel the treatment was, or is, worthwhile?
a1486	who straightened, or is straightening, your teeth?
a1481	have you ever had your bite checked by an orthodontist?

Age 18, from **dental18** dataset

a1288	P18: Missing teeth
a1289	P18: Crowding of incisors
a1290	P18: Incisal spacing
a1291	P18: Central diastema - upper anterior
b261	P18: Largest anterior irregularity - upper (mm)
b262	P18: Largest anterior irregularity - lower (mm)
b263	P18: Maxillary overjet (mm)
b264	P18: Mandibular overjet (mm)
a1292	P18: Largest open bite (mm)
a1293	P18: Molar relation: largest deviation
b265	P18: Would treatment benefit the occlusion?
b266	P18: Would treatment benefit the appearance?
a1352	Ever had teeth straightened?
dai_18	**P18: DAI score**

Age 38 years

dh44p38	Have you ever been told that you grind your teeth at night time (e.g. by a partner or room-mate) (ph38)
dh45p38	Have you ever noticed yourself clenching or grinding your teeth during day time (ph38)
dh46p38	Do you ever experience pain in your jaw joint (ph38)
dh47p38	Do you ever experience clicking in your jaw joint (ph38)
dh48ap38	TMJ pain (ph38)
dh48bp38	TMJ clicking (ph38)

Age 45 years, from DentalSC_P45

dh13ap45	Have you heard any jaw noises when you move or used your jaw during the last 12 months - left side (ph45)
dh13bp45	Have you heard any jaw noises when you move or used your jaw during the last 12 months - right side (ph45)
dh14ap45	Have you had pain in your jaw, temple, in the ear, in front of the ear during the last 12 months - left side (ph45)
dh14bp45	Have you had pain in your jaw, temple, in the ear, in front of the ear

	during the last 12 months - right side (ph45)
dh15p45	How often did you grind your teeth when awake during the last 12 months (ph45)
dh16p45	How often did you clench your teeth when awake during the last 12 months (ph45)
dh17p45	How often did you clench/grind your teeth when asleep (ph45)
dh18p45	How satisfied are you with your smile (ph45)
dh19p45	How satisfied are you with the colour (whiteness) of your teeth (ph45)
dh20p45	How satisfied are you with the straightness of your teeth (ph45)

Age 45 years, from Dental_P45

denx7clk1_p45	**Examiner detected click on open - P45**
denx7clk2_p45	**Examiner detected click on close - P45**
denx7clk3_p45	SM felt click - P45
denx7clk4_p45	**SM felt pain with click - P45**
denx7clk5_p45	**SM felt familiar click with pain - P45**
denx7crp1_p45	Examiner detected crepitus on open - P45
denx7crp2_p45	Examiner detected crepitus on close - P45
denx7crp5_p45	SM felt crepitus - P45

Age 45 years, from DentalDAI_P45

orthoDAI1_max_p45	Number of missing maxillary teeth
orthoDAI1_mand_p45	Number of missing mandibular teeth
orthoDAI2_p45	Crowding in the incisal segments
orthoDAI3_p45	Spacing in the incisal segments
orthoDAI4_p45	Size of midline diastema
orthoDAI5_p45	Largest maxillary irregularity
orthoDAI6_p45	Largest mandibular irregularity
orthoDAI7_p45	**Maxillary overjet**
orthoitem5_p45	**Overbite**
orthoDAI8_p45	Mandibular overjet
orthoitem6_p45	Number of anterior teeth in cross bite
orthoDAI9_p45	Vertical open bite
orthoitem7_p45	**Number of posterior teeth in cross bite left**
orthoitem8_p45	**Size of posterior cross bite left**
orthoitem9_p45	**Number of posterior teeth in cross bite right**
orthoitem10_p45	**Size of posterior cross bite right**
orthoitem11_p45	Posterior open bite
orthoDAI10_p45	Molar relationship
orthoitem12a_p45	Irregularity Index 33/32
orthoitem12b_p45	Irregularity Index 32/31
orthoitem12c_p45	Irregularity Index 31/41
orthoitem12d_p45	Irregularity Index 41/42
orthoitem12e_p45	Irregularity Index 42/43

	orthoitem13a_p45	Lower fixed retainer
	orthoitem13b_p45	Fixed retainer comments
	orthoDAI_p45	**P45: DAI score**

Significance of the study (for theory, research methods or clinical practice):

Orthodontics is the speciality of dentistry concerned with management and treatment of so-called malocclusion. Malocclusion itself does not represent a disease state, but rather a variation from what is considered ideal. Orthodontic treatment has the capacity to change occlusal relationships towards the ideal through tooth movement. Advocates of an ideal occlusion argue that it is necessary to avoid temporomandibular disorders (TMDs), long-term occlusal instability and periodontal breakdown (Cobourne & DiBiase, 2016). Unfortunately, there is a lack of evidence to support these claims.

Occlusion is often cited as an aetiological factor in the development of TMD; however, controversy still surrounds the relationship between these two entities. Some authors have shown that the association between TMD and malocclusion is weak (Egermark et al., 2003) or non-existent (John et al., 2002), meaning this link remains contentious.

Despite this, a positive relationship between occlusal factors and TMD is the basis for many therapeutic approaches used in clinical practice. It is important to have a clear understanding of the relationship between these two entities because many of these interventions are costly, time-consuming for the patient and (to some extent) irreversible. High-quality research is required in this area to address the disagreement among previous findings.

Stability is key to successful orthodontic treatment, and obtaining an ideal incisor relationship is thought to enhance the long-term stability of the anterior teeth. Occasionally, a decision is made to accept a residual overjet (e.g. not obtain an ideal incisor relationship). In such instances, permanent bonded retainers are recommended

due to the potential instability of these cases (Williams et al., 2004). This in turn may result in progressive increases in overbite, palatal impingement of mandibular incisors, and possibly a greater susceptibility of the anterior teeth to periodontal disease. To our knowledge, there has been no research conducted that has been able to address the issue of incisor stability over time.

Randomised control trials (RCTs) are acknowledged as being able to generate the highest level of evidence. However, for many orthodontic research questions, RCTs are usually not possible because of the difficulties associated with undertaking them (Cunningham et al., 2011). The reasons for RCTs being unfeasible in orthodontic research are related to their high costs, their time-consuming nature, ethical issues, and the inability to recruit sufficient numbers of patients. Nevertheless, it is important to acknowledge that well-designed prospective and retrospective studies are still capable of providing valuable evidence.

For research into occlusal risk factors and long-term oral health outcomes, only a handful of prospective studies have been conducted. Most of these studies are cross-sectional in nature, limited by small sample sizes, a lack adequate follow-up and no not allow for confounding important variables. These all compromise confidence in the findings.

Additional benefits of this research:

Unique to the phase 45 dental examinations is the introduction of digital impression techniques using the TRIOS® intraoral scanner. Digital impressions are more stable than conventional impressions, easier to store, and allow for data acquisition at a later date. Furthermore, tooth measurements have been shown to be highly accurate when digital and plaster casts have been compared (Wiranto et al., 2013; Naidu & Freer, 2013).

The digital models will be analysed using Ortho Analyzer™ (3Shape) software. The software requires the scans to be placed on a digital ‘base’, similar to traditional

orthodontic plaster models. This step is necessary before measurements can be carried out on the models. This important but time-consuming step will be carried out by the research team. The digital models will therefore be ready for subsequent research projects (such as tooth wear, tooth shade, retention, tooth loss etc.).

Furthermore, many dental and orthodontic measurements (beyond the scope of the proposed research questions) will be collected as part our 'P45 Orthodontic Data Capture Form'. This project therefore adds value to the overall data set through the generation of new orthodontic and dental codes.

Orthodontic research using Dunedin Study data is limited. Long-term follow-up papers on this cohort are now possible owing to the more accessible digital data set. Past research has included work on the Dental aesthetic Index (DAI) (Thomson, 2002) and patient satisfaction after orthodontic treatment (Barker et al., 2005).

This research has the potential to answer some important and controversial questions in orthodontics that have not been possible in the past, as well as adding value to the dental section of the Dunedin Study.

References:

Barker, M.J., Thomson, W.M., & Poulton, R. (2005). Personality traits in adolescence and satisfaction with orthodontic treatment in young adulthood. *Australian Orthodontic Journal*, 21, 87-93.

Cobourne, M., & DiBiase, A. (2016). *Handbook of Orthodontics (2nd ed.)*. London, England: Elsevier.

Cunningham, S., Bearn, D., Bensen, P., Johal, A., Millett, D., O'Brien, K., & Luther, F. (2011). In search of the sample: recent experiences of a trial team in orthodontics. *Contemporary Clinical Trials*, 32, 530-534.

Egermark, I., Magnusson, T., & Carlsson, G.E. (2003). A 20-year follow-up of signs and symptoms of temporomandibular disorders and malocclusions in subjects with and without orthodontic treatment in childhood. *The Angle Orthodontist*, 73, 109-115.

John, M.T., Hirsch, C., Drangsholt, M.T., Mancl, L.A., & Setz, J.M. (2002). Overbite and overjet are not related to self-report of temporomandibular disorder symptoms. *Journal of Dental Research*, 81, 164-169.

Naidu, D., & Freer, T.J. (2013). Validity, reliability, and reproducibility of the iOC intraoral scanner: a comparison of tooth widths and Bolton ratios. *American Journal of Orthodontics and Dentofacial Orthopedics*, 144, 304-310.

Thomson, W.M. (2002). Orthodontic treatment outcomes in the long term: Findings from a longitudinal study of New Zealanders. *Angle Orthodontist*, 72, 449-455.

Wiranto M.G., Engelbrecht, W.P., Tutein Nolthenius, H.E., van der Meer, W.J., & Ren, Y. (2013). Validity, reliability and reproducibility of linear measurements on digital models obtained from intraoral and cone-beam computed tomography scans of alginate impressions. *American Journal of Orthodontics and Dentofacial Orthopedics*, 143, 140-147.

Williams, P., Roberts-Harry, D., Sandy, J. (2004). Orthodontics. Part 7: Fact and fantasy in orthodontics. *British Dental Journal*, 196, 143-148.