European Journal of Orthodontics 19 (1997) 39–45

The effect of professional violin and viola playing on the bony facial structures

Outi Kovero,* Mauno Könönen** and Sinikka Pirinen***
Departments of *Dental Radiology, **Prosthetic Dentistry and ***Orthodontics and Pedodontics, Institute of Dentistry, University of Helsinki, Finland

SUMMARY Professional violin and viola playing involves a particular kind of asymmetric face, neck and shoulder muscle activity. The aim of this study was to find out whether players' facial morphology is influenced by this occupational orofacial muscle activity. Lateral and posteroanterior cephalograms and panoramic tomograms of 26 adult professional violin and viola players were evaluated and compared with those of age, sex and dentition matched controls. Significant differences were found between the players and the controls. The players had smaller facial heights, more proclined maxillary incisors and greater mandibular lengths. Thus, intense long-term violin/viola playing has the effect of modifying facial morphology.

Introduction

The dentitions and perioral soft tissues of wind instrument musicians have been studied widely, especially with regard to the influence of different kinds of wind instrument on the positions of anterior teeth in different types of occlusion (Herman, 1974, 1981; Pang, 1976; Ma and Laracuente,1979; Gualtieri, 1979). The dentofacial morphology in children playing wind instruments has been studied by Brattström *et al.* (1989). They found a smaller anterior facial height and wider dental arches in the players compared with their controls. The possibility, that a modified pattern of orofacial muscle activity might explain these dentofacial morphological differences, was discussed. The dentofacial morphology of professional opera singers has been found to be influenced by their facial muscle hyperactivity and respiratory hyperfunction, manifesting as increased facial height (Brattström *et al.*, 1991).

Professional violin and viola playing involves asymmetric face, neck and shoulder muscle activity. The players are also subject to the vibrations and weight of their instrument, which they hold between the left shoulder and left angle of the mandible for long periods daily. The pressures exerted by the chin in holding a violin have been found to range from 0.2–2.3 kg (Herman, 1974). Professional violin players have usually started playing at the age of 6–8 years. Repeated or continuous application of pressure or force is known to influence bone morphology. Actually the concept of orthodontic and orthopaedic treatment is based on the fact that bone growth and morphology can be modified by pressure. The aim of this investigation was to study the possible effect of long-term violin and viola playing on the facial skeleton.

Subjects and methods

A total of 26 professional violinists and violists (13 males and 13 females, mean age 37 years, range 22–58 years), from the Helsinki Philharmonic Orchestra, Finland, were studied. There were 16 violinists (seven men and nine women) and 10 violists (six men and four women). All played right-handed, that is, held the instrument on the left. On average, they had been playing for 29 years (range 16–46 years) and at the time of the investigation were playing for an average of 36 hours (range 24–62 hours) per week. All the subjects had almost complete natural dentitions, with at maximum two teeth missing (wisdom teeth excluded) and bilaterally at least one pair of occluding molars. None of the subjects had unilateral or bilateral crossbite malocclusions.

Controls (*n* = 26, mean age 36, range 22–56 years) were selected from patients seeking ordinary dental treatment at the Institute of Dentistry, University of Helsinki. They were individually matched to the study group according to sex, age (±2 years) and dentition in relation to molar support. One of the controls had bilateral skeletal crossbite, but open bite in the molar areas. The players and controls showed similar distributions of occlusal characteristics. None of the controls had played a violin or viola.

The subjects were questioned about the duration of their violin or viola playing in years and about the number of weekly playing hours. Each subject and control underwent a radiographic examination comprising lateral and posteroanterior (PA) cephalograms and a panoramic tomogram of the jaws. The lateral cephalograms were taken in a rigid cephalostat (Wehner 517) with a film-focus distance of 154 cm (from median sagittal plane to focus 140 cm), the linear enlargement being 10 per cent for points situated in the median plane.

Posteroanterior cephalograms were taken using a Bucky skull board, the patient being positioned with the Frankfort plane horizontal and the tip of the nose touching the vertically positioned skull board. The film–focus distance was 100 cm. The enlargement of the PA cephalogram varied for different frontal planes. It was 17–18 per cent at the plane of gonions, 13–14 per cent at the plane of Bz points and 8–9 per cent at the plane of So points, depending on the horizontal dimension of the nose. Panoramic tomograms were taken with PM 2002 CC® (Planmeca Oy, Helsinki, Finland). The enlargement in the ramus region was 20 per cent.

The cephalometric landmarks detected from the lateral cephalograms are presented in Figure 1, and the measurements made are listed in Table 1. The cephalometric landmarks detected from the PA cephalograms, together with the measurement method, are presented in Figure 2.

The vertical and gonial symmetry of the mandible was analysed from the panoramic tomogram of the jaws according to the method described by Mattila *et al.* (1995). The reference points, lines and angles used are shown in Figure 3.

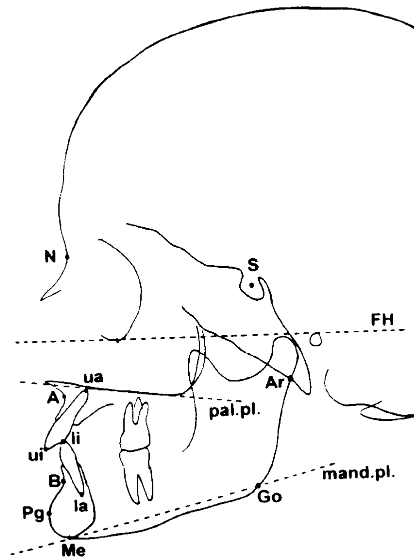

Figure 1 Reference points in lateral cephalograms: sella (S), nasion (N), subspinale (A), submentale (B), pogonion (Pg), menton (Me), gonion (Go), articulare (Ar), maxillary incisor apex (ua), maxillary incisor incisal edge (ui), mandibular incisor incisal edge (li), mandibular incisor apex (la). Reference lines: Frankfort horizontal plane (FH), palatal plane (pal. pl.), mandibular plane (mand. pl.).

All measurements are presented without correction concerning the enlargement. The study was approved by the ethical board of Institute of Dentistry of the University of Helsinki.

Error of method

The error of the method included double determination of the cephalometric landmarks used in measurements from radiographs. The method error was calculated using the formula:

$$S_{(i)} = \sqrt{\Sigma d^2/2N}$$

where *d* is the difference between two measurements and *N* is the number of double determinations. With regard to each angle or line used, the error of the method was less than 3 per cent of the total biological variance.

Table 1 Cephalometric comparison of 26 adult professional violin and viola players (VP) and their matched controls (C).

Parameter	VP group (n = 26) Mean ± SD Range	Group C (n = 26) Mean ± SD Range	Difference between groups (paired t-test) x	P
SNA (°)	82.19 ± 3.48 76.0 – 89.5	83.85 ± 3.96 77.0 – 91.0		
SNB (°)	79.73 ± 3.54 69.0 – 86.0	79.50 ± 3.60 72.0 – 86.5		
ANB (°)	2.85 ± 2.81 –1.5 – 10.0	4.35 ± 2.27 –1.5 – 8.5	–1.5	0.0418*
SNPg (°)	81.33 ± 3.63 71.0 – 87.0	80.62 ± 3.89 73.0 – 89.0		
FH/NPg (°)	89.02 ± 3.63 82.0 – 95.0	88.15 ± 3.41 82.0 – 95.0		
SN/mand.pl (°)	29.89 ± 6.16 19.5 – 49.0	30.65 ± 5.02 20.0 – 44.0		
SN/pal.pl (°)	7.04 ± 3.92 0.0 – 14.5	6.15 ± 3.81 0.0 – 14.0		
Pal.pl/mand.pl (°)	22.85 ± 5.34 10.0 – 36.0	24.50 ± 4.55 15.0 – 35.0		
NSAr (°)	126.17 ± 4.95 113.0 –139.0	122.46 ± 4.95 114.0 –130.0	3.71	0.0172**
SArGo (°)	138.10 ± 6.26 123.0 –150.0	142.40 ± 6.10 128.0 –156.5	–4.31	0.0117**
ArGoMe (°)	126.73 ± 7.98 113.5 –147.0	127.73 ± 3.73 122.0 –139.0		
Ar–Go (mm)	52.69 ± 5.53 44.0 – 63.5	53.73 ± 5.63 46.0 – 65.0		
Go–Me (mm)	76.79 ± 5.15 68.0 – 90.0	73.10 ± 5.40 59.5 – 83.5	3.69	0.0187**
Max.inc/pal.pl (°)	110.42 ± 8.11 96.0 –127.0	105.14 ± 9.93 82.0 –120.5	5.29	0.049*
Mand.inc/mand.pl (°)	93.29 ± 8.48 76.0 –108.0	93.91 ± 7.29 78.0 –106.0		
AFH (N–Me) (mm)	124.50 ± 8.01 110.5 –136.5	128.08 ± 8.45 110.0 –143.5	–3.58	0.0341*
LFH (Me–pal.pl) (mm)	69.08 ± 6.00 56.5 – 78.5	72.77 ± 7.02 61.0 – 92.5	–3.69	0.0175**
PFH (S–Go) (mm)	85.04 ± 7.63 72.5 – 99.0	87.96 ± 7.57 77.5 –102.5	–2.92	0.0313*

AFH = anterior facial height; LFH = lower facial height; PFH = posterior facial height.
*$P < 0.05$; **$P < 0.02$.

Results

The results of the radiographic measurements are shown in Tables 1, 2 and 3. In the lateral cephalograms statistically significant differences between the groups were found in the angles ANB (mean difference, –1.5 degrees), NSAr (3.7 degrees), SArGo (–4.3 degrees) and max.inc./pal.plane (5.3 degrees), in the mandibular corpus length (Go-Me, mean difference 3.7 mm) and in three facial heights (mean differences: anterior facial height (AFH), –3.6 mm; lower facial height (LFH), –3.7 mm; posterior facial height (PFH), –2.9 mm) (Table 1).

The PA cephalograms revealed statistically significant differences in the right (mean difference, –6.6 mm) and left (–4.7 mm) PA–TFH, in

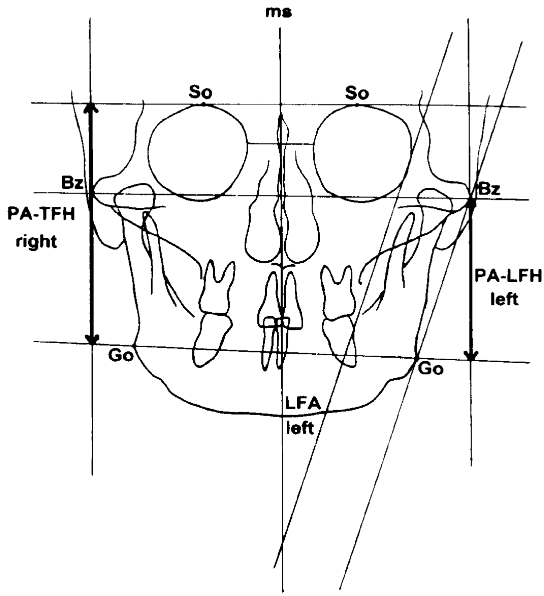

Figure 2 Reference points in PA cephalograms: supraorbitale (So), bizygomatic (Bz), gonion (Go). The So points were connected to the line So–So, the Bz points to the line Bz–Bz and gonions to the line Go–Go. The medial orbital margins were connected with a line parallel to So–So at the height of the base of the crista galli. From the midpoint of this line a line was drawn through the anterior nasal spine: this was the constructed median sagittal plane (ms). Through each Bz point a line was drawn parallel to the median sagittal plane. From these vertical lines the right and left total facial heights (PA–TFH) and right and left lower facial heights (PA–LFH) were measured. The PA–TFH was determined as the distance between the line So–So and the line Go–Go and the PA–LFH as the distance between the line Bz–Bz and the line Go–Go. The lower face angle (LFA) was determined as the angle between the midsagittal and the line connecting the Bz and Go points on each side.

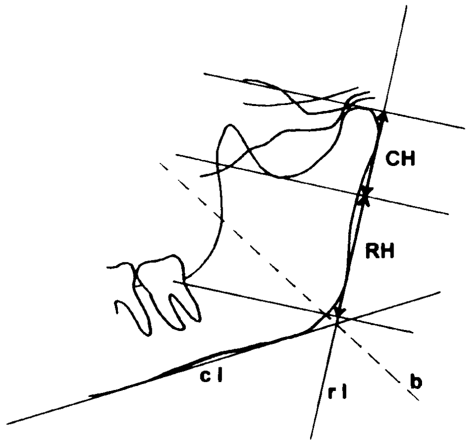

Figure 3 Lines used in measurements from panoramic tomograms: ramus line (rl), corpus line (cl), bisector of gonial angle (b). Three perpendiculars were drawn to the ramus line: through the condylion point, through the lowest point of the incisura mandibulae and through the intersection of the outline of the angulus and the bisector of the gonial angle. These perpendiculars thus determined the condylar height (CH) and the ramal height (RH).

the right PA-LFH (–4.2 mm) and in the left LFA (2.4 degrees) (Table 2).

The measurements made from the panoramic tomograms revealed no statistically significant differences between the groups (Table 3). A negative correlation was found between the number of weekly playing hours and the right PA–LFH ($r = -0.39$; $P < 0.05$).

Positive correlations were found in the violin and viola group between age and AFH ($r = 0.59$; $P < 0.01$) and between age and LFH ($r = 0.49$; $P < 0.01$) as well as between age and the right and left PA–TFH ($r = 0.43$, $P < 0.05$; $r = 0.50$, $P < 0.01$, respectively).

In the control group positive correlations were found between age and AFH ($r = 0.45$, $P < 0.05$) and between age and PFH ($r = 0.57$, $P < 0.01$). Positive correlations were also found between age and right and left PA–TFH ($r = 0.54$, $P < 0.01$; $r = 0.40$, $P < 0.05$, respectively) as well as between age and right and left PA–LFH ($r = 0.61$, $P < 0.001$; $r = 0.46$, $P < 0.05$, respectively).

Discussion

It is evident from the results of the present study that professional violin or viola playing influences facial morphology. It reduces growth of the facial height, but does not totally prevent it, since there is a positive correlation between age and facial height also in the player group. This continuance of growth of facial height in adulthood is normal in Caucasian populations (Tallgren, 1957; Forsberg, 1979; Behrents 1984, 1989; Forsberg *et al.*, 1991; Bishara *et al.*, 1994). It also proclines the maxillary incisors and increases the length of the mandibular corpus (Figure 4). Surprisingly, no statistically significant asymmetry of the face or the mandible was found, although the instrument is pressed against the mandibular angle at the left, and the

Table 2 Posteroanterior (PA) cephalometric comparison of 26 adult professional violin and viola players (VP) and their matched controls (C).

Parameter	VP group (n = 26) Mean ± SD range	C group (n = 26) Mean ± SD range	Difference between groups (paired t-test) x	P
Right TFH (mm)	107.29 ± 9.26 92.0 –125.0	113.89 ± 9.52 100.0 –134.0	– 6.60	0.0049***
Left TFH (mm)	108.04 ± 8.65 94.0 –122.0	112.77 ± 9.61 93.0 –130.5	– 4.73	0.0094***
Right LFH (mm)	66.83 ± 8.08 47.0 – 85.5	71.00 ± 8.06 59.0 – 93.0	– 4.17	0.0306*
Left LFH (mm)	67.37 ± 7.03 52.0 – 80.5	69.52 ± 7.95 57.0 – 85.0		
Right LFA (°)	14.94 ± 2.80 11.0 – 19.5	13.87 ± 2.27 8.5 – 18.5		
Left LFA (°)	14.78 ± 2.95 10.0 – 19.5	12.37 ± 2.08 7.0 – 16.0	2.40	0.0011***

TFH = total facial height; LFH = lower facial height; LFA = lower facial angle.
*P < 0.05; **P < 0.02; ***P < 0.01.

Table 3 Comparison of vertical and gonial symmetry of the mandible in 26 adult professional violin and viola players (VP) and their matched controls (C).

Parameter	VP group (n = 26) Mean ± SD Range	C group (n = 26) Mean ± SD Range
Right condylar height (mm)	25.98 ± 3.73 20.0 – 34.0	26.44 ± 3.83 20.0 – 33.0
Left condylar height (mm)	25.79 ± 4.05 14.0 – 34.0	25.25 ± 4.06 17.0 – 32.0
Right ramal height (mm)	44.39 ± 6.82 32.0 – 54.5	46.46 ± 5.26 37.5 – 57.0
Left ramal height (mm)	45.02 ± 6.45 33.0 – 55.0	46.58 ± 6.28 36.5 – 60.5
Right gonial angle (°)	124.48 ± 9.47 105.0 –144.0	125.69 ± 4.79 116.0 –134.0
Left gonial angle (°)	123.25 ± 8.07 107.5 –145.0	125.27 ± 5.44 117.0 –138.0

right condyle is pressed into the articular fossa during playing. Some cases have even demonstrated degenerative remodelling in the right condyle (Rieder, 1976; Bialy and Bialy, 1982; Kovero, 1989). The statistically significant difference in the left LFA between players and controls, the angle being greater in players (mean difference 2.4 degrees, P = 0.0011), is a consequence of the fact that the controls were asymmetric with regard to the LFA. The mean right LFA in the controls was 13.9 degrees and the left 12.4 degrees. In the players these were 14.9 degrees and 14.8 degrees respectively. The finding that the LFA is greater at the right in the controls, i.e. in a 'normal population' is similar to the results of the longitudinal study by Melnik (1992), although his measurements were made from 45 degree oblique cephalograms.

Figure 4 Lateral cephalogram of a female professional violist, aged 30. She had started playing the violin at the age of nine and the viola at the age of 15 and was playing for 48 hours per week at the time of the examination. Her facial structures demonstrate a small anterior facial height, a horizontal mandibular plane and symmetrical structures, which were characteristic features of the violin/viola players in the present study.

Melnik found that by the age of 16 years the right side of the mandible had grown statistically significantly longer than the left, measured from condyle to symphysis, although no statistically significant difference was found between the right and left gonial angles. Shah and Joshi (1978) studied measurements made in the craniofacial complex from PA cephalograms of 43 subjects with harmonious faces and normal occlusions. They found that the right side of the face was larger than the left. Chebib and Chamma (1981) created indices of craniofacial asymmetry. Their material consisted of PA cephalograms of 64 Caucasian subjects; according to their index of oblique distortion the right facial angle was greater than the left in this material. Although the angles used as a basis for the oblique distortion index were measured from the temporal region of the skull to the gonion (that is, starting at a higher point than in the present study), the finding is in accordance with our results.

There are also studies of facial symmetry to support the opposite opinion, as reviewed by Pirttiniemi (1994). In their study of 63 PA cephalograms, Letzer and Kronman (1967) found the left side of the face to be larger than the right, although statistical significance was reached only for the upper part of the face (cranial base and maxillary regions). Vig and Hewitt (1975) studied 50 subjects with excellent occlusion and 50 with malocclusion using PA cephalograms and found a slight trend towards left side dominance of the face.

Conclusion

Long-term violin and viola playing has a modifying effect on dentofacial morphology. According to the present study, this effect is manifested as smaller facial heights, greater proclination of the maxillary incisors and greater length of the mandibular corpus in violin/viola players than in controls. However, it seems that with regard to facial symmetry, the forces and pressures involved in violin and viola playing are not unfavourable as they seem to reduce rather than increase facial asymmetry.

Address for correspondence

Outi Kovero
Department of Dental Radiology
Institute of Dentistry
PO Box 41 (Mannerheimintie 172)
FIN-00014 Helsingin Yliopisto
Finland

References

Behrents R G 1984 A treatise on the continuum of growth in the aging craniofacial skeleton. Doctoral dissertation, The University of Michigan, Ann Arbor

Behrents R G 1989 The consequences of adult craniofacial growth. In: Carlson D S (ed.) Orthodontics in an aging society. Monograph No. 22, Craniofacial Growth Series, Center for Human Growth and Development, University of Michigan, Ann Arbor, pp. 53–63

Bialy D, Bialy H 1982 Temporomandibular bilateral arthropathy in a female violinist. Czasopismo Stomatologiczne 35: 49–52

Bishara S E, Treder J E, Jakobsen J R 1994 Facial and dental changes in adulthood. American Journal of Orthodontics and Dentofacial Orthopedics 106: 175–186

Brattström V, Odenrick L, Kvam E 1989 Dentofacial morphology in children playing musical wind instruments: a longitudinal study. European Journal of Orthodontics 11: 179–185

Brattström V, Odenrick L, Leanderson R 1991 Dentofacial morphology in professional opera singers. Acta Odontologica Scandinavica 49: 147–151

Chebib F S, Chamma A M 1981 Indices of craniofacial asymmetry. Angle Orthodontist 51: 214–226

Forsberg C M 1979 Facial morphology and ageing: a longitudinal cephalometric investigation of young adults. European Journal of Orthodontics 1: 15–23

Forsberg C M, Eliasson S, Westergren H 1991 Face height and tooth eruption in adults – a 20-year follow-up investigation. European Journal of Orthodontics 13: 249–254

Gualtieri P A 1979 May Johnny or Janie play the clarinet? The Eastman study: a report on the orthodontic evaluations of college-level and professional musicians who play brass and woodwind instruments. American Journal of Orthodontics 76: 260–276

Herman E 1974 Orthodontic aspects of musical instrument selection. American Journal of Orthodontics 65: 519–530

Herman E 1981 Influence of musical instruments on tooth positions. American Journal of Orthodontics 80: 145–155

Kovero O 1989 Degenerative temporomandibular joint disease in a young violinist. Dentomaxillofacial Radiology 18: 133–135

Letzer G M, Kronman J H 1967 A posteroanterior cephalometric evaluation of craniofacial asymmetry. Angle Orthodontist 37: 205–211

Ma H-C, Laracuente J M 1979 The influence of playing musical wind instruments on oral tissues. General Dentistry 27: 46–50

Mattila M, Könönen M, Mattila K 1995 Vertical asymmetry of the mandibular ramus and condylar heights measured with a new method from dental panoramic radiographs in patients with psoriatic arthritis. Journal of Oral Rehabilitation 22: 741

Melnik A K 1992 A cephalometric study of mandibular asymmetry in a longitudinally followed sample of growing children. American Journal of Orthodontics and Dentofacial Orthopedics 101: 355–366

Pang A 1976 Relation of musical instruments to malocclusion. Journal of the American Dental Association 92: 565–570

Pirttiniemi P M 1994 Associations of mandibular and facial asymmetries—a review. American Journal of Orthodontics and Dentofacial Orthopedics 106: 191–200

Rieder C E 1976 Possible premature degenerative temporomandibular joint disease in violinists. Journal of Prosthetic Dentistry 35: 662–664

Shah S M, Joshi M R 1978 An assessment of asymmetry in the normal craniofacial complex. Angle Orthodontist 48: 141–148

Tallgren A 1957 Changes in adult face height due to ageing, wear and loss of teeth and prosthetic treatment. Acta Odontologica Scandinavica 15: suppl. 24

Vig P S, Hewitt A B 1975 Asymmetry of the human facial skeleton. Angle Orthodontist 45: 125–129