European Journal of Orthodontics 19 (1997) 355–359

Secular trends in malocclusion in Austrian men

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SUMMARY A comparison between occlusal deviations in the permanent dentition in the skulls of 94 19th century and 157 present-day Austrian males was made by means of the PAR Index. It was found that the contemporary dentitions showed significantly higher malocclusion scores than the 19th century sample (weighted PAR Index 11.79 and 6.62, respectively). The results show that secular changes in malocclusion have occurred during the last 100 years.

Introduction

An increase in both the prevalence and severity of malocclusion since medieval times has been reported in the literature (Smyth, 1934; Brash, 1956; Helm and Prydsö, 1979). Harper (1994), however, found that the irregularity of modern teeth was less pronounced than that seen in a medieval skull sample. On the other hand, it has been suggested that secular increases in malocclusion have accelerated during the last 150 years in technologically advanced communities, after having shown relatively modest changes for 6000 years (Andrik, 1963; Corruccini, 1984; Vyslozil and Jonke, 1994). So far, however, no comprehensive study has been undertaken concerning the development of various occlusal traits during the last century. The aim of the present study was, therefore, to quantify secular changes in malocclusion by means of a comparison between present-day adult Austrian males and adult Austrian men who lived in the second half of the 19th century.

Materials and methods

The 19th century material comprised upper and lower casts made on the skulls of 94 soldiers of the Austro-Hungarian Monarchy's army, who died in the 1880s at a mean age of 23 years and 7 months (range 20–30 years). The skulls are part of a collection housed in the Museum of Natural History, Vienna. Because of the soldiers' affiliation to the army, exact documentation regarding age, height, weight, cause of death, etc. was available. The present-day material consisted of dental casts of 157 recruits, aged 18–30 years (mean age 21 years) stationed at one military base in Vienna. To select a particular set of models for inclusion in the study, the casts had to be intact, of high quality and show a stable and reproducible intercuspal position. The dentitions (from second molar to second molar) of the 19th century sample presented with 104 missing teeth, due to extractions (93), agenesis (9) or other reasons (2). In the present-day recruits, 119 teeth were missing; 106 had been extracted, 10 were agenetic and 3 were missing due to other reasons.

To score the severity of the malocclusion the Peer Assessment Rating (PAR) Index was used (Richmond *et al.*, 1992). This index, originally developed to record treatment changes, allocating scores to (1) alignment of the dentition, (2) buccal segment relationship, (3) overjet, (4) overbite and (5) centreline discrepancies, was used in this investigation as an index of malocclusion severity. A weighting was applied to several components (Table 1; Richmond *et al.*, 1992).

Statistical analysis and error of the method

The means and standard deviations (SD) were calculated for each parameter. Intergroup differences were tested with the Mann–Whitney *U*-test. The levels of significance used were $P < 0.001$, $P < 0.01$ and $P < 0.05$. $P > 0.05$ was designated as not significant (NS).

The errors of the method were evaluated by calculating the systematic and accidental errors. Duplicate determinations were made on 20 pairs of casts randomly selected from the material.

The mean difference between the two determinations (systematic error) was tested with the paired t-test. No systematic errors were found. The accidental error s_i was calculated with the formula $s_i = \sqrt{(\Sigma d^2/2n)}$, where d is the difference between the two determinations and n is the number of duplicate measurements. The largest accidental error was 0.84 for the weighted PAR score, whereas all single components showed errors of less than 0.27.

Table 1 Weightings for the components of PAR for malocclusion severity (Richmond *et al.*, 1992).

Component of malocclusion	Severity weighting
Buccal segments	0
Anterior segments	1
Buccal occlusion	1
Overjet	6
Overbite	2
Centreline	4

Results

Both the PAR Index and the weighted PAR Index scores were significantly higher in the present-day material than in the 19th century group, the weighted PAR value showing a 78 per cent increase from 6.62 to 11.79 (Table 2). Generally, the individual items of the contact point displacement score were higher in the present-day recruits than in the 19th century sample. The differences in the lower right buccal segment and the lower anterior segment, however, were not significant.

Buccal occlusion

Antero-posterior scores in the buccal segments

Table 2 Mean PAR scores in 19th century and present-day material.

Variable	19th century skulls		Present-day recruits		Significance of intergroup differences
	Mean	SD	Mean	SD	
Contact point displacement scores					
Upper right buccal segment	0.64	0.91	1.01	1.16	**
Upper anterior segment	0.52	0.89	1.11	1.47	**
Upper left buccal segment	0.77	1.01	1.04	0.99	*
Lower right buccal segment	0.69	0.86	0.90	1.28	NS
Lower anterior segment	0.57	0.92	0.75	1.02	NS
Lower left buccal segment	0.60	0.92	1.16	1.36	***
Buccal occlusion assessment					
Antero-posterior right segment	0.74	0.80	1.11	0.80	***
Vertical right segment	0.03	0.18	0.04	0.19	NS
Transverse right segment	0.16	0.49	0.48	0.96	**
Antero-posterior left segment	0.68	0.74	1.11	0.80	***
Vertical left segment	0.03	0.18	0.04	0.19	NS
Transverse left segment	0.15	0.49	0.54	1.03	***
Overjet assessment					
Overjet	0.14	0.40	0.32	0.72	*
Anterior crossbite	0.18	0.44	0.22	0.64	NS
Overbite assessment					
Open bite	0.15	0.55	0.08	0.43	NS
Overbite	0.29	0.52	0.87	0.71	***
Centreline assessment					
Centreline	0.23	0.47	0.34	0.56	NS
PAR score	6.57	3.91	11.13	6.39	***
Weighted PAR score	6.62	5.67	11.79	8.29	***

NS, $P > 0.05$; *$0.01 < P < 0.05$; **$0.001 < P < 0.01$; ***$P < 0.001$.

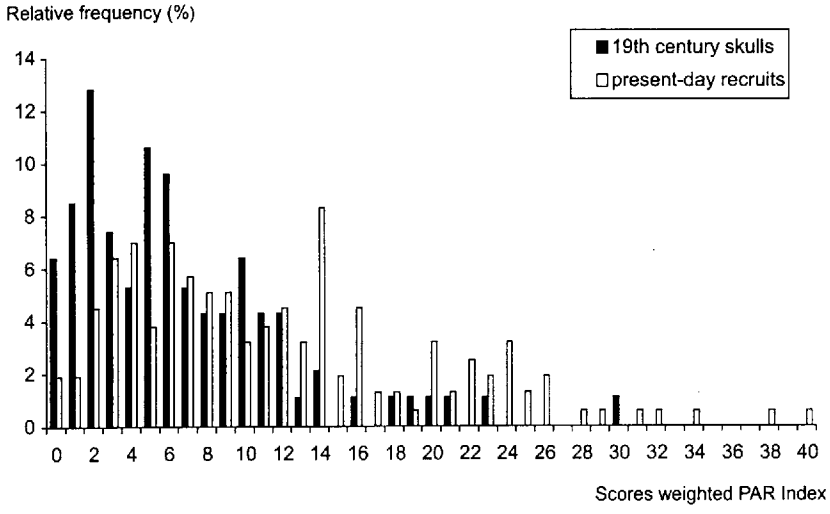

Figure 1 Distribution of the relative frequency of scores of the weighted PAR Index in the two groups.

of the arch showed a significantly higher score in the recruits (an increase of 0.4 on both sides). Vertical deviations were minimal in both groups. Scores for crossbites and scissors bites (transverse deviations) were approximately three times lower in the skull sample than in the recruits.

Both groups showed low anterior crossbite scores. The overjet score, being low in the 19th century sample, was somewhat higher in the present-day recruits.

Among the vertical anomalies, in the anterior part of the arch, frontal open bite scores were low in both groups and did not differ significantly. Deep bite scores, however, differed to a highly significant extent between the two groups, the present-day value being three times the 19th century value. Midline discrepancies had low scores in both groups. The intergroup difference was not significant.

Discussion

One method to assess objectively the severity of a malocclusion or the amount of dento-occlusal change during treatment is the application of an occlusal index. After reviewing the literature, it was decided to apply the PAR Index developed by Richmond *et al.* (1992) for this investigation. A major advantage of the PAR Index is the straightforward scoring system, resulting in a good reproducibility as shown by an accidental error that did not exceed 0.27 for any single component in our material. Although primarily developed to measure treatment results, it is possible to score the deviation from normal occlusion at a given moment by attaching various degrees of importance to several components of the PAR Index (Table 1; Richmond *et al.*, 1992). It should be stated, however, that the weighted PAR score reflects current British orthodontic opinion and may not reflect the views of orthodontists in other countries. The reason that the PAR and the weighted PAR scores hardly differed was that the contact point displacements within the buccal segments, which accounted for more than 50 per cent of the unweighted PAR score in either group, were excluded from the weighted PAR Index.

The results show that the severity of dento-alveolar malocclusion was significantly higher in the present-day recruits than in the 19th century sample. This result is in accordance with the reported rapid increase in prevalence of malocclusion over the past few generations in industrialized countries (Corruccini, 1984). It should be noted, however, that there is a wide variation between individuals within the respective groups, as illustrated by the distribution of the relative frequency of the weighted PAR values (Figure 1). Table 3 shows weighted PAR

Table 3 Weighted PAR scores for the levels of malocclusion severity (derived from Richmond *et al.*, 1992).

Malocclusion severity	Weighted PAR scores
Ideal occlusion	0
Mild	1–16
Moderate	17–32
Severe	33–48
Very severe	>48

scores for the levels of malocclusion severity as derived from Richmond *et al.* (1992). The mean weighted PAR scores of both groups are within the range of mild malocclusion. The relative distribution of the scores (Figure 1), however, reveals that the frequency of moderate to severe malocclusions is higher in the present-day recruits. Very severe malocclusions showing PAR values higher than 48 were not seen in either group.

Marked differences between the groups were seen in the antero-posterior and transverse buccal occlusion (due to the tendency towards Class II development and the higher number of crossbites in the present-day sample). Additionally, the overbite scores increased, and tooth alignment within the arches deteriorated, as shown by the contact point displacement scores. Interestingly, however, the score of the lower anterior segment did not differ significantly. This is in contrast with the results of Vyslozil and Jonke (1994), who investigated a sample similar to ours and found a greater degree of lower incisor irregularity, as indicated by Little's Irregularity Index, in the present-day recruits. These differing results might be due to the different scoring systems used in these two indices, with Little's index being more fine tuned, measuring tenths of millimetres of malalignment.

The intergroup differences could theoretically be attributed to racial, genetic or environmental factors affecting these groups. The origin of the subjects of the 19th century sample was exactly documented. The sample represented a typical cross-section of the male population of the Austro-Hungarian Monarchy of the second half of the 19th century. The present-day group was taken from recruits of Central European origin. It can be reasonably assumed that the two samples belonged to similar racial groups.

It has been suggested that the genetic constitution of a given population may show changes in a relatively short period, with more rapid changes having occurred during the last 160 years compared with preceding centuries (Ingervall *et al.*, 1972). However, Corruccini *et al.* (1986) state that genetic variance only plays a minor role in the increasing prevalence of malocclusion. Whether this development has a bearing on our sample is under investigation.

The majority of dentoalveolar deviations are attributed to environmental influences (Andrik, 1963; Corruccini and Potter, 1980; Corruccini, 1984; Sharma and Corruccini, 1986; Harris and Johnson, 1991). It should be borne in mind, however, that many occlusal traits are dependent upon a combination of variation in tooth position (mostly environmentally influenced) and skeletal development, which is to a greater extent genetically determined (Moyers and Wainwright, 1977; Harris and Johnson, 1991). Among the most frequently mentioned environmental factors is the change in nutrition with a trend towards a more refined diet demanding less powerful masticatory action. Jaw development has been associated with masticatory function (Lombardi, 1982). Several studies of laboratory animals raised on soft food show that a variety of occlusal variations may occur, which seem attributable to normal-sized teeth erupting in undersized jaws (Beecher and Corruccini, 1981; Corruccini and Beecher, 1982; Corruccini, 1984; Kiliaridis *et al.*, 1985). A second consequence of changing dietary habits is an increase in caries incidence with premature deciduous tooth loss (Corruccini, 1984). In relation to the number of investigated casts, however, more permanent teeth were missing in the 19th century sample. This could have led to a decrease in arch length discrepancy and, as a consequence, at least partly account for the better arch alignment in this group. On the other hand, uncontrolled tipping movement of neighbouring teeth might just as well have a negative impact on contact point displacement scores and occlusion assessment

scores. Another major factor is the increased frequency of chronic mouthbreathing in westernized populations due to nasorespiratory obstructions (Preston, 1979; Proffit, 1986). This has been made responsible for a growing tendency towards crossbites and open bites (Proffit, 1986). For obvious reasons, the possible role played by differences in the frequency and type of oral habits could not be assessed in this investigation.

In conclusion, the results of this study underline the concept that a rapid transition in the prevalence of malocclusion has occurred during the recent generations, probably due to the changing lifestyle and inherent effects.

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Acknowledgement

The authors are indebted to Prof. O. Vyslozil for collecting the material investigated in this study.

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