Studies of Severe Upper Jaw Defects.

By

AUNE YLPPÖ.

The author's previous investigations into various causes of jaw defects and their prosthetic treatment in the light of oscillographic-analytical studies have been published in Suomen Hammaslääkäriseuran Toimituksia, Acta Odont. Scand. and, more recently, in the Skandinavisk Tandlægeforenings 28. Kongres publication. The first paper of this series treats of cases of congenital cleft palate; the subsequent publications are concerned with cases of simple, minor or major, upper jaw acquired defects, where an abnormal connection has occurred from the oral into the nasal cavity. These papers also include the related general surveys and classifications of ordinary maxillary reactions. In this respect specific reference is made to the author's most recent publications.

The Material and its Treatment.

The material of the present investigations comprises difficult and complicated cases of upper jaw defects, all of them war-disablements. These investigations aim at throwing light on the application of peripheral resection prostheses in severe cases of defect, *i. e.* on the achievements of previous investigations, constructed according to medico-phonetical principles.

The question of the fixing and attachment of resection prostheses which has also received wide attention in the literature lately (*e. g.* ENGSTRÖM) does not come within the scope of the

present investigations. It has been mentioned separately only in connection with each case.

The method of investigation is, in the main, similar to that employed in the author's previous studies; the only difference is that in every case the patient's speech has been recorded during the test, both without and with the prosthesis under test. The voice has thus been preserved for posterity. The recording has been effected by Messrs. Rytmi Oy. Subsequent phonetical investigation of the cases and the mathematical calculations have been carried out at the Institute of Phonetics, Helsinki University, under the direction of Professor SOVIJÄRVI, whose "formant method" has been applied in these severe special cases deviating from the normal.

The prostheses were made in the Prosthetic Department of the Red Cross Hospital for War Disabled in compliance with the author's instructions. Case No. 2 is a private patient.

Case No. 1.

Lieutenant A. A., 36 years of age; war disabled. Diagnosis: Defect. sclop. max. subtol. 1 amb.

Case history: Wounded on August 31st, 1941. The bullet penetrated from behind the right jaw angle and exploded in the mouth, destroying the entire external portion of the upper jaw, upper lip and the left side of the nose. One eye lost its sight. Operated on 26 times (Professor FALTIN and Dr. SOIVIO), the majority of the operations involving plastic surgery. In addition to surgical treatment the patient received various prostheses in order to lift and stretch the soft parts and to prevent excessive contraction of the cicatrized tissues. In the Autumn of 1943 the patient received the final upper jaw prosthesis with teeth, fitted with a large obturator completely filling the defect. Seen through the nostril the nasal cavity is completely blocked by the prosthesis, and the patient has respiratory difficulties. Because of the heavy weight of the prosthesis (54 grammes) its posterior part continually slipped out of position, despite several attempts to lighten it with a cotton wool packing or cork, or to make it otherwise hollow. The patient wishes to have the prosthesis renewed. Without it he suffers difficulties in eating, and speech is indistinct.

Status praesens: Health and nutrition good. Constitution normal, slim. The face gives the impression of being shortened and

collapsed in the middle (See Fig. 4). The lower lip fully normal. The upper lip is formed of a rigid chest grafting tissue, its mobility is limited and labial opening consequently rather small, not elastic. Cicatrized tissue on both sides of the nose. The nose itself sunk down. Direct connection between the nostrils and the oral cavity. Intra-oral examination reveals complete absence of anterior and central part and alveolar process on both sides of the

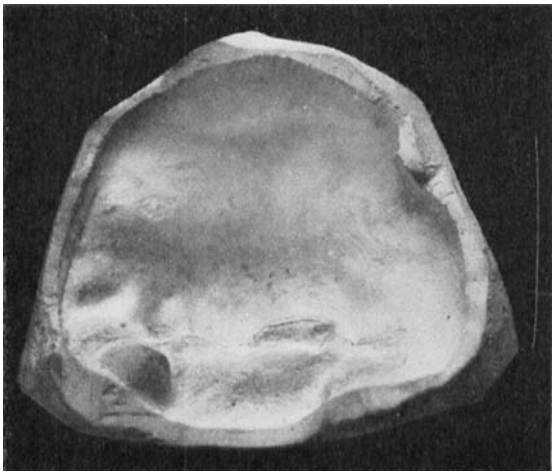


Fig. 1.

palate. The defect extends dorsally almost to the midline of the soft and hard palate, only a narrow strip and tubers being left of the hard palate (Fig. 1). Velum intact, mobility normal.

In addition, the absence of the anterior part of the vomer can be detected through the opening, the lower nasal conchae being visible. Strips of mucous membrane running bridgelike from the right at the rear of the vomer to the right-hand concha. The mucous membrane is livid red in colour. On the left side of the tongue are two transverse scars; however, mobility is good. Only + 7 remains of the upper jaw teeth. Of the lower jaw teeth only 6— and 2— are missing.

Resection prosthesis: The impression was made by means of the old prosthesis and black gutta-percha. Bite impression and arrangement of the teeth (cross bite) according to normal procedure. The prosthesis was given the shape of a normal palate and the part corresponding to the defect was built up peripherally

only; only the gingival wall rises up and leans firmly against the edges of the defect, the cavity itself remaining completely free. The fixing of the prosthesis is effected with the aid of the small

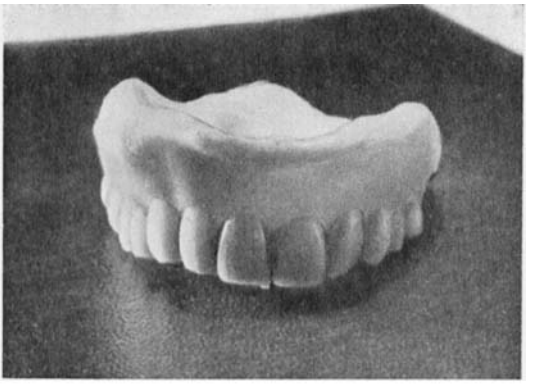


Fig. 2.

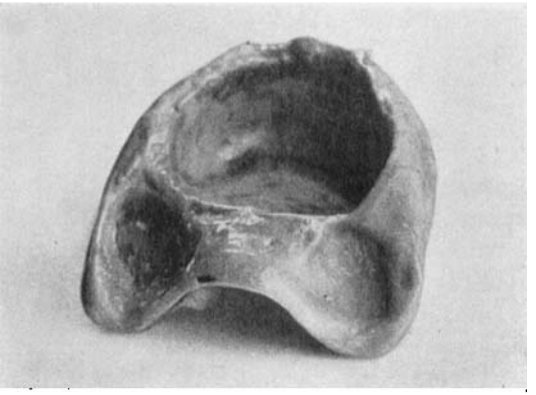
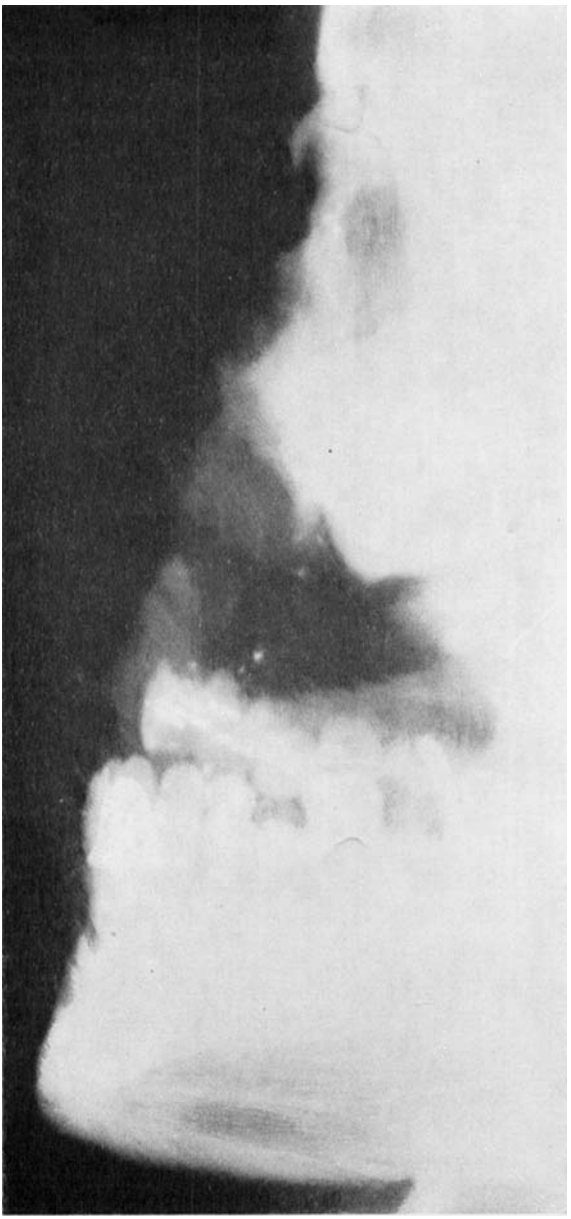


Fig. 3.

extensions supported from inside the nose on the external nostrils together with a steel wire clasp bent round + 7. The prosthesis as a whole is the simplest possible, made of paladon and weighing only 23 grammes (Fig. 2 and 3).

The patient finds the prosthesis comfortable, breathing and speaking are easy and speech sounds normal. Intake of tough and



The X-ray picture taken from the side with the prosthesis in position. X-rays penetrate the paladon so that only the teeth are visible in the prosthesis. Only black shadowing is in the region of the destroyed upper jaw.

solid food is fairly difficult, but that of soft easy. The patient's appearance is considerably improved (cf. Fig. 4 and 5).

Follow-up examination, $1^1/_2$ years later. The prosthesis has functioned well. Only in the evenings the patient has a very dry feeling in his mouth if he throws his head back or lies down.

Fig. 4. Without prosthesis.

Fig. 5. With prosthesis.

No pressure points. The clasp tooth has become detached but the prosthesis remains in position, serviceable. Breathing is easy, speech good and fluent.

Recording by Rytmi Oy. on January 5th, 1946
a) without prosthesis, b) with prosthesis;

m oscillograms at the Institute of Phonetics
a) without prosthesis, b) with prosthesis.

Tables 7 a and b show calculations made at the Institute of Phonetics. The results achieved have been adapted to sound analysis No. 8 without prosthesis and No. 9 with prosthesis.

Fig. 6 has been included in order to facilitate understanding of the analyses.

Examination and Explanation of Results of the Analyses.

R, the formant of the pharyngeal cavity (5th—6th partial tone) has become lowered without prosthesis on account of the palatal defect, the patient having instinctively raised the anterior dorsum of his tongue in order to enable the formant of the oral

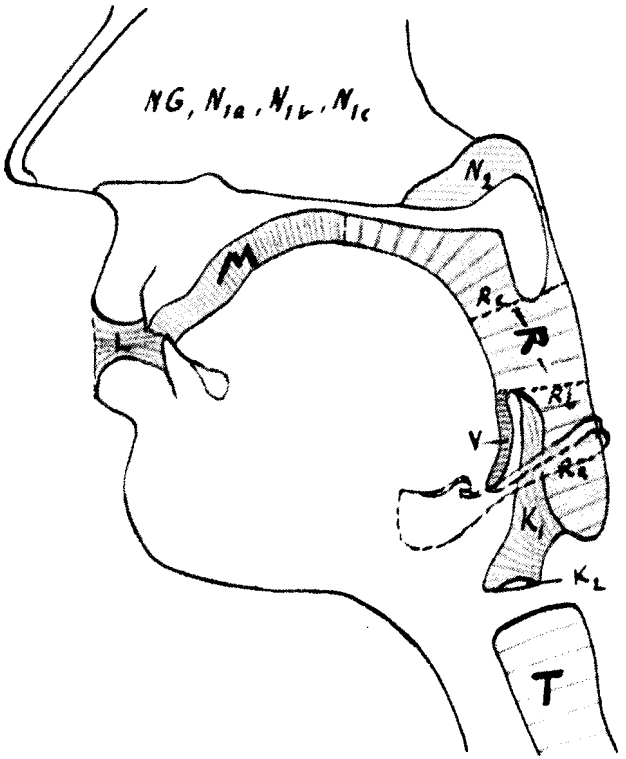


Fig. 6. The picture indicates the location of different formant cavities, of which only the suprapalatal and others situated above the larynx are of importance in odontological investigations. (The picture is adapted from Professor Sovijärvi's "Die gehaltenen etc".).

cavity, *i. e.* M, to rise to the correct height. M is the most important formant as regards acoustic colour. This results in the anterior opening (the midline opening of the pharyngeal and oral cavities) decreasing in size, with a lowering effect on the specific tone of the pharyngeal cavity. (In conformity with acoustical laws the diminishing of the resonator opening brings about lowering of the resonance.) Despite this reduction of the anterior open-

Table 7 a.

$\mu^0 =$	$\Sigma +$	$\Sigma -$	a = $\Sigma(+)-\Sigma(-)$	$\Sigma' +$	$\Sigma' +$	b = $\Sigma' +(-)\Sigma'(-)$	$\mu = \sqrt{a^2+b^2}$	%	Hz	Form.
1	300	287	13	258	317	59	60	68	87	B
2	306	275	31	285	274	11	34	39	174	
3	303	241	62	292	301	9	63	72	261	T RN2
4	281	285	4	276	314	38	38	43	348	RM
5	324	238	86	233	343	10	88	100	435	R
6	259	314	55	276	292	16	58	66	522	
7	279	301	22	316	292	24	33	38	609	Ra
8	261	308	47	282	303	21	53	60	696	Rb
9	279	289	10	269	304	35	37	42	783	
10	298	306	8	261	273	12	14	16	870	
11	289	286	3	292	289	3	4	5	957	
12	270	305	35	279	283	4	36	41	1044	Rc
13	293	287	6	285	287	2	6	7	1131	
14	282	285	3	291	292	1	3	3	2118	
15	232	219	13	231	219	12	18	21	1305	
16	272	295	23	294	289	5	24	27	1392	N2
17	296	284	12	283	294	11	16	18	1479	
18	287	287	0	279	283	4	4	5	1566	
19	292	283	9	295	284	11	14	16	1653	
20	285	319	34	268	266	2	34	39	1740	M
21	289	279	10	293	292	1	10	11	1827	
22	285	284	1	294	291	3	3	3	1914	
23	294	280	14	294	286	8	16	18	2001	
24	276	297	21	282	286	4	21	24	2088	NG
25	289	263	26	289	273	16	31	35	2175	
26	268	298	30	293	297	4	30	34	2262	N1a
27	279	265	14	302	291	11	18	21	2349	
28	274	307	33	287	289	2	33	38	2436	
29	298	289	9	275	288	13	16	18	2523	N1b
30	451	450	1	0	0	0	1	1	2610	

Curve: *m* (*vasemman*) Without prosth. Fundamental tone: 87 Hertz.
Reckoned: R. Haltsonen. Date: 27. 2. 47.

ing, the formant Rc of the partial cavity of the pharyngeal cavity has been able to retain its normal pitch on account of the simultaneous contraction in the cubic capacity of the RC cavity.

M, the formant of the oral cavity (19th—20th partial tone) has remained normal without prosthesis, as regards this tone, owing to the instinctive raising of the back of the tongue. It has thus caused contraction in the volume of the M cavity and at the same time diminution of the posterior opening, and they are consequently able jointly to compensate for the increase in volume caused by the palatal defect. It has not been possible, in general, to produce this compensation movement in other cases investigated by the author, and the M formant has risen, as a consequence, by approximately 1—2 partial tones.

R (6th—7th partial tone) has risen to normal height on account

Table 7 b.

$\mu^0 =$	$\Sigma+$	$\Sigma-$	a = $\Sigma(+)-\Sigma(-)$	$\Sigma' +$	$\Sigma' -$	b = $\Sigma'(+)-\Sigma'(-)$	$\mu = \sqrt{a^2+b^2}$	%	Hz	Form.
1	208	205	3	202	181	21	21	28	85	B
2	223	196	27	201	181	20	34	45	170	RN2
3	217	195	22	185	193	8	24	32	255	T
4	216	184	32	198	204	6	33	44	340	RM
5	195	196	1	190	212	22	22	29	425	
6	229	179	50	166	217	51	75	100	510	R
7	172	229	57	193	207	14	60	80	595	Ra
8	195	210	15	200	196	4	16	21	680	Rb
9	199	201	2	197	194	3	4	5	765	
10	215	216	1	184	185	1	1	1	850	
11	202	201	1	200	199	1	1	1	935	
12	201	204	3	193	192	1	4	5	1020	Rc
13	202	200	2	199	200	1	2	3	1105	
14	201	200	1	196	199	3	3	4	1190	
15	156	156	0	158	161	3	3	4	1275	
16	196	200	4	198	197	1	4	5	1360	N2
17	202	200	2	201	198	3	4	5	1445	
18	201	204	3	193	192	1	3	4	1530	
19	204	199	5	199	190	9	10	13	1615	M
20	210	221	11	183	186	3	11	15	1700	
21	200	200	0	193	198	5	5	7	1785	
22	202	203	1	197	199	2	2	3	1870	
23	203	198	5	198	202	4	6	8	1955	NG
24	200	208	8	190	193	3	9	12	2040	
25	198	194	4	205	187	18	19	25	2125	N1a
26	196	204	8	200	202	2	8	11	2210	
27	208	204	4	189	189	0	4	5	2295	
28	206	213	7	191	191	0	7	9	2380	N1b
29	207	206	1	190	193	3	3	4	2465	
30	312	319	7	0	0	0	7	9	2550	

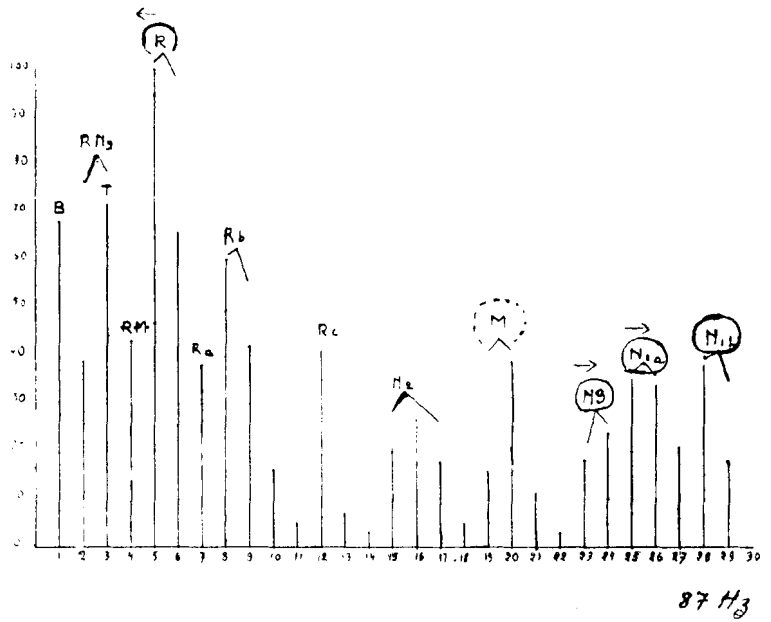
Curve: *m* (*vasemman*) With prosth. Fundamental tone: 85 Hertz.
Reckoned: R. Haltsonen. Date: 20. 2. 47.

of the prosthesis. The formant, Rc, of the partial cavity of the pharynx has remained unchanged although the anterior opening of the pharynx has expanded since the dorsum of the tongue is now lowered, no longer being obliged to compensate by its movements the effect of the defect of the M cavity. The prosthesis now closes the defect and the M formant is consequently of normal height too.

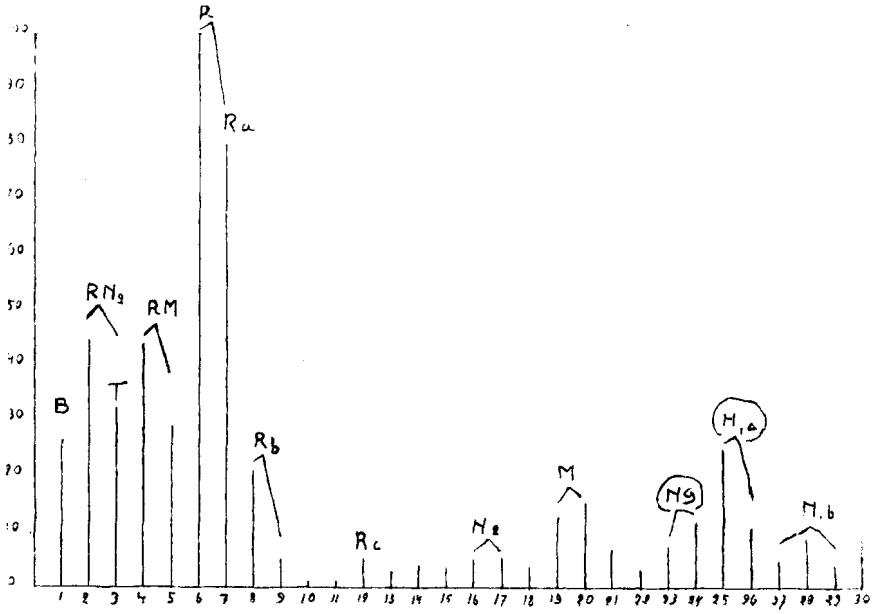
N_2, the formant of the naso-pharyngeal cavity (15tb—17th partial tone) is normal, both with and without prosthesis. The mobility of the velum is normal.

NG, the formant of the joint nasal passage (23rd—24th partial tone) has risen. *In the absence of the anterior nasal septum* the NG cavity itself has diminished and become shortened while the resonance has risen in accordance with acoustical laws. On account

In order to facilitate interpretation, abnormal formants have been supplied with a circle in all following analyses.



Analysis No. 8.
Case No. 1 m (vasemman) Without prosthesis.



Analysis No. 9.
Case No. 1 m (vasemman) With prosthesis.

of the missing anterior nasal septum a new, fairly low cavity has been formed at the same time in the front. The height of its resonance is difficult to estimate; it seems, however, to have no considerable influence. The NG formant remains unchanged, even with the prosthesis applied, as the latter has no effect whatever, in this case, on the volume of the contracted NG cavity. It is still difficult to ascertain the resonance of the new cavity which has originated in front of the NG cavity on account of the missing nasal septum.

N_{1a}, the formant of the lower nasal passage (25th—26th partial tone) has risen without prosthesis. On account of the origination of a new opening due to the palatal defect the resonance has risen in accordance with acoustical laws. The prosthesis does not seem to have appreciably affected the height of this formant either. It is true that the volume decreases because of the prosthesis, but the opening of the joint nasal passage diminishes at the same time and the situation remains unchanged.

N_{1b}, the formant (27th—29th partial tone) of the medial nasal passage is of normal height, both with and without prosthesis.

N_{1c}, the formant of the superior nasal passage is not visible in the analyses. It is higher than the 30th partial tone. The analysis only covers a height of about 2,500—2,600 Hz, but should extend to a height of 2,800—3,000 Hz to make N_{1c} visible. On the basis of previous investigations it has, however, already been ascertained that the height of the N_{1c} formant is never affected by the palatal defect. In all the nasal formants, N_2, NG, N_{1a} and N_{1b}, the relative intensity is found, however, to have been lowered by the prosthesis to the extent that the pathological strength of the nasal resonances due to the palatal defect has fallen by over 50 per cent, and the nasality is usually no longer present in speech.

Summary:

A case of jaw defect due to war injury has been described above. The entire anterior and medial portions of the palate are missing on both sides up to the midline of the soft and hard palate. The anterior nasal septum also has been destroyed. There is a direct connection from the external nostrils to the oral cavity. The sound-pathological situation caused by this jaw defect has been analysed.

A peripheral prosthesis, made in conformity with medico-phonetical principles, substituting the missing jaw portion as

well as closing the caused defect by separating the nasal cavity from the oral cavity is able to improve satisfactorily the sound-pathological situation. The slight additional improvement in sound (in the formants of the NG and N_{1a} cavities) which would be effected by building a partition in the prosthesis on the corresponding site to replace the destroyed nasal septum, does not justify the procedure as it would involve a deterioration in hygienic conditions. It would result in several small cavities in the prosthesis which is, on the whole, fairly neat — the distance of the bicuspids (5 + and + 5) being only about 3.2 centimetres, as calculated from the palatal surfaces. These cavities would be difficult to keep clean on account of the mucus accumulating in them. Further, this artificial partition might chafe the soft parts of the nose during the various bite movements of the prosthesis.

Case No. 2.

Lieutenant O. J. H., aged 29; war disabled. Diagnosis: Defect. bomb. max. part. 1 dextr.

Case history: Wounded in June, 1944. The right cheek was penetrated by a shell fragment which destroyed a part of the upper jaw lodging in the left corner of the jaw. Several operations performed (Professor KIVIMÄKI). A large defect remained in the palate. Difficulties during speech and intake of food, which are, however, relieved when the patient holds a large gauze pack in his mouth.

Status praesens: General condition good. Slender constitution. Small facial scars in the right cheek and the left jaw corner. Lips full and mobile. Intra-oral examination reveals a partial defect in the right palate and alveolar process extending from behind the canine tooth backwards to the tuber and medially to the median line (Fig. 10 a). Open connection from the oral cavity to the right-hand nasal and buccal cavities. Some of the fatty tissue of the cheek protrudes from the lateral wall of the buccal cavity. The septum nasi is intact, the nasal conchae are visible. A resected piece, about 2 centimetres in length, is missing in the middle of the inferior concha on the damaged side. Choana is seen dorsally through the opening. Velum intact and its mobility normal. Tongue normal. Slight anchylosis; left mandibular joint stiff. Opening capacity of mouth about 2.5 centimetres.

Tooth scheme: $\frac{321}{54321} \mid \frac{12345}{12345.7}$

Resection prosthesis: Impression with Kerr's compound. The technical preparation of the prosthesis (3/—, fixation with bent steel wire clasps round 3 + and + 5) in its different stages pro-

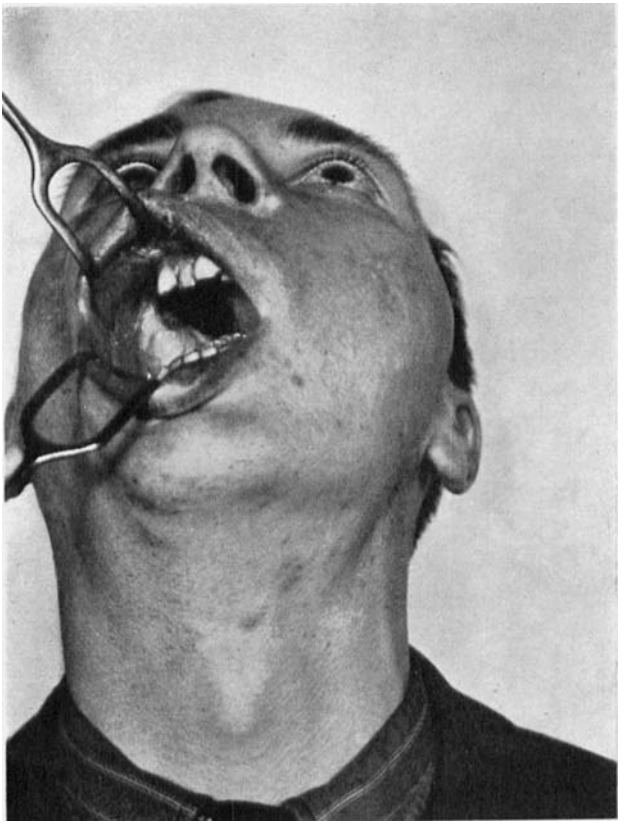


Fig. 10 a. Without prosthesis.

ceeds in the normal way. The prosthesis follows the shape of a normal palate, the defect is covered closely but not completely filled by the palatal and alveolar process parts, leaving the intercommunicating buccal and nasal cavities free (the weight of the prosthesis, made of caoutchouc, is 20 grammes; Fig. 10 b and 11). — The patient finds the prosthesis comfortable, difficulties in

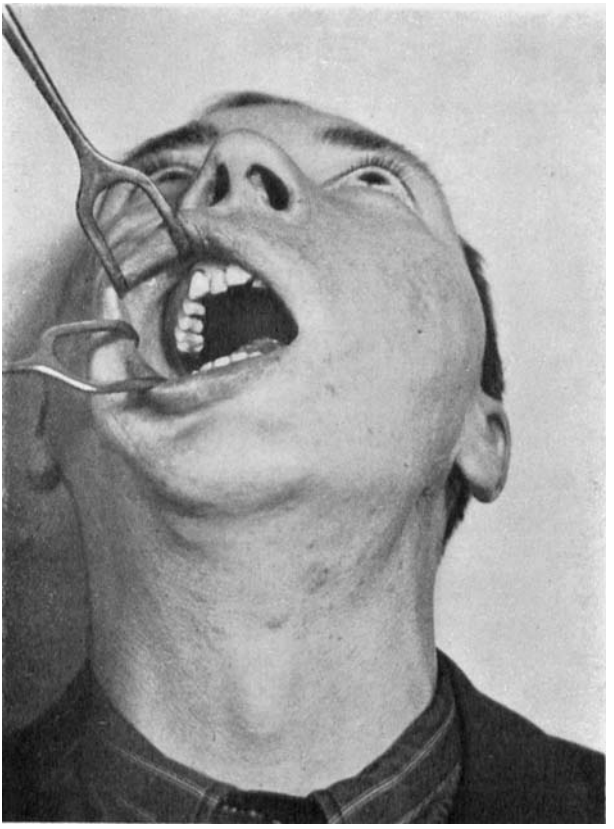


Fig. 10 b. Prosthesis in situ.

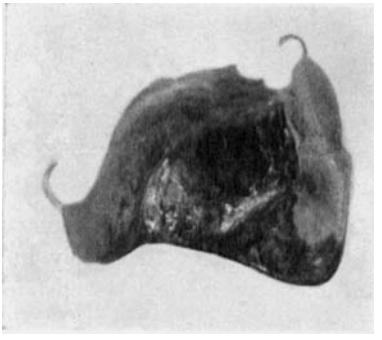


Fig. 11. Prosthesis seen cranially (without the obturator part).

eating disappear. Speech is also easy and fluent, the nasality can no longer be detected aurally.

For sound tests the prosthesis is fitted temporarily, for duration of the tests only, with a wax pack, about 2 centimetres high, filling the defect of the nasal cavity for the most part but not the

Fig. 12 a. Prosthesis with test-obturator attached.

Fig. 12 b. Obturator part separately; natural size.

side of the buccal cavity (Fig. 12 a and b). The aim is to substitute the resected portion of the concha.

Recording performed by Rytmi Oy. on October 30th, 1946

1) without prosthesis, 2) with prosthesis + obturator, 3) with prosthesis

o and m oscillograms at the Institute of Phonetics

1) without prosthesis, 2) with prosthesis + obturator, 3) with prosthesis.

Examination and Explanation of Results of the Analyses.

Table 13, showing the vibration frequency figures and sound analyses 14—19.

M, the formant of the oral cavity is higher than normal for a vowel without prosthesis on account of the defective opening of the palate. Owing to the prostheses the M formant has been lowered to normal in both cases. Both prostheses create a whole palate.

Rc, the formant of the partial cavity of the pharyngeal cavity (situated below the velum and extending to the anterior border of the pharyngeal cavity) has risen in nasal sounds without prosthesis on account of the defect opening. Ra and Rb, the formants

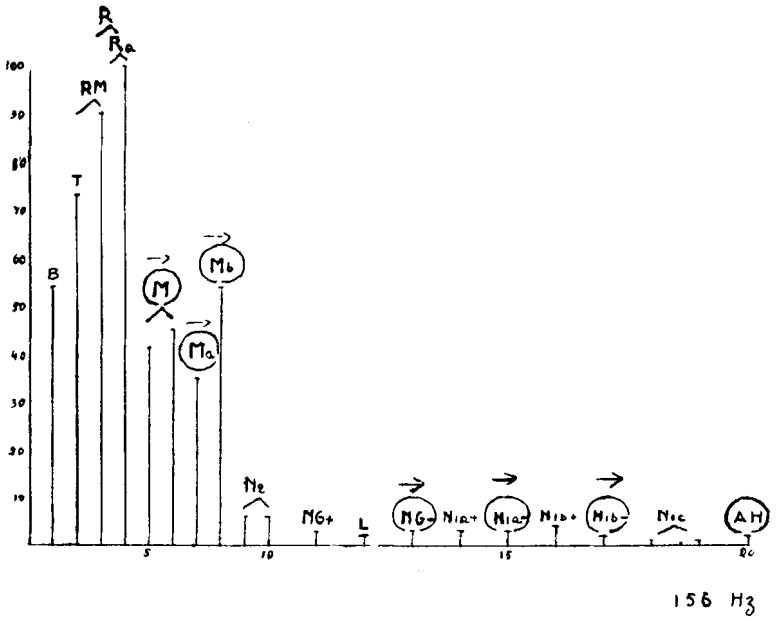
Table 13.

For-mants	Without prosthesis		Prosthesis + Obturator		Prosthesis without obt.	
	o (sota) 156 Hz	(e) m 105 Hz	o (sota) 140 Hz	(e) m 98 Hz	o (sota) 135 Hz	(e) m 98 Hz
RN_2		210—315		196—294		196—294
RM	312—468	315	280—240	294	270—405	294
R	468—642	420	240—560	392—490	405—540	392
Ra	642	525—630	560—700	588—686	540—675	490—588
Rb		735—840		794—882		686—784
Rc		945—1050		980—1078		882—980
M	780—936	1155	700	1176	675—810	1176
Ma	1092	1260	980	1372	945—1080	1274
Mb	1248	1575	1120—1260	1568	1215—1350	1568
N_2	1404—1560	1365	1400—1540	1666—1764	1485	1372—1470
NG	1710 (NG–2028)	1785 (NG–1995)	1680	1862	1620—1755 (NG–2025)	1862 (NG—1960—2058)
N_1a	2184 (N_1a–2340)	2205 (N_1a–2310)	2240 (N_1a–2380)	2156 (N_1a–2254)	2160—2295 (N_1a–2430)	2156 (N_1a–2352)
N_1b	2496 (N_1b–2652)	2415 (N_1b–2520)	2520 (N_1b–2660)	2548 (N_1b–2646)	2565 (N_1b–2700)	2548 (N_1b–2646)
N_1c	2808—2964	2730—2835	2800	2940	2970	
AH	3120	3045—3150	3080—3220		3240—3375	

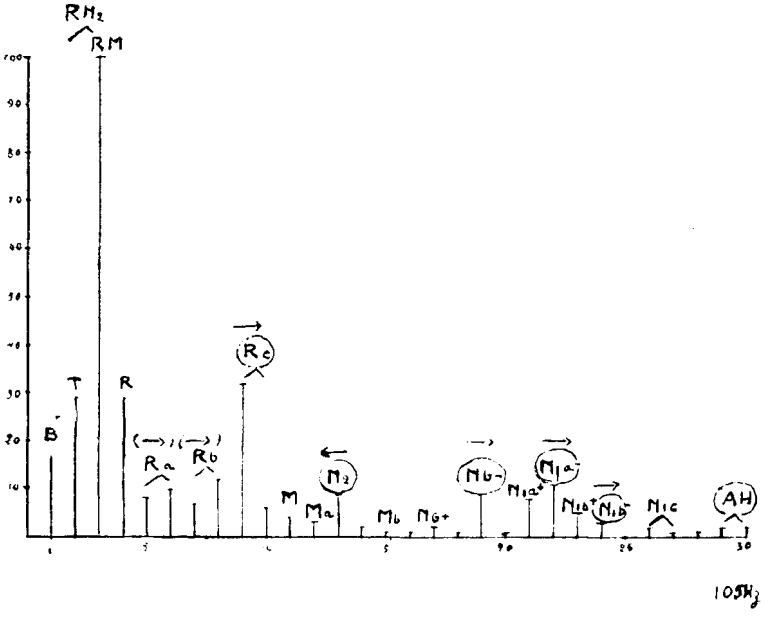
Case No 2. Vibration frequency figures of the various formants, or Hz. (NG- N_1a- and N_1b- denote the formants of the defect side.)

of the pharyngeal part cavities also seem to have risen slightly in nasal sounds without prosthesis. The effect of the defect opening appears thus to extend over one more cavity. Owing to the effect of the prosthesis Ra, Rb and Rc become normalised in a non-obturator case. The obturator causes, on the other hand, the rising of all formants of the pharyngeal cavity. The velum is lowered more than usual in order to enable the intake of more air in the nose for nasal sounds to compensate for the obstructing effect of the obturator on the defect side. To this is due the contraction in volume of the cavities concerned and the corresponding rising of the respective formants.

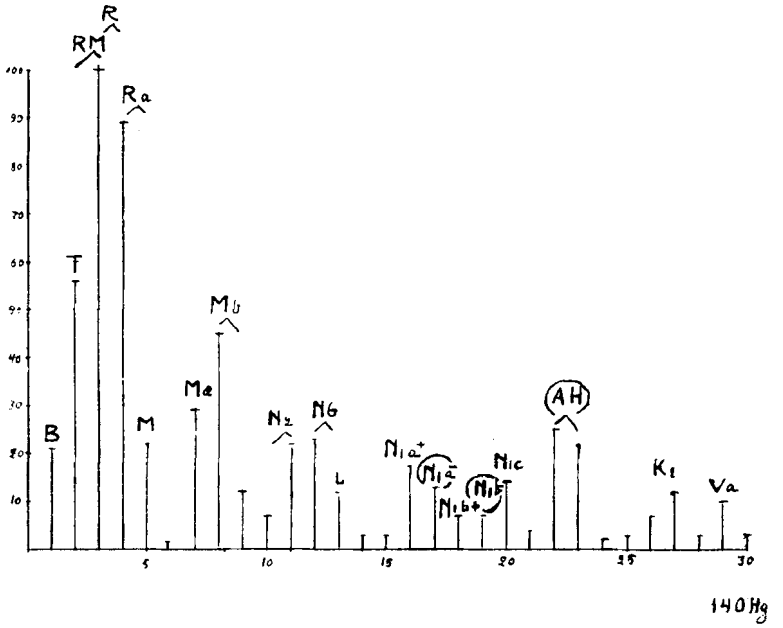
N_2, the formant of the naso-pharyngeal cavity has been lowered without prosthesis because the lower opening of the cavity is smaller than normal. The patient raises his velum in order to prevent the passage of superfluous air in the nasal cavity, and the lower opening of the naso-pharyngeal cavity diminishes in consequence. This is the only means of regulating the passage of air into the nasal cavity; too much air flows into the nose in any case, without prosthesis, on account of the palatal defect opening.



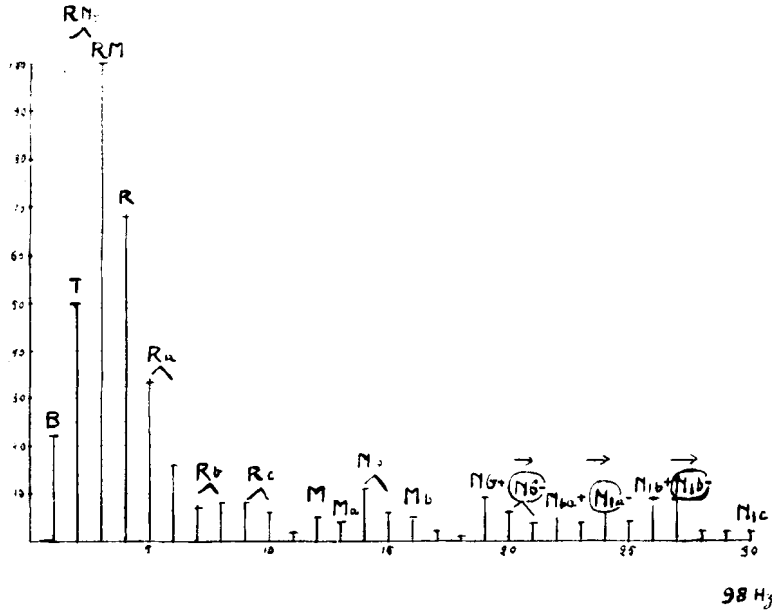
Analysis. No 14.
Case No. 2 o (sota-) Without prosthesis.



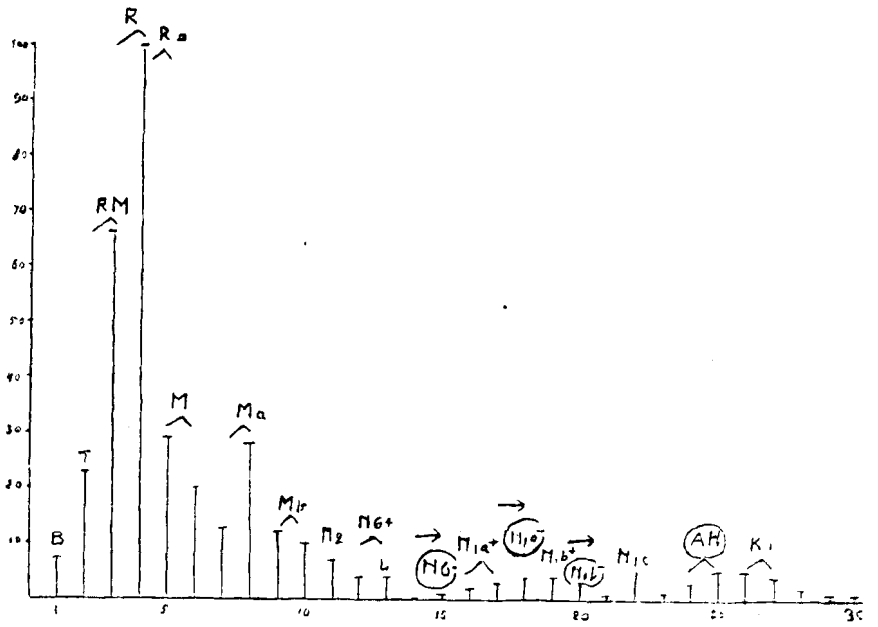
Analysis No. 15.
Case No. 2 m (vasempaan) Without prosthesis.



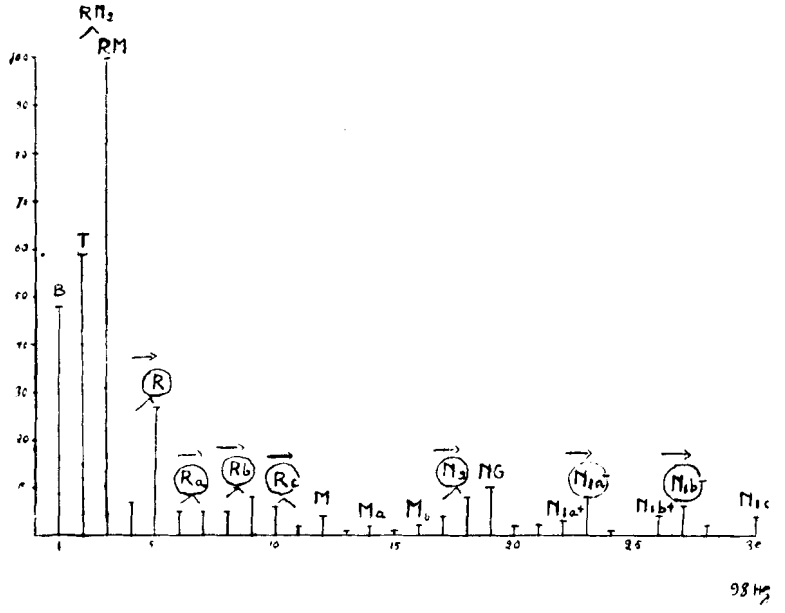
Analysis No. 16.
Case No. 2 o (sota-) Prosthesis with obturator.



Analysis No. 17.
Case No. 2 m (vasempaan) Prosthesis with obturator.



Analysis No. 18.
Case No. 2 o (sota-) Prosthesis without obturator.



Analysis No. 19.
Case No. 2 m (vasempaan) Prosthesis without obturator.

N_2 has risen owing to the presence of the prosthesis. In an obturator case it is appreciably higher than normal and also higher than in a non-obturator case as a consequence of the lower opening of the naso-pharyngeal cavity being larger, due to the lower location of the velum in order to allow for an ampler intake of air with the obturator now acting as an obstruction.

NG, the formant of the joint nasal passage has risen on the defective side in the absence of prosthesis on account of the defect opening in the lower region of the cavity. Compared with the corresponding formant on the healthy side it has risen about 300—200 Hz. NG has been lowered by the prosthesis. On account of *the additional opening caused by the lowest resected concha* (See Case history) NG is, however, higher on the defect side in the non-obturator case than in the presence of an obturator.

N_{1a}, the formant of the lower nasal passage has also risen on the defect side. On account of the prosthesis it has been lowered on the defect side in an obturator case. The posterior opening of the lower nasal passage, and its volume, have contracted because of the obturator, although the effect of the volume contraction is not as considerable as that of the diminution of the posterior opening.

N_{1b}, the formant of the medial nasal passage has also risen, without prosthesis, on account of the defect opening. Attention must be paid, further, to the partial resection of the lowest nasal concha, which also involves the increasing of the opening downwards of the nasal passage. As an effect of the prosthesis N_{1b} is higher on the side of the defect opening than on the healthy side, as the obturator also reduces slightly the volume of the medial nasal passage (the obturator extends as far as that, though this was by no means the original intention). In a non-obturator case the opening of the medial nasal passage has expanded downwards (the resected lowest concha) with a similar effect.

N_{1c} is of normal height without prosthesis, even on the defect side. The effect of the openings does not extend there. N_{1c} is of normal height also when articulation takes place in the presence of a prosthesis.

AH, the formant of the buccal cavity, normally non-existent, now appears on the defect side without prosthesis because of the opening up of the buccal cavity. The number of vibrations is 3,045—3,150 Hz. AH also appears in both cases when articulating with prosthesis. In the obturator case the lateral opening is smaller

and the resonance is consequently lower. In a non-obturator case resonance is higher as there is no obturator to reduce the size of the lateral opening.

Prosthetic Conclusions on the Basis of the Analyses.

From the point of view of normal acoustic colour both cases are of equal value as regards the AH formants as there should be no AH resonance. It would have been possible to prevent its appearance had the obturator wall on the side of the buccal cavity completely filled the medial lateral opening of the cavity. However, since the obturator causes, as the analyses reveal, much more numerous and powerful pathological formants when in a wrong position anatomically, the correct solution would be to separate the buccal and nasal cavities from each other by means of a partition. In addition, the missing part of the concha should be fixed to the partition in this case. It is, however, a difficult performance from the technical-prosthetic point of view; besides, possible movements of the prosthesis might damage or rub the soft nasal conchae. AH, *i. e.* the particular shade in the acoustic colour produced by the resonance of the buccal cavity is also so small (the number of vibrations high) that it cannot be heard by ear, and therefore has scarcely any practical significance. This partition can consequently be left out and the resection prosthesis constructed peripherally only. The reader is referred to a similar case analysed by the author (See Aune Ylppö, Hankittujen suulakiaukkojen etc., Case No. 3).

Summary:

The above treats of a case of a right-hand partial defect in palate and alveolar process due to war trauma with both nasal and buccal cavities opening into the mouth; in addition, the lowest nasal concha reveals a corresponding defect of about 2 centimetres. The sound-pathological situation following from this has been analysed. The rôle of the resected nasal concha is also apparent in the analyses. A peripheral covering prosthesis normalises the formants of the oral and pharyngeal cavities, but the slight pathological evidence (in the NG, N_{1a} and N_{1c} formants) due to the resected concha of the defect side, however, still remains visible in the analyses, though without disturbing the

acoustic colour as heard aurally. It was not possible to create a normal situation by means of a defect cavity obturator aiming partly at the compensation of the missing portion of the lowest concha as well and attached for the test occasion to the peripheral cover prosthesis. From the anatomical standpoint the obturator was malplaced, which caused, further, the rising of the formants of the pharyngeal and naso-pharyngeal cavities.

Case No. 3.

Lieutenant I. L., 33 years of age; war disabled. Diagnosis: Defect. sclop. procc. palat. et alveol. l. amb.

Case history: Wounded on September 25th, 1941. Explosive rifle bullet penetrated from the left side of the nose destroying the upper jaw and a part of the right-hand lower jaw with its soft parts, with the result that a large hole of about 4 centimetres appeared in the right cheek. There were two fractures on the left side of the lower jaw. Of the tip of the tongue a portion about 2 centimetres in length was destroyed. After many series of preparatory treatments bearing upon the jaw fractures and the wounds, 25 different operations have been performed on the patient since 1942 (Professor FALTIN). A jaw graft operation was performed in 1943 on the right side of the lower jaw. The patient has also had several preliminary jaw prostheses. His present prosthesis was made in 1944, but fails to remain in position and keeps on slipping. It is very heavy, weighing 49.7 grammes (caoutchouc), and the tongue does not touch it in spite of several caoutchouc ridge additions on the palatal surface of the prosthesis.

In 1946 the patient returned to the Prosthetic Department of the Hospital for War Disabled for a new prosthesis.

Status praesens: General condition good. Constitution normal. Colour of complexion good and healthy. On the left side of the face a scar where the bullet penetrated. On the right side of the cheek a horizontal scar, about 11 centimetres long, beginning from the corner of the mouth and running transversely to the right jaw angle. A second scar runs below the left lower jaw (caused by the jaw grafting operation). The left-hand corner of the mouth has slipped slightly downwards. Inter-oral examination reveals much cicatrized tissue in the buccal mucous membranes, particularly on the right side. The entire hard palate (procc. palatini et alveolares) has disappeared on both sides (Fig. 20). The soft

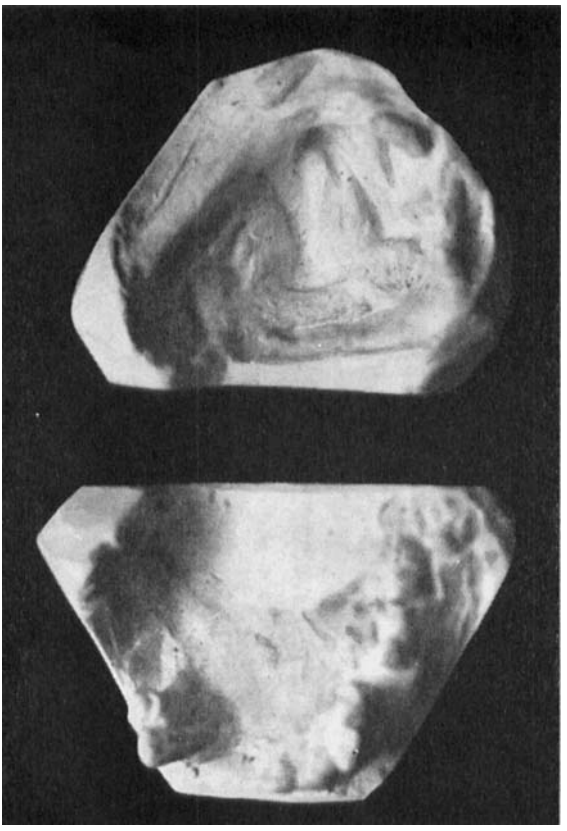


Fig. 20.

palate intact and its mobility normal. Conchae well preserved, the lowest right-hand concha hypertrophic. Conchae inferiores joined in front of the soft velum by a muco-muscular bridge of about $^1/_2$ centimetre in width. On the right also, formation resembling mucous membrane bridge on the right-hand side of the lowest concha.

The tip of the tongue cleft. In the tongue a deep scar running backwards anteriorly from the middle and branching off more forcibly to the right. Mobility of the tongue very weak to begin with, but has shown continuous improvement. The tongue projects about 5 millimetres past the lips and even in this position is very rigid.

Tongue: 

Tooth scheme: 32. . 2345 678

Resection prosthesis: The impression with dentocol. The beginning as usual. Because the mobility of the tongue is relatively limited, it must be ensured, when making the palate and the alveolar process parts of the prosthesis, that the tongue touches it.

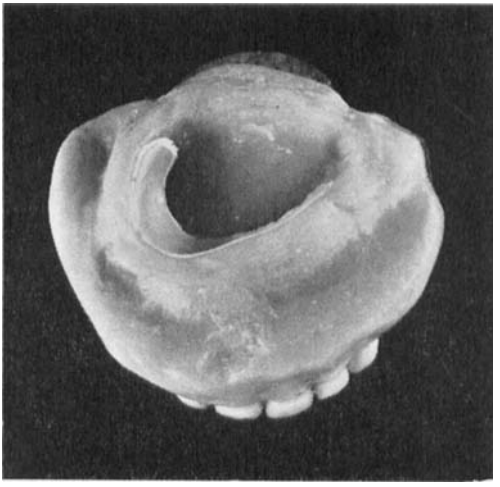


Fig. 21. Prosthesis seen cranially.

In consequence, the prosthesis will have a comparatively thick part corresponding to the anterior part and the alveolar process, which will, however, be hollowed out inside the finished prosthesis later. Towards the mouth the palate is given the form of a normal palate. Towards the nasal cavity the new palate leaves room between the lower conchae and the prosthesis. The latter is supplied with spirals to fix the lower jaw to the prosthesis. The weight of the prosthesis of the upper jaw is 34.4 grammes (paladon). Fig. 21 and 22.

The prosthesis functions comparatively well during eating and speech. S sound is, however, not good, as it is not possible to form a channel in the tongue because of the scar injuries.

Recording on June 6th, 1946, by Rytmi Oy.
a) without prosthesis, b) with prosthesis;
m oscillograms on May 24th, 1947, at the Institute of Phonetics
a) without prosthesis, b) with prosthesis.

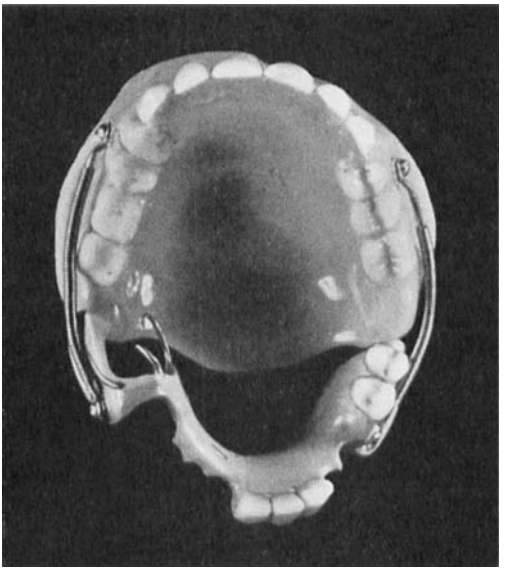


Fig. 22.

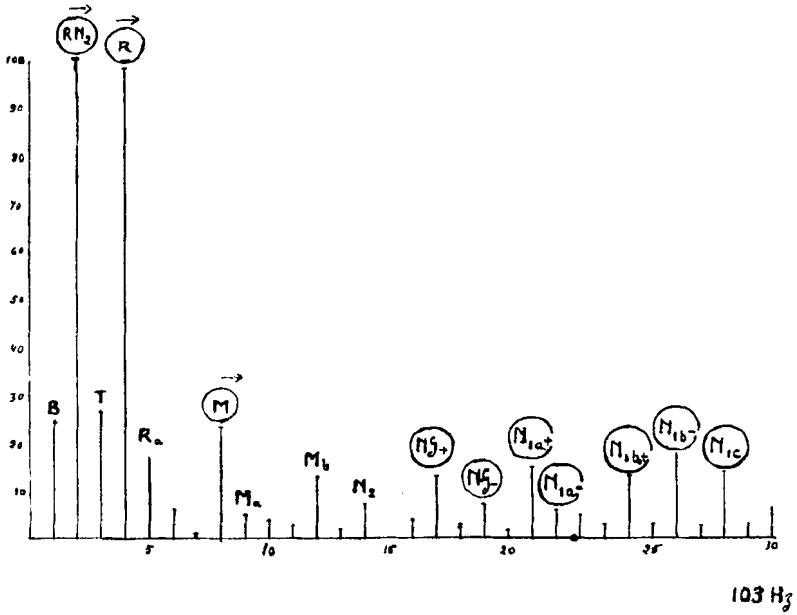
Examination and Explanation of Results of the Analyses.

M (8th partial tone) has risen without prosthesis on account of the missing palate and fallen (8th—7th partial tone) because of

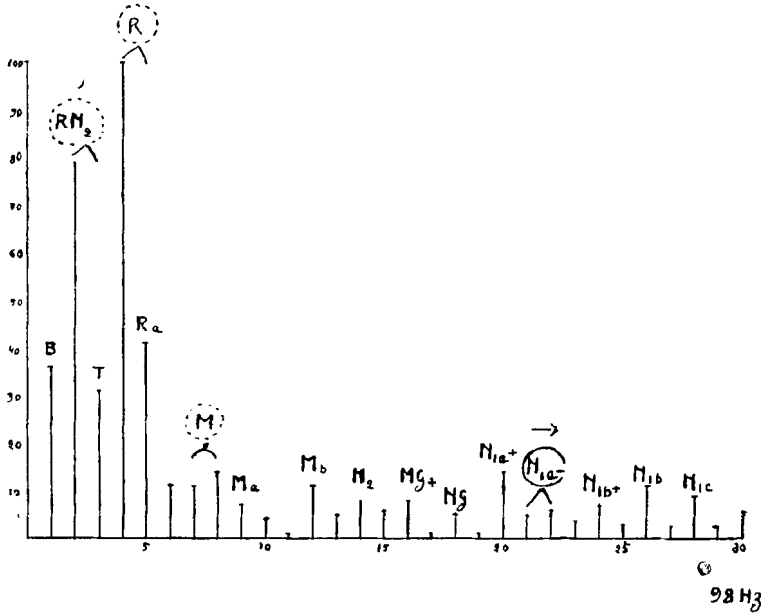
Table 23.

	Without prosthesis Fundamental tone 103 Hz	With prosthesis Fundamental tone 98 Hz
RN_2	206	196—294
R	412	392—490
Ra	515	490
M	824	686—784
Ma	927	882
Mb	1236	1176
N_2	1442	1372
Ng +	1648 (Ng—1854)	1568 (Ng—1764)
N_1a +	2060 (N_1a—2163)	1960 (N_1a—2058—2156)
N_1b +	2472 (N_1b—2678)	2352 (N_1b—2548)
N_1c	2884	2744

Vibration frequency figures of the various formants or Hz.



Analysis No. 24.
Case No. 3 m (Lehmusvirta) Without prosthesis.



Analysis No. 25
Case No. 3 m (Lehmusvirta) With prosthesis.

the prosthesis. Normalisation by means of the prosthesis has, however, not taken place fully as the oral passage is still too large due to contraction of the tongue mass.

R and RN_2 have risen without prosthesis. The anterior openings of the pharyngeal and naso-pharyngeal cavities have enlarged owing to the compensation phenomenon, *i. e.* the raising of the dorsum of the tongue to compensate for the palatal defect. Air should pass through the nose and the tongue rises to prevent its passage into the mouth. However, it has not been possible to effect this compensation phenomenon because of *the poor mobility of the contracted tongue* in normalising the M formant. On the contrary, the influence of the palatal defect remains. When articulating with a prosthesis applied, the respective formants R and RN_2 rise still further compared with normal. This is due to the sub-normal position taken by the velum now that the anterior part of the tongue has become reduced; the tongue must therefore move further forward than normally and the velum drops lower than usual to diminish the pharyngeal cavity thus originated to its former size. The diminution, however, is not even and overshoots the mark, for with the velum moving down the larynx rises and the pharyngeal cavity decreases too much. Here the compensation for the reduction in the tongue mass lowers the velum and diminishes the pharyngeal cavity, resulting in the rising of the R and RN_2 formants which would otherwise be normalised with the prosthesis, forming an "intact" palate.

N_2 is the same, whether articulating with or without prosthesis.

NG, N_{1a} and N_{1b} are the formants of the nasal passage. It has been possible to discern in these formants separately between the left-hand (marked +) and the right-hand (marked —) formants in the analyses on account of the dissimilarity of the lower conchae. This has caused different volume and opening spaces in the cavities in question (See Case history).

N_{1a} has risen by one partial tone when articulating with the prosthesis as the lowest concha on the same side has become hypertrophied, causing a larger-scale diminution of the volume of the lowest right-hand concha together with a corresponding rising of the formant.

A comparison of other nasal passage formants during speech, with and without prosthesis, reveals differences in intensity only and not in height. The closing of the palate with a prosthesis has brought about an average reduction of 40 per cent in the analyses.

Its effect in speech is considerably to reduce the nasality. On the basis of auditory observation this case does give a normal effect with the prosthesis applied, whereas the nasality is noticeable without the prosthesis.

According to information of a later date the patient has, however, taken to the old prosthesis as his tongue finds it difficult, on account of its poor mobility, to adapt itself to the new prosthesis and to form with it the new resonance cavities required to replace the familiar old ones (cf. the author's previous paper Hankittujen suulakiaukkojen etc., Case No. 2 where the patient has acquired a permanent defect in the articulation of the velum because of the lengthy use of a prosthesis of a wrong construction.

Summary:

A complicated case of war defect has been described with permanent injuries to the soft parts of the mouth and absence of the hard palate. Also, the tongue has contracted, is scarred, and its mobility is limited. The sound-pathological situation thus originated has been analysed. A prosthesis, constructed in conformity with medico-phonetical principles, with attention paid to the tongue's reaching to it, is able to improve the sound-pathological situation satisfactorily. However, the unsuccessful compensatory effects of the contracted tongue with regard to the pharyngeal and oral formants are still observable in the analyses.

Final Conclusion.

As it is apparent from the author's investigations accurate knowledge of the anatomical and physiological basis of the defect is of primary importance in all cases of jaw defect. It is only from this basis that success can be achieved in so-called surgical prosthetics concerned with repair of tissue loss and the restoration of bite function and speech. In the above severe cases of jaw defects in war disabled, peripheral resection prostheses have given satisfactory results with regard to these requirements. If absence of the nasal septum and nasal conchae enter into the problem in addition to actual upper jaw defects, the question of their replacements by prosthetic means must be considered in casu.

In severe traumatic cases with other complications, for instance injury to the soft tissues of the mouth, contraction of the tongue mass and limitation of jaw and tongue movements, an immediate decision as to the correct prosthetic measures is desirable as it may be difficult for the patient later on to form by tongue movements and use the new resonance cavities required for normal speech with another, albeit otherwise better prosthesis (Case No. 3). It is also advisable that dentists have some experience of phonetics: correct evaluation of speech is possible only by means of phonetic tests, their recording and calculation of the mathematical values. Accurate results are obtained by applying SOVIJÄRVI's "formant method" in these studies, which indicate the lines to be followed in surgical prosthetics.

Finally, the author wishes to express her deep gratitude to Professor ANTTI SOVIJÄRVI in collaboration with whom over a period of many years and with whose never-failing guidance in solving the phonetical questions it has been possible to realise this long series of publications.

The author wishes, at the same time, also to thank Professors FALTIN and KIVIMÄKI, as well as Dr. SOIVIO, for their kind co-operation in the acquisition of this research material.

Zusammenfassung.

Bei allen Kieferverletzungen ist eine genaue Kenntnis des anatomisch-physiologischen Hintergrundes der Verletzung von grösster Bedeutung. Nur mit Rücksicht hierauf ist es möglich, Erfolge mit der sogenannten chirurgischen Prothese, deren Ziel ist, zerstörte Gewebe zu ersetzen and die Kautätigkeit und die Sprechfunktion wieder herzustellen, zu erlangen.

Bei sehr schwerartigen Verletzungen bei denen ausser Kieferverletzungen auch andere Komplikationen vorhanden sind — Verletzungen der Weichteile des Mundes oder Einschränkung in den Bewegungen des Unterkiefers und der Zunge — muss man gewöhnlich von Anfang an die richtige prothetische Lösung zu erreichen suchen. Es ist nämlich möglich, dass der Kranke später eventuelle Schwierigkeiten haben wird, mit seiner neuen, vielleicht sogar besseren Prothese, die neuen Resonanzräume, die für das normale Sprechen notwendig sind, anzuwenden, und zu lernen, sie durch Zungenbewegungen zu bilden. Eine gewisse Kenntnis in dem Spezialgebiet der Phonetik ist wünschenswert, denn ein

richtiges Ausformen des Sprechens gelingt nur durch phonetische Experimente, durch Registrieren derselben und durch rationelle Berechnung der mathematischen Werte. Gerade durch Anwenden der »Formant-Methode« von SOVIJÄRVI erzielt man bei diesen Versuchen sichere Resultate. Mit Hilfe dieser Methode erhält man nötige Anweisungen für die Prothesen.

Zu diesen Untersuchungen gehören drei Fälle von Kriegsverstümmelung, die ganz besonders eingehend beobachtet worden sind, und bei deren Verlauf die oben erwähnte Methode angewendet worden ist. Bei diesen besonderen Fällen von Oberkieferverletzungen hat man mit Lateralwand versehenen Resektions-Prothesen befriedigende Erfolge erzielt. Wenn ausser den Oberkieferschäden auch die Nasenscheidewand und die Conchae nasales fehlen, muss die Wiederherstellung dieser Schäden in casu entschieden werden.

Résumé.

Dans tous les cas de défectuosité des mâchoires une connaissance exacte de la base anatomo-physiologique de la défectuosité est d'une importance fondamentale. Ce n'est qu'en se fondant sur cette base qu'il devient possible d'arriver à des résultats avec la soi-disante prothèse chirurgicale, dont le but est de remplacer la perte des tissus, et de rétablir l'activité de mastication et de la parole. En général dans des cas traumatiques d'un caractère très grave, dans lesquels se présentent outre les défectuosités des mâchoires, encore d'autres complications — lésions des parties molles de la bouche, limitation des mouvements de la mâchoire inférieure et de la langue — il faut tâcher d'atteindre dès le début, la juste solution prothétique, car il est possible que plus tard, le malade pourrait avoir des difficultés éventuelles pour employer avec sa nouvelle prothèse — peut être même meilleure — les nouvelles cavités de résonance, nécessaires pour le langage normal, et d'apprendre à les former à l'aide des mouvements de la langue. Une certaine connaissance de la partie spéciale de la phonétique serait à désirer, car une véritable évaluation du langage réussit seulement à l'aide d'expériences phonétiques, de son enregistrement et d'un calcul rationnel des valeurs mathématiques. C'est par l'application de la formant-methode de SOVIJÄRVI qu'on parvient à des résultats sûrs dans ces expérien-

ces. A l'aide de cette méthode on reçoit les directives nécessaires pour les prothèses.

A ces études appartiennent trois cas concernants des mutilés de guerre et qui ont été l'objet d'examens particulièrement minutieux, et au cours desquels la méthode sus-mentionnée a été appliquée. Dans ces cas particuliers des défectuosités des mâchoires supérieures chez les mutilés de guerre, on a obtenu des résultats satisfaisants à l'aide de resekto-prothèses, munis d'une paroi latérale. Si à côté des défectuosités de la mâchoire supérieure se présente encore le manque de la paroi nasale et des conchae nasales — leur rétablissement doit être décidé in casu.

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