From:
The Department of Orthodontics,
Royal Dental College,
Copenhagen, Denmark

POSITIONAL CHANGES OF COMPLETE DENTURES
A 7-YEAR LONGITUDINAL STUDY

by

ANTJE TALLGREN

INTRODUCTION

In spite of the great interest paid to the problem of alveolar bone loss under complete dentures, the positional changes of the dentures have not been investigated to any great extent. *Johnson* (1964 a, b, c, 1967), in a 3-year study on the maxillary resorption under immediate complete upper dentures, observed the positional changes of the dentures from tracings and superimposition of cephalometric films. The most common change was found to be an upward movement of the anterior part of the denture accompanied by a distal displacement of the denture body. This movement was found mainly related to the healing period and was only slight or negligible during the subsequent observation periods, during which relining of the dentures was performed. However, no data on the positional changes of the dentures were reported.

Brigante (1965) studied cephalometrically the migration of complete dentures by means of lead-shot reference points imbedded in the denture body. He found the positional changes greater and more rapid in the case

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of immediate dentures than in dentures remade upon healed ridges, this in spite of periodic corrections. The lower dentures showed a greater change than the upper ones and were found to have settled on the denture foundation, as bone resorbed. In relation to cranial landmarks, the upper and lower dentures, as a pair, were usually found to have moved in an upward and forward direction due to mandibular closure.

Carlsson et al. (1967), in a longitudinal cephalometric study of resorptive changes in the maxillary process under immediate complete dentures, measured the position of the upper central incisors in the natural dentition before extraction and in the dentures 5 years after insertion. They found that the incisal edges of the denture incisors were situated by a mean of 1.8 mm higher and 2.3 mm further forward than the corresponding points on the natural teeth, this despite various prosthetic measures. The intermediate stages were not examined, however.

The present roentgenographic cephalometric study aims to evaluate the positional changes of complete upper and lower dentures during a 7-year period of denture wear as related to resorption of the alveolar processes and reduction in the occlusal vertical dimension.

MATERIAL AND METHODS

The cephalometric analysis was carried out on lateral head films of 22 Finnish adults, who had received prosthetic treatment at the Institute of Dentistry, University of Helsinki. 11 of the subjects (Group A) were provided with complete upper and lower dentures, and 11 (Group B) with a complete upper denture, the lower jaw being furnished with a partial free-end denture. The two samples were the same as in a previous study (*Tallgren*, 1967) and comprised test subjects from a larger initial group, the reduction of which has previously been accounted for (*Tallgren*, 1957, 1966). Thus, subjects who had had their dentures remade or relined during the periods of observation were not included. The distribution of the test subjects according to age, sex and type of dentures is shown in Fig. 1.

The treatment performed was of the conventional type, the dentures being constructed 2—3 months after extraction (*Tallgren*, 1957). No pre-extraction records were used in construction of the dentures. The occlusion was recorded in the centric jaw relationship by means of gothic arch tracing. Porcelain anatomical teeth were used in all the dentures.

The roentgenographic examination has been accounted for in the above-mentioned publications. The stages of observation were the following:

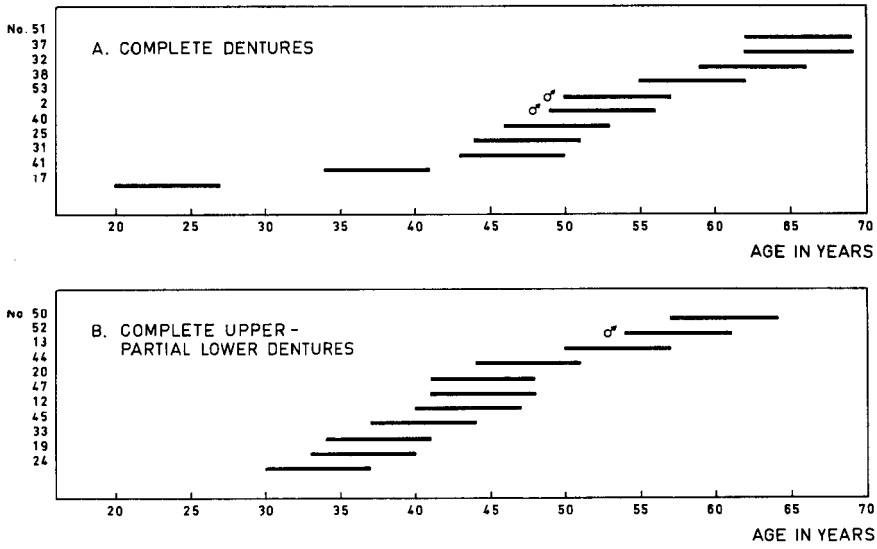


Fig. 1. Distribution of the test subjects according to age, sex and type of dentures. Each line indicates the age of the subject during the 7-year period of observation. ♂ = male subject.

(I) Before extraction, (II) after insertion and correction of the dentures, (III) after six months of denture wear, (IV) after 1 year, (V) after 3 years and (VI) after 7 years of denture wear. The films obtained at each of the above-mentioned stages comprised one film taken in the occlusal position at maximal closure and 2—4 films taken in the rest position of the mandible. The rest position exposures at stages II—VI were made both with and without the dentures in the mouth.

Measurements. The reference points and lines on the cephalometric films were defined mainly according to *Björk* (1960) with minor modifications in some instances. The reference points and lines are listed in Table I and illustrated in Fig. 2. The linear and angular measurements are listed in Table II with short definitions.

The horizontal position of the upper and lower incisal edges (*is* and *ii*) in relation to the cranial base was measured to a perpendicular to NSL through *n* (NSPn). The horizontal position of *ii* in relation to the mandibular body was measured to a perpendicular to ML through *pg* (MLP). Cf. Table II and Fig. 2. Concerning the differences in these measurements between the stages of observation, it should be noted that a positive sign indicates a change in posterior direction and vice versa.

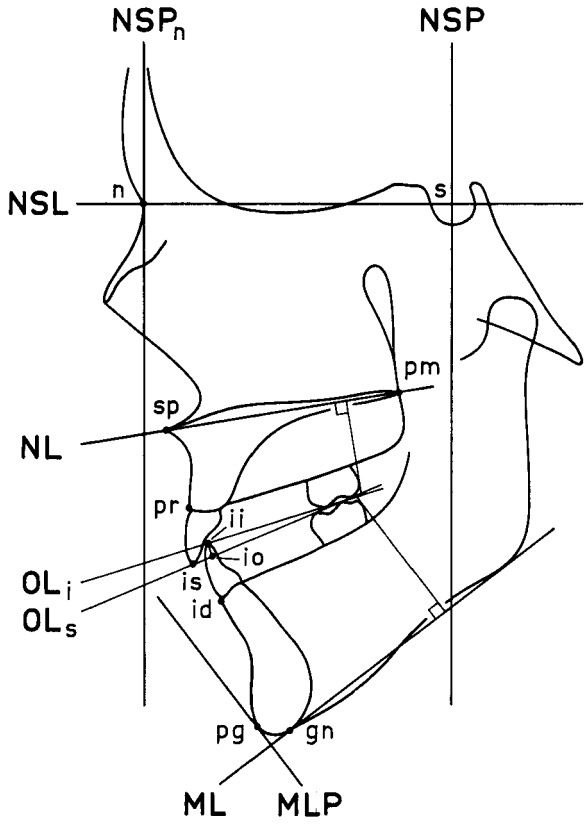


Fig. 2. Reference points and lines on the profile cephalometric films.

The linear vertical resorption of the alveolar processes was determined as the difference in height of the processes between the stages of observation. In the posterior segments, the height of the alveolar processes was determined in the first molar region. The reference points for these measurements were determined on the occlusal films with dentures, stage II, according to the following procedure. For the maxillary process, the reference point was determined as the intersection between the NL-line and the tangent to the distal surface of the first molar of the upper denture, perpendicular to the NL-line. For the mandibular process, the reference point was determined as the intersection between the ML-line and the tangent to the distal surface of the first molar of the lower denture, perpendicular to the ML-line (Fig. 2). The points were marked with a pencil and subse-

Table I.

Reference points and lines on the cephalometric films

Reference points	
Gnathion (gn)	The lowest point on the mandibular symphysis
Incision inferius (ii)	The mid-point of the incisal edge of the most prominent lower central incisor
Incision superius (is)	The mid-point of the incisal edge of the most prominent upper central incisor
Incision occlusale (io)	The normal projection of the incision inferius on the upper occlusal line (OLs)
Infradentale (id)	The most antero-superior point on the bony contour of the mandibular alveolar process
Nasion (n)	The most anterior point on the frontonasal suture
Pogonion (pg)	The most anterior point on the mandibular symphysis
Prosthion (pr)	The most antero-inferior point on the bony contour of the maxillary alveolar process
Pterygomaxillare (pm)	The point of intersection between the contour of the nasal floor and the posterior contour of the maxilla
Sella (s)	The centre of the sella turcica. The upper limit of sella turcica is defined as the line joining tuberculum sellae and dorsum sellae
Spinal point (sp)	The apex of the anterior nasal spine
Reference lines	
Mandibular line (ML)	The tangent to the lower border of the mandible through *gn*
Mandibular line perpendicular (MLP)	The line through *pg* perpendicular to ML
Nasal line (NL)	The line through *sp* and *pm*
Nasion-sella line (NSL)	The line through *n* and *s*
Nasion- sella perpendicular (NSP)	The line through *s* perpendicular to NSL
Nasion-sella perpendicular NSPn)	The line through *n* perpendicular to NSL
Lower occlusal line (OLi)	The line through *ii* and the distobuccal cusp of the first lower molar. (If this tooth is absent, the mesiobuccal cusp of the lower second molar or in absence of molars, the buccal cusp of the second or first premolar)
Upper occlusal line (OLs)	The line through *is* and the distobuccal cusp of the upper first molar. (If this tooth is absent, the mesiobuccal cusp of the second molar or in absence of molars, the buccal cusp of the second or first premolar)

It should be noted that the reference points and lines referring to the dentition apply both to the natural dentition and to the artificial teeth of the dentures.

Table II.

Measurements on the cephalometric films

No.	Variable	Definitions
1.	n-gn	
2.	s-n-pr	
3.	id-n-pr	
4.	is vert. NSL	The perpendicular distance from *is* to NSL
5.	is hor. NSPn	The perpendicular distance from *is* to NSPn
6.	ii vert. NSL	The perpendicular distance from *ii* to NSL
7.	ii hor. NSPn	The perpendicular distance from *ii* to NSPn
8.	ii vert. ML	The perpendicular distance from *ii* to ML
9.	ii hor. MLP	The perpendicular distance from *ii* to MLP
10.	NSL-OLs	
11.	NSL-OLi	
12.	OLi-ML	
13.	ii-io	
14.	is-io	
15.	Anterior height maxill. process[r]	The perpendicular distance from the NL-line to the tangent parallel to the NL-line through the lowest point on the bony contour of the process
16.	Posterior height maxill. process[r]	The perpendicular distance from the NL-line to the bony contour of the process, measured from the point defined on p. 542.
17.	Anterior height mand. process[r]	The perpendicular distance from the ML-line to the tangent parallel to the ML-line through the uppermost point on the bony contour of the process
18.	Posterior height mand. process[r]	The perpendicular distance from the ML-line to the bony contour of the process, measured from the reference point defined on p. 542

r Measured on rest position films

quently transferred to te rest position films from the different stages by superimposition, using the basal structures as references. For stages II—VI, the rest position films without dentures were used. The posterior height of the alveolar processes was defined as the perpendicular distance from the reference line to the bony contour of the process, measured from the reference point.

All measurements, with the exception of the variables 15—18 (Table II), were performed on the occlusion films. The rest position films were used as an additional check of the measuring points and of the bony contours.

The measurements were made according to *Björk* and *Solow* (1962); the details have been accounted for in a previous paper (*Tallgren*, 1967).

Statistical methods. The statistical methods used in the present study have been reported elsewhere (*Tallgren*, 1967). The numerical calculations were carried out with the aid of an electronic computer. The F-test (*Snedecor*) was used in the comparison of variances and *Student's* t-test for the means. The 5, 1 and 0.1 per cent levels of significance were denoted *, ** and ***.

An estimate of the total method error related to the serial roentgenographic method of measurement was obtained in the above-mentioned study. In the present study, an estimate of the method error related to the special procedure employed in measuring the posterior height of the alveolar processes was obtained from a series of 22 pairs of duplicate films taken in the rest position without dentures, stage II. The method errors, s(i), ranged from 0.23 mm to 0.32 mm.

Table III.

Distributions of the linear and angular variables at the pre-extraction stage

	Group A Complete dentures			Group B Complete upper — partial lower dentures		
Variable	$\bar{x}$	s ($\bar{x}$)	s	$\bar{x}$	s ($\bar{x}$)	s
1. n-gn	122.09	2.03	6.72	120.91	2.75	9.11
2. s-n-pr	84.59	.81	2.70	87.73	1.41	4.67
3. id-n-pr	3.86	.69	2.29	3.41	.95	3.15
4. is vert. NSL	83.41	1.32	4.36	81.45	1.40	4.64
5. is hor. NSPn	8.64	1.15	3.82	3.91	2.02	6.69
6. ii vert. NSL	79.77	.95	3.15	76.91	1.84	6.11
7. ii hor. NSPn	11.55	1.35	4.47	7.77	1.87	6.19
8. ii vert. ML	41.86	1.45	4.80	43.50	1.49	4.92
9. ii hor. MLP	11.95	1.74	5.77	12.77	1.59	5.26
10. NSL-OLs	20.18	1.76	5.82	14.86	1.09	3.63
11. NSL-OLi	16.27	1.66	5.50	10.68	1.31	4.34
12. OLi-ML	16.55	1.70	5.65	18.95	1.83	6.06
13. ii-io	3.00	.44	1.45	3.55	.58	1.92
14. is-io	3.23	.87	2.89	4.23	.97	3.23
15. Ant. height maxill. proc.	18.23	.98	3.24	21.55	1.03	3.42
16. Post. height maxill. proc.	13.41	.79	2.61	18.00	1.06	3.50
17. Ant. height mand. proc.	29.32	1.10	3.65	34.14	.99	3.28
18. Post. height mand. proc.	22.23	.68	2.26	23.55	1.05	3.49

Samples sizes for all variables = 11

RESULTS

The distributions of the variables at the pre-extraction stage are described in Table III. The mean differences between the stages of observation in groups A and B are shown in Tables IV and V. The differences between the means of the two groups are given in Table V. The most important findings are presented in the following sections. The mean differences reported in the text are all significant at least at the 5 % level.

Initial changes

The initial changes due to the prosthetic treatment were studied by comparing the measurements from the pre-extraction and the post-insertion stages (stages I and II, Tables IV and V). In comparison with that of the corresponding natural teeth, the position of the artificial incisors showed divergencies both in the horizontal and vertical directions. In the complete denture group, a tendency to a further inward positioning of the upper incisal edges was noted (is hor. NSPn) and to a lowering of the lower incisal level (ii vert. ML). However, great individual variations were observed and the mean differences did not reach the level of significance. Owing in part to an increase in the pre-extraction face height, in part to the vertical positional changes of the incisors, the overbite was found reduced by a mean of 2 mm. In the complete upper — partial lower group the differences in position of the upper incisal edges were approximately of the same order as in the other group. The pre-extraction face height was found increased by a mean of 2.8 mm and the overbite reduced by a mean of 2.4 mm.

Changes during 7 years of denture wear

Alveolar processes and jaw relationships. The total vertical and area resorption in the anterior segments of the alveolar processes resulting from the 7-year period of denture wear has been reported in a previous study (*Tallgren*, 1967). The individual variations in resorption pattern are shown in Figs. 3 a, b, c and 4 a, b.

The gradual reduction in anterior and posterior height of the alveolar processes is shown in Tables IV and V. In the complete denture group, the mean reduction in anterior height of the mandibular process during the first six months of denture wear was approximately twice the maxillary reduction. Owing to a continuing resorption, pronounced in the case of the mandibular process but only slight in the maxillary process, this rela-

Table IV.

Mean differences ($\bar{x}$) between the stages of observation. A negative value indicates a decrease from the earlier to the later stage

		Group A. Complete dentures							
		BE–AI	AI–½ yr.	½–1 yr.	1–3 yrs.	3–7 yrs.	1–7 yrs.	AI–7 yrs.	BE-7 yrs.
		n = 11	n = 11	n = 11	n = 7	n = 7	n = 11	n = 11	n = 11
1. n-gn	$\bar{x}$	1.41	—2.59***	—1.27***	—2.43**	—2.57**	—4.55***	—8.41***	—7.00***
	s	2.63	.86	.79	1.21	1.57	2.14	2.32	2.55
2. s-n-pr	$\bar{x}$	—1.55***	— .32	— .23	— .21	— .50*	— .64***	—1.18***	—2.73***
	s	1.04	.72	.47	.27	.41	.32	.68	1.56
3. id-n-pr	$\bar{x}$	.41	— .95**	— .23	— .36	— .86***	—1.18**	—2.36***	—1.95**
	s	1.09	.88	.41	.69	.38	1.01	1.31	1.72
4. is vert. NSL	$\bar{x}$	— .14	— .50***	— .18	— .29	— .71	—1.05**	—1.73***	—1.86*
	s	2.15	.22	.46	.64	. 81	.96	1.15	2.52
5. is hor. NSPn	$\bar{x}$	1.32	— .50*	— .23	— .14	— .21	— .36*	—1.09**	.23
	s	3.04	.59	.47	.38	.27	.50	.89	3.44
6. ii vert. NSL	$\bar{x}$	2.23**	— .59**	— .09	— .29	— .36	— .68	—1.36**	.86
	s	2.15	.44	.49	.49	1.03	1.12	1.12	2.29
7. ii hor. NSPn	$\bar{x}$	.86	— .86**	— .36*	— .50*	—1.29**	—1.68***	—2.91***	—2.05
	s	2.76	.90	.50	.50	.81	1.15	1.28	3.69
8. ii vert. ML	$\bar{x}$	—1.59	—1.45***	—1.18***	—2.36**	—2.21**	—3.86***	—6.50***	—8.09***
	s	2.51	.72	.78	1.35	1.32	2.12	2.56	3.60
9. ii hor. MLP	$\bar{x}$	.14	— .36*	— .32*	— .29	— .43	— .68*	—1.36**	—1.23
	s	3.33	.50	.40	.64	.84	.98	1.25	3.69
10. NSL-OLs	$\bar{x}$	—1.32	— .50	— .59**	— .36	— .93	—1.14**	—2.23**	—3.55***
	s	2.09	.77	.49	.80	1.17	1.19	1.66	1.86
11. NSL-OLi	$\bar{x}$	1.64	— .68*	— .36	— .64	— .79	—1.45**	—2.50***	— .86
	s	2.86	.72	.67	.80	1.29	1.42	1.55	2.38
12. Oli-ML	$\bar{x}$	—1.41	— .59**	— .64**	— .57*	— .79*	—1.18**	—2.41***	—3.82***
	s	2.43	.49	.64	.53	.81	.93	1.51	2.62
13. ii-io	$\bar{x}$	—2.14**	.00	— .14	— .14	— .21	— .36*	— .50*	—2.64***
	s	1.61	.32	.50	.63	.49	.50	.55	1.75
14. is-io	$\bar{x}$	— .59	— .41*	— .27	— .50	— .79**	—1.27**	—1.95***	—2.55*
	s	3.40	.49	.41	.87	.49	1.15	1.08	3.64
15. Ant. height	$\bar{x}$	—1.27*	— .50**	— .23	— .21	— .86*	—1.00**	—1.73***	—3.00***
max. proc.	s	1.68	.50	.41	.39	.85	.77	.98	1.96
16. Post. heigth	$\bar{x}$	— .68**	— .23	— .14	— .07	— .14	— .23*	— .59**	—1.27**
max. proc.	s	.64	.34	.23	.35	.24	.26	.44	.96
17. Ant. height	$\bar{x}$	—1.41*	—1.14***	—1.27***	—2.21***	—2.71***	—4.14***	—6.55***	—7.96***
mand. proc.	s	1.63	.67	.72	.91	1.11	2.03	2.52	3.50
Diff. 15–17	$\bar{x}$	.14	.64*	1.04**	2.00**	1.85**	3.14***	4.82***	4.95**
18. Post. height	$\bar{x}$	— .86**	—1.23***	— .82**	—1.00*	—1.14*	—1.91***	—3.95***	—4.82***
mand. proc.	s	.78	.65	.81	.87	.94	1.00	1.71	1.72
Diff. 16–18	$\bar{x}$	.18	1.00**	.68*	.93*	1.00*	1.68***	3.36***	3.55***

BE = Before extraction, AI = After insertion

Table V.

Mean differences ($\bar{x}$) between the stages of observation. A negative value indicates a decrease from the earlier to the later stage

		Group B. Complete upper — partial lower dentures							
		BE–AI	AI–½ yr.	½–1 yr.	1–3 yrs.	3–7 yrs.	1–7 yrs.	AI–7 yrs.	BE–7 yrs.
		n = 11	n = 11	n = 11	n = 6	n = 6	n= 11	n = 11	n = 11
1. n-gn	$\bar{x}$	2.82*	—1.59**	— .32	.67	— .67	—1.95*	—3.86**	—1.05
	s	3.28	1.22	.64	.75	.88	2.10	3.08	2.43
	$\bar{x}A–\bar{x}B$	—1.41	—1.00*	— .95**	—1.76*	—1.90*	—2.60**	—4.55***	—5.96***
2. s-n-pr	$\bar{x}$	—1.36***	— .91*	— .14	— .17	— .25	— .45***	—1.50**	—2.86***
	s	.95	1.07	.39	.41	.42	.27	1.32	1.12
	$\bar{x}A–\bar{x}B$	— .19	.59	— .09	— .04	— .25	— .19	.32	.13
3. id-n-pr	$\bar{x}$	— .64	—1.05**	— .41*	— .17	— .33*	— .86*	—2.32**	—2.95**
	s	1.40	1.06	.54	.26	.26	1.07	2.10	2.27
	$\bar{x}A–\bar{x}B$	1.05	.10	.18	— .19	— .53*	— .32	— .04	1.00
4. is vert. NSL	$\bar{x}$	— .09	—1.18***	— .36*	— .25	— .67*	—1.55**	—3.09***	—3.18**
	s	2.34	.75	.39	.27	.52	1.57	2.17	3.23
	$\bar{x}A–\bar{x}B$	— .05	.68*	.18	— .04	— .04	.50	1.36	1.32
5. is hor. NSPn	$\bar{x}$	1.55	— .45*	— .32	— .17	— .25	— .14	— .91	.64
	s	2.98	.65	.60	.26	.27	.78	1.39	2.73
	$\bar{x}A–\bar{x}B$	— .23	— .05	.09	.03	.04	— .22	— .18	— .41
6. ii vert. NSL	$\bar{x}$	2.64*	—1.27**	— .55**	— .50*	— .75*	—1.77**	—3.59**	— .95
	s	2.99	1.25	.52	.32	.69	1.56	2.72	2.81
	$\bar{x}A–\bar{x}B$	— .41	.68	.46*	.21	.39	1.09	2.23*	1.81
7. ii hor. NSPn	$\bar{x}$	.86	— .73***	— .23	— .25	— .25	— .55**	—1.50***	— .64
	s	1.47	.52	.34	.52	.27	.57	.89	1.32
	$\bar{x}A–\bar{x}B$	.00	— .13	— .13	— .25	—1.04*	—1.13**	—1.41**	—1.41
10. NSL-OLs	$\bar{x}$	—1.18	— .82**	— .73***	— .75**	—1.08	—1.86***	—3.41***	—4.59**
	s	2.42	.78	.52	.42	1.24	1.27	1.74	3.77
	$\bar{x}A–\bar{x}B$	— .14	.32	.14	.39	.15	.72	1.18	1.04
13. ii-io	$\bar{x}$	—2.41**	.36	.14	.08	.25	.23	.73*	—1.68**
	s	1.81	.64	.39	.20	.27	.41	1.08	1.33
	$\bar{x}A–\bar{x}B$	.27	— .36	— .28	— .22	— .46	— .59**	—1.23**	— .96
14. is-io	$\bar{x}$	— .95	— .41	.18	— .08	.00	— .32	— .55	—1.50*
	s	1.96	.77	.34	.20	.32	.68	1.13	1.95
	$\bar{x}A–\bar{x}B$	.36	.00	— .45*	— .42	— .79**	— .95*	—1.40**	—1.05
15. Ant. height max. proc.	$\bar{x}$	—2.36***	—1.14**	— .36*	— .33	— .83	—1.45**	—2.96***	—5.32***
	s	.84	1.12	.50	.41	.82	1.23	1.75	2.16
	$\bar{x}A–\bar{x}B$	1.09	.64	.13	.12	— .03	.45	1.23	2.32*
16. Post. height max. proc.	$\bar{x}$	—1.09**	— .09	— .14	— .33	— .33	— .68*	— .91*	—2.00**
	s	.86	.20	.23	.82	.41	.78	1.07	1.75
	$\bar{x}A–\bar{x}B$	.41	— .14	.00	.26	.19	.45	.32	.73

BE = Before extraction, AI = After insertion

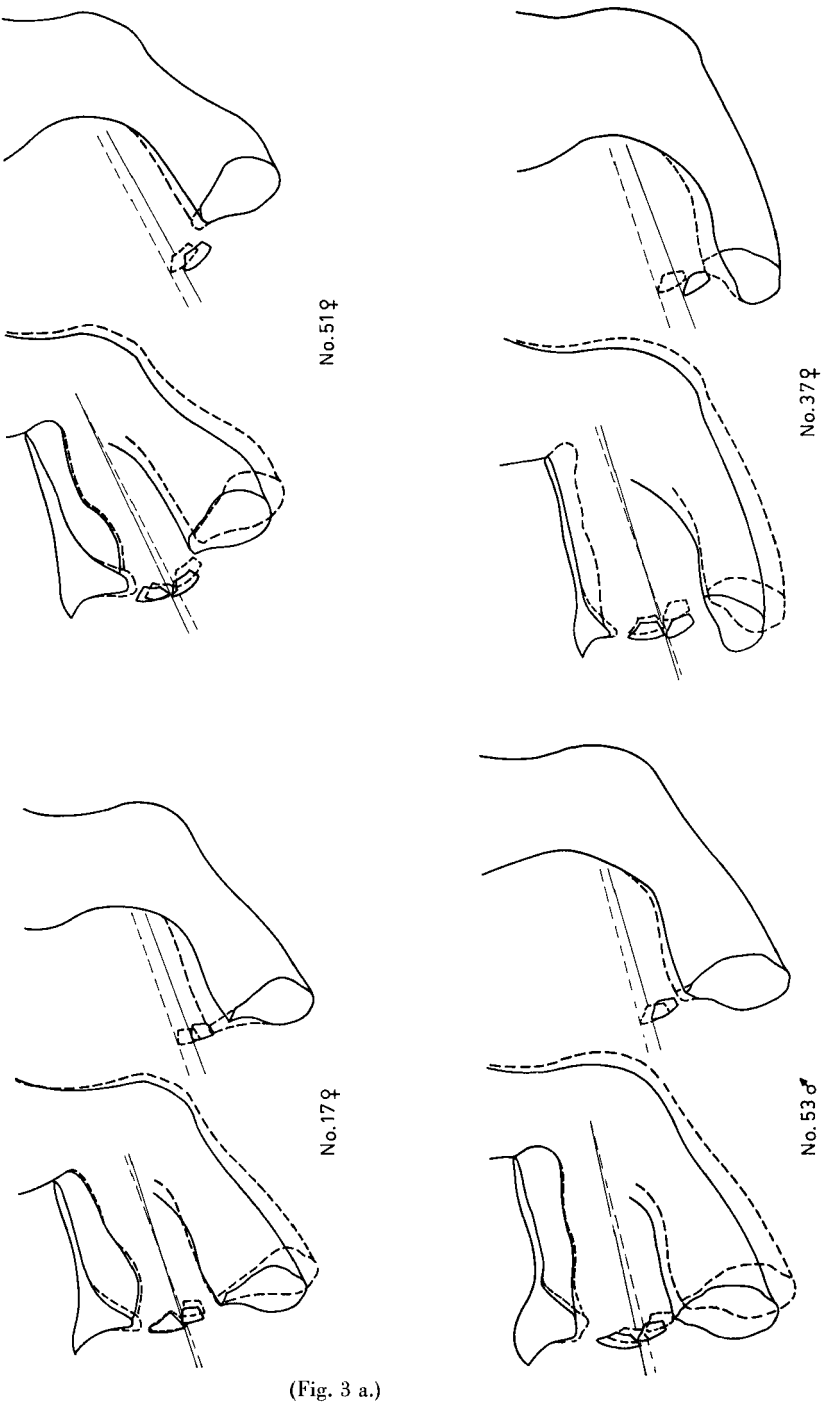
tionship increased to approximately 4:1 at the 7-year stage. In the posterior segments the relationship between the mandibular and maxillary reduction was even more marked. In the complete upper — partial lower group, the mean reduction of the maxillary process was greater than in the complete denture group. However, no significant differences between the groups were found.

As previously reported (*Tallgren*, 1967), and further illustrated in Figs. 3 a, b, c and 4 a, b, the resorption of the alveolar processes was accompanied by a decrease in mandibular inclination, i.e. an anterior rotation of the mandible and a consequent increase in mandibular prognathism. In the complete denture group these changes were especially marked, the mean decrease in facial height after 7 years of denture wear being approximately twice that noted in the other group. The mean decrease in sagittal alveolar relationship (id-n-pr) showed no appreciable difference between the two groups (Tables IV and V).

Positional changes of the dentures. In the complete denture group (Table IV), the incisal edges of the artificial upper incisors after the 7 years of denture wear were found situated by a mean of 1.7 mm higher than at the stage of insertion (is vert. NSL) and approximately 1 mm further forward (is hor. NSPn). The changes were greatest and most rapid during the first six months of denture wear. The inclination of the upper occlusal plane showed a mean decrease of 2.2°. The incisal edges of the artificial lower incisors in relation to the mandibular body were found situated by a mean of 6.5 mm further down than at the stage of insertion (ii vert. ML) and 1.4 mm further forward (ii hor. MLP). The inclination of the lower occlusal plane (OLi-ML) had decreased by a mean of 2.4°. These changes were most pronounced during the first year of denture wear.

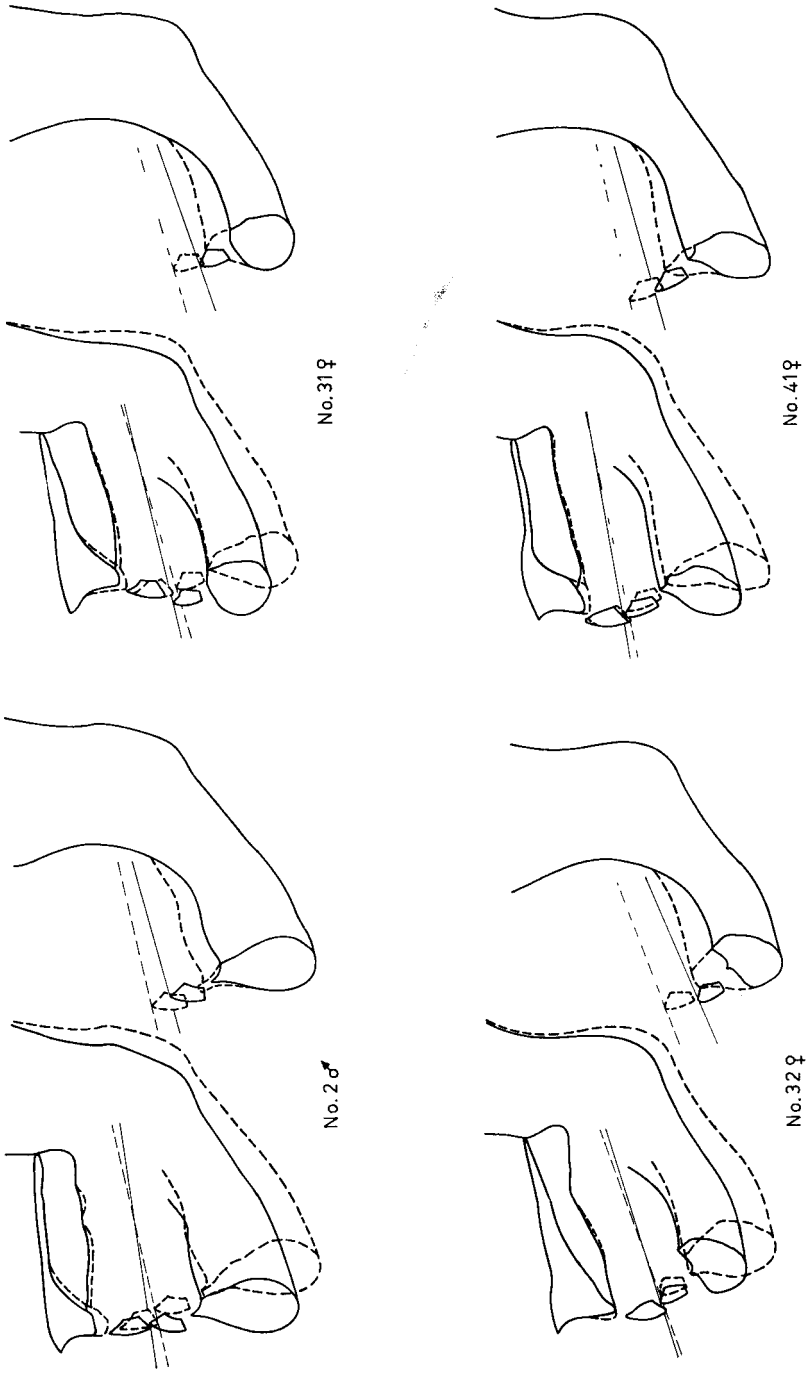
In relation to the cranial base the incisal edges of the artificial lower incisors at the 7 year stage were found situated by a mean of 1.4 mm further up and 3 mm further forward than at the stage of insertion (ii vert. NSL and ii hor. NSPn). The inclination of the lower occlusal plane to the cranial base (NSL-OLi) showed a mean decrease of 2.5°. During this development the overjet was reduced by a mean of 2 mm and the overbite by 0.5 mm. The individual variations in positional changes of the artificial upper and lower incisors and the accompanying changes in jaw and incisal relationship are illustrated in Figs. 3 a, b and c.

In the complete upper — partial lower group (Table V), the mean changes in the vertical direction of the upper incisal edges (is vert. NSL) were greater than in the complete denture group. However, a significant difference (at the 5 % level) was noted only during the first six months of denture

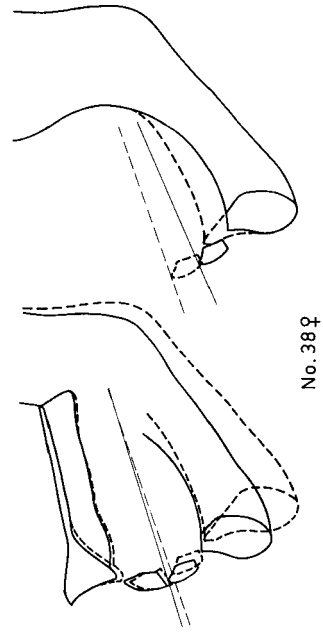


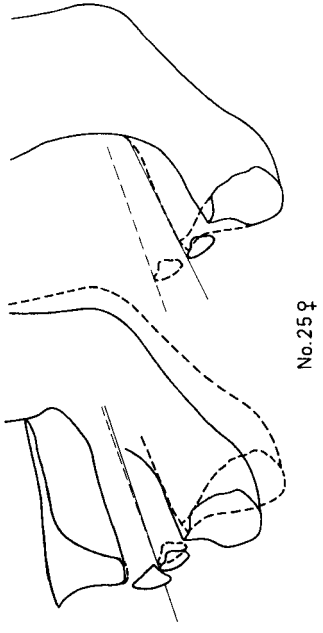
Figs. 3 a, b and c. Complete denture wearers. Individual tracings illustrating changes between the stage of insertion (broken line) and the 7-year stage (solid line). For each subject the figure to the right illustrates the changes of the lower central incisors and the lower occlusal plane due to resorption of the mandibular process. The figure to the left illustrates the positional changes of the upper and lower incisors and the change in inclination of the lower occlusal plane due to resorption mandibular closure. Sequence arranged according to decrease in mandibular inclination (NSL-ML). Position of tracings orientated to the NSL-horizontal.

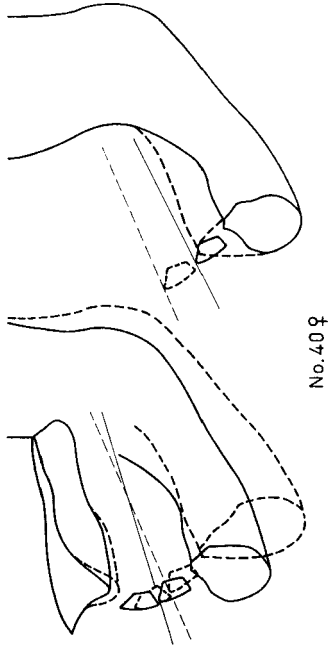
(Fig. 3 a.)



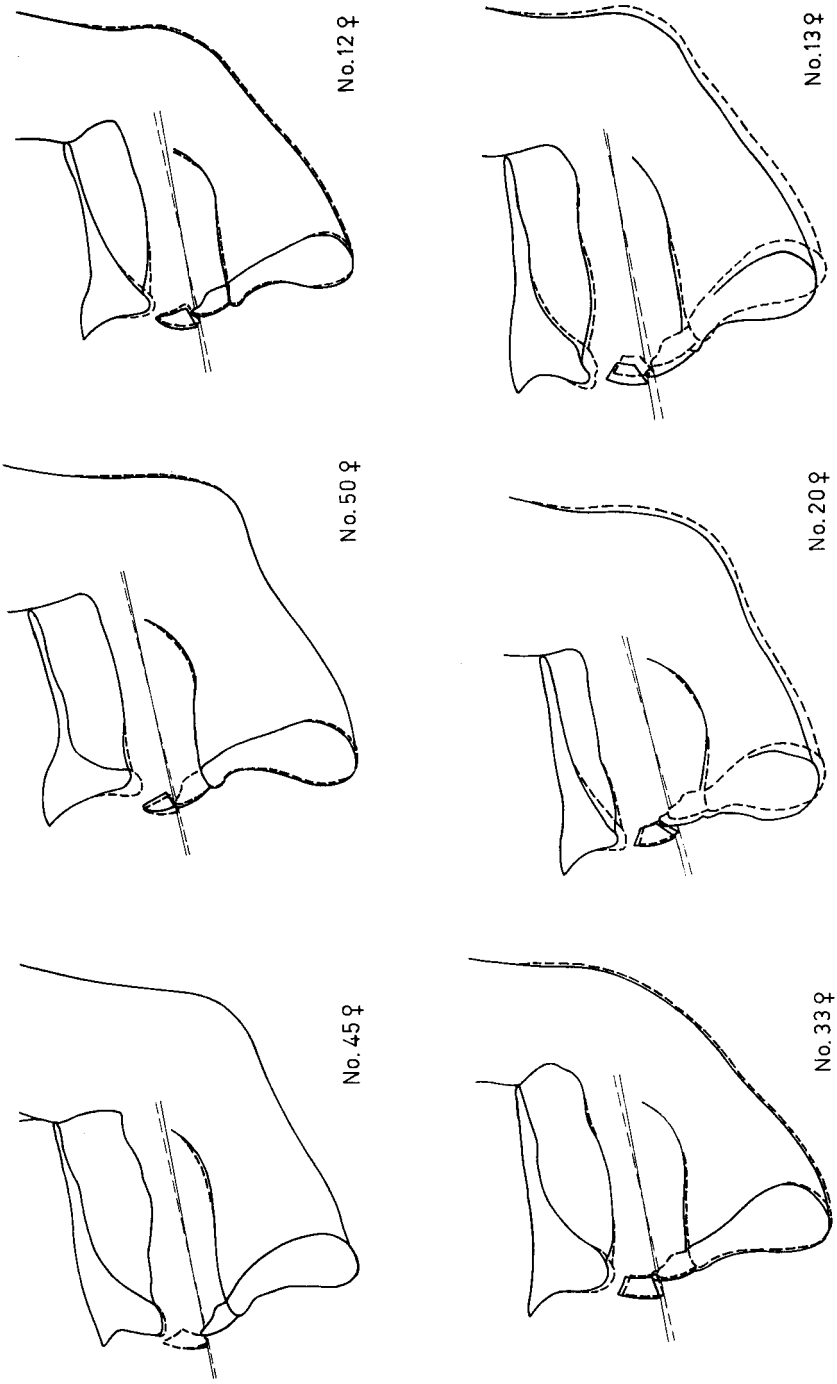
(Fig. 3 b.)





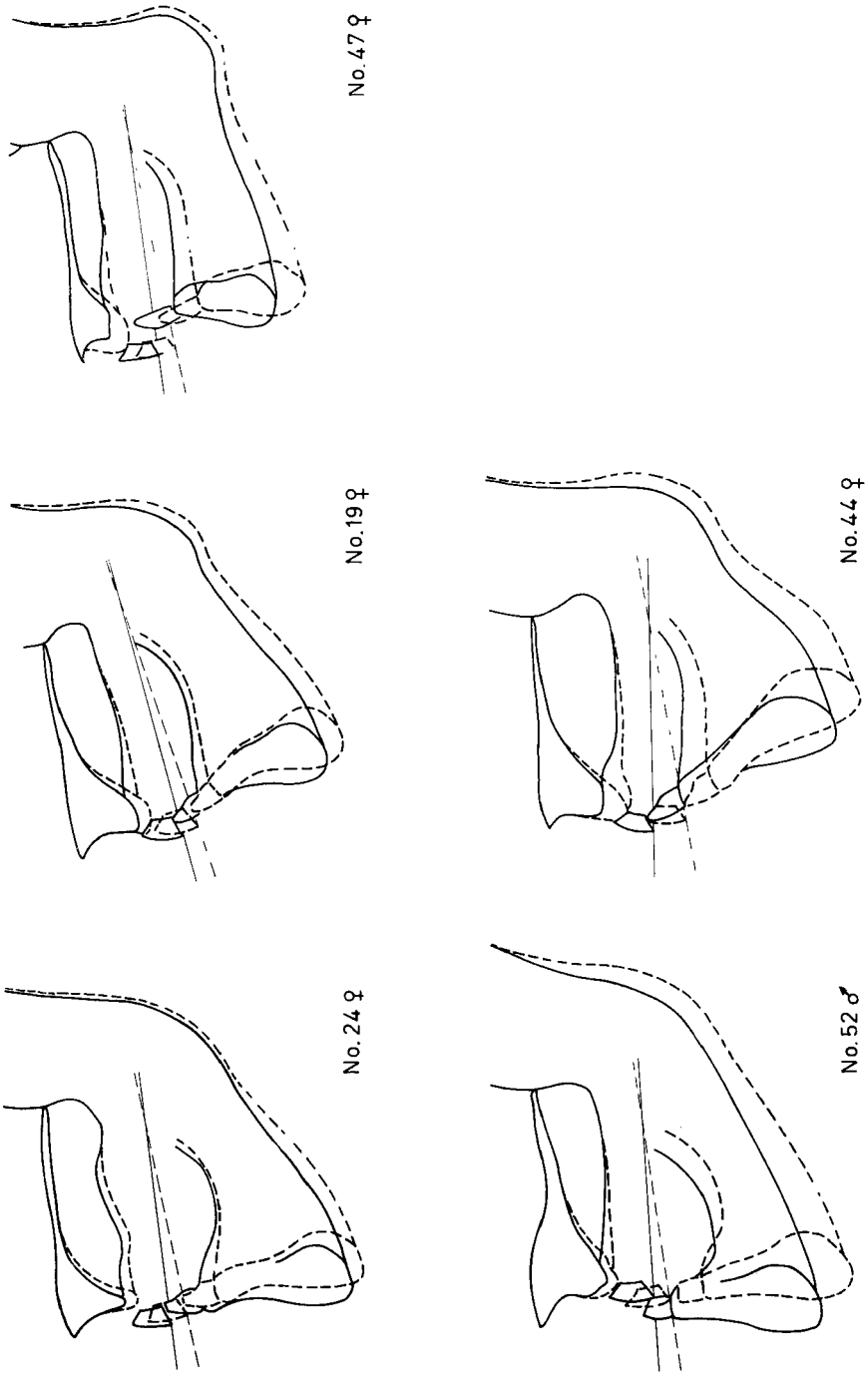


(Fig. 3 c.)



(Fig. 4 a.)

Figs. 4 a and b. Complete upper — partial lower dentures. Individual tracings illustrating resorption of the maxillary alveolar process and the changes of the upper central incisors and the upper occlusal plane between the stage of insertion (broken line) and the 7-year stage (solid line). Note the further upward positioning of the natural lower incisors due to mandibular closure. Sequence arranged according to decrease in mandibular inclination (NSL-ML). Position of tracings orientated to the NSL-horizontal.



(Fig. 4 b.)

wear. Owing to the decrease in the occlusal vertical dimension, the incisal edges of the natural lower incisors at the 7-year stage were found situated by a mean of 3.6 mm further up than at the stage of insertion of the dentures (ii vert. NSL). This difference was significantly greater than that in the complete denture group (at the 5 % level). Accordingly, the overbite showed a mean increase of 0.7 mm. The individual variations in regard to these changes are illustrated in Figs. 4 a and b.

DISCUSSION

A comparison of the position of the artificial incisors at the stage of insertion of the dentures with that of the corresponding natural teeth displayed differences both in the horizontal and vertical directions, the individual variations being noticeable. These deviations may in part have been related to resorptive changes of the alveolar processes, in part to an endeavour to create a moderate overbite and overjet and, accordingly, a favourable occlusal plane to ensure the stability of the dentures. Aesthetic requirements may also have played a part. The increase in pre-extraction face height, discussed in previous publications (*Tallgren*, 1957, 1966), may also to some extent have been related to these clinical aspects. Nevertheless, it should be pointed out that no pre-extraction records were utilized in the construction of the dentures, which further may explain the differences noted from the natural dentition.

The positional changes of the upper incisors during the 7-year period of denture wear, as recorded in the occlusal position, indicated an upward and forward movement of the denture, the vertical component being more marked than the horizontal. This anterior upward rotation of the maxillary denture, further indicated by a decrease in inclination of the upper occlusal plane, is in accordance with observations by *Johnson* (1964 a, b, c, 1967). However, a distal displacement of the denture accompanying the upward movement, as noted by *Johnson*, was seen in only two of the present 22 subjects, both from the complete upper — partial lower group (Figs. 4 a and b, Nos. 50 and 52). The changes in position of the artificial lower incisors and the decrease in inclination of the mandibular occlusal plane (OLi-ML) indicated a marked settling of the lower denture, especially pronounced in the anterior region, and an accompanying forward displacement of the denture. A settling of full lower dentures, as bone resorbed, was also found by *Brigante* (1965).

The anterior rotation of the mandible accompanying the positional changes of the dentures was found to have brought the lower incisal edges further

upward and forward in relation to the cranial base. However, in the complete denture group, the lower incisal edges at the 7-year stage were mostly found situated only slightly above the level noted at the stage of insertion, despite a marked decrease in facial height. This finding is explained by the marked settling of the lower denture due to resorption of the mandibular process. The distance the lower incisal level was raised approximated to the amount of anterior upward change of the maxillary denture.

The change in inclination of the lower occlusal plane (NSL-OLi), noted during this development, is explained by the difference between the decrease in mandibular inclination (NSL-ML) due to the closure, and the decrease in inclination of the lower occlusal plane (OLi-ML) due to the settling of the lower denture. The individual changes in the lower occlusal plane inclinations 7 years after insertion of the dentures are illustrated in Figs. 3 a, b and c.

The noticeable forward positioning of the artificial lower incisors in relation to the cranial base was in part related to the increase in mandibular prognathism, in part to the forward slide of the lower denture. As the forward movement of the upper denture, especially during the later part of the observation period, was markedly less, this led to a decrease in overjet. It would seem likely that the forward movement of the upper denture was an adaptation to the forward positioning of the lower denture in order to preserve the occlusal relationship. However, a further forward movement of the upper denture was probably restricted by anatomical factors. As illustrated in Figs. 3 a, b and c, the positional changes of the upper and lower dentures and the accompanying changes in jaw and incisal relationship showed great individual variation.

In the complete upper — partial lower group, a tendency, although not significant, to a greater upward rotation of the maxillary denture was noted and may have some connexion with the presence of the remaining lower anterior teeth. However, as illustrated in Figs. 4 a and b, wide individual variations were observed. In some of the subjects the changes were slight or even negligible, whereas in others they were pronounced. In one subject (Fig. 4 b, No. 52), the marked anterior rotation of the mandible led to a mandibular overjet, which seemed to have caused the previously mentioned distal displacement of the upper denture.

In both samples the positional changes of the upper dentures after the first six months of denture wear were, generally, fairly slight, although no relining of the dentures had been performed. On the other hand, the reduction in facial height, especially marked in the complete denture wearers and mainly resulting from the settling of the lower denture, clearly reflects

the lack of prosthetic compensation for the resorption of the alveolar processes. The important question arising from the present study is whether the resorption of the alveolar processes and the consequent positional changes of the dentures can be prevented by regular relining of the dentures. The 3-year observations on maxillary immediate dentures by *Johnson* (1964 a, b, c, 1967), would seem to indicate that by early adjustments the positional changes may be minimized. However, a continuous although slight resorption of the maxillary ridge was found in approximately half of the subjects. A comparison of the resorption values in the present samples with findings reported in longitudinal studies, in which frequent corrections of the dentures had been made (*Wictorin*, 1964; *Carlsson* et al., 1967; *Carlsson* and *Persson*, 1967), indicated no appreciable differences during comparable periods of observation. Thus, it would seem likely that despite relining or rebasing of the dentures the resorption of the alveolar processes may continue. Further studies on this problem are in progress.

The present analysis and findings from previous investigations (*Tallgren* 1966, 1967) indicate that the wearing of complete upper and lower dentures may lead to a pronounced reduction in facial height and accompanying changes in sagittal jaw and dental relationships, these changes being closely related to marked resorption of the mandibular process. The maxillary process, on the other hand, seems to be much less affected. The wearing of a complete upper and a partial lower free-end denture may lead to some greater resorption of the maxillary process than the wearing of complete dentures. On the other hand, by preserving a residual natural lower dentition, the risk of a reduction in facial height would seem to be reduced to about half. This in turn, may prevent undesirable changes in the oral environments and in facial and jaw muscular balance, which may be difficult to restore.

From a clinical point of view, the present study further confirms the necessity of regular controls and early adjustments in order to prevent marked positional changes of the dentures and consequent changes in jaw relationship. However, as resorption of the alveolar processes under complete dentures may continue despite prosthetic measures, the rendering edentulous of the lower jaw should be carefully considered.

SUMMARY

The positional changes of complete dentures during 7 years of denture wear were analysed from lateral cephalometric occlusion films of 22 Finnish subjects: 11 provided with complete upper and lower dentures, and 11 with

a complete upper and a partial lower free-end denture. All dentures were of the conventional type. The dentures had not been remade or relined during this period.

In the complete denture group, the lower denture, as measured in the anterior region, had settled by a mean of 6.5 mm during the 7 years and showed a forward displacement of 1.4 mm. The upper denture displayed an upward and forward movement of the anterior part, the means for the 7-year period being 1.7 mm and 1 mm. In the complete upper — partial lower group, the maxillary denture showed a tendency, although not significant, to a greater upward rotation than that noted in the complete denture group. In both samples, the positional changes of the dentures showed great individual variation.

In accordance with the rate of resorption, the positional changes of the dentures were greatest during the first year. The accompanying anterior rotation of the mandible, especially marked in the complete denture group and mainly resulting from the settling of the lower denture, led to pronounced changes in the incisal relationship as well.

The present study confirmed the necessity of regular controls and early adjustments in order to prevent marked positional changes of the dentures and consequent changes in jaw relationship. As such changes are difficult to assess by a clinical examination, roentgen cephalometric records as a control of the treatment are of great value.

It was further pointed out that the rendering edentulous of the lower jaw should be carefully considered.

RÉSUMÉ

CHANGEMENTS DE POSITION DES PROTHÈSES COMPLÈTES
ÉTUDE LONGITUDINALE SUR 7 ANS

L'auteur a analysé au moyen de radiographies céphalométriques de profil faites en occlusion sur 22 sujets finlandais ayant porté des prothèses complètes pendant 7 ans les changements de position de ces prothèses au cours de ces 7 années: 11 des sujets avaient une prothèse complète du haut et une prothèse inférieure partielle à extension, les 11 autres avaient des prothèses complètes du haut et du bas. Toutes les prothèses étaient du type classique. Les prothèses n'avaient été ni refaites ni rebasées pendant cette période.

Dans le groupe des prothèses complètes haut et bas, la prothèse inférieure, au cours de la période de 7 ans, et suivant les mesures faites dans la région antérieure, se tassait de 6,5 mm en moyenne et présentait un déplacement

de 1,4 mm vers l'avant. La prothèse supérieure présentait un déplacement de la partie antérieure vers le haut et vers l'avant dont les moyennes pour la période de 7 années étaient de 1,7 mm et de 1 mm. Dans le groupe des prothèses complètes du haut et partielles du bas, la prothèse supérieure présentait une rotation vers le haut qui tendait à être plus marquée que celle trouvée dans le groupe des prothèses complètes haut et bas, mais cette tendance n'était pas significative. Dans les deux échantillons, les changements de position des prothèses présentaient de grandes variations individuelles.

De même que le degré de résorption, les changements de position des prothèses étaient plus marqués pendant la première année. La rotation antérieure de la mandibule qui avait lieu en même temps, particulièrement marquée dans le groupe des prothèses complètes haut et bas et résultant principalement du tassement de la prothèse inférieure, déterminait également une altération marquée dans les rapports incisifs.

La présente étude a confirmé la nécessité d'effectuer des contrôles réguliers et de faire dès les premiers temps des corrections afin d'empêcher des altérations marquées dans les rapports entre les maxillaires. Etant donné que ces altérations sont difficiles à évaluer à l'examen clinique, les clichés radiographiques céphalométriques sont d'une grande valeur pour le contrôle du traitement.

L'auteur souligne encore que l'édentation totale de la mâchoire inférieure ne doit être envisagée qu'après mûre réflexion.

ZUSAMMENFASSUNG

STELLUNGSVERÄNDERUNGEN VON VOLLPROTHESEN
EINE 7-JÄHRIGE UNTERSUCHUNG

Die Stellungsveränderungen von Vollprothesen wurden über 7 Jahre hinaus mit Hilfe von lateralen cephalometrischen Okklusionsaufnahmen bei 22 finnischen Personen untersucht: Elf dieser Personen trugen eine Vollprothese sowohl im Ober- wie im Unterkiefer, die anderen elf eine Volprothese im Oberkiefer und eine partielle Freiendprothese im Unterkiefer. Alle Prothesen wurden nach konventioneller Methode hergestellt. Keine der genannten Prothesen wurde während dieser Zeit rebasiert oder auf andere Weise verändert.

In der Gruppe mit Vollprothese im Ober- und Unterkiefer war die untere Prothese in der anterioren Region durchschnittlich 6.5 mm während der sieben Jahre abgesunken und gleichzeitig um 1.4 mm nach vorwärts dis-

plaziert. Die oberen Prothesen wiesen eine aufwärts und vorwärts Rotation des anterioren Teiles um durchschnittlich 1.7 mm bzw. 1 mm.

In der Gruppe mit Vollprothese im Oberkiefer und partielle Prothese im Unterkiefer hatte die obere Prothese eine Tendenz, obwohl nicht signifkant, zu einer stärkeren Aufwärts-Rotation als in der anderen Gruppe. In beiden Gruppen waren die Stellungsveränderungen der Prothesen von grosser individueller Variation.

In Übereinstimmung mit dem Resorptionsgrad waren die Stellungsveränderungen der Prothesen am grössten während des ersten Jahres. Die aufwärts Rotation des Unterkiefers, welche in der Totalprothesengruppe besonders bemerkbar war, und die hauptsächlich eine Folge des Absinkens der unteren Vollprothese war, führte auch zu merkbaren Veränderungen der inzisalen Relationen.

Die gegenwärtige Untersuchung bestätigt die Notwendigkeit regelmässiger Kontrollen und frühzeitiger Korrektionen um Stellungsveränderungen der Prothesen und den damit verbundenen Veränderungen der Kieferrelationen vorzubeugen. Da es schwierig ist, solche Veränderungen bei einer klinischen Untersuchung zu beobachten, ist eine röntgencephalometrische Kontrolle sehr wertvoll.

Es wurde weiter darauf hingewiesen, dass die Totalextraktion im Unterkiefer nur nach sorgfältiger Überlegung vorzunehmen ist.

REFERENCES

Björk A., 1960: The relationship of the jaws to the cranium. In Lundström, A. (ed.): Introduction to Orthodontics. McGraw-Hill, New York.

Björk A. & B. Solow, 1962: Measurement on radiographs. J. dent. Res., *41:* 672.

Brigante R. F., 1965: A cephalometric study of the settling and migration of dentures. J. prosth. Dent., *15:* 277.

Carlsson G. E., B. Bergman & B. Hedegård, 1967: Changes in contour of the maxillary alveolar process under immediate dentures. Acta odont. scand. *25:* 1.

Carlsson G. E. & G. Persson, 1967: Morphologic changes of the mandible after extraction and wearing of dentures. Odont. Revy, *18:* 27.

Johnson K., 1964a: A study of the dimensional changes occurring in the maxilla after tooth extraction. Part II. Closed face immediate denture treatment. Aust. dent. J., *9:* 6.

—»— 1964b: Part III. Open face immediate denture treatment. Aust. dent. J., *9:* 127.

—»— 1964c: Part IV. Interseptal alveolectomy and closed face immediate denture treatment. Aust. dent. J., *9:* 312.

—»— 1967: A three-year study of the dimensional changes occurring in the maxilla following immediate denture treatment. Aust. dent. J., *12:* 152.

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

—»— 1966: The reduction in face height of edentulous and partially edentulous subjects during long-term denture wear. Acta odont. scand., *24:* 195.

—»— 1967: The effect of denture wearing on facial morphology. Acta odont. scand., *25:* 563.

Wictorin L., 1964: Bone resorption in cases with complete upper denture. Acta radiol.(Stockholm), suppl. 228.

Address:
The Royal Dental College,
Jagtvej 160,
Copenhagen, Denmark