

The Analysis Of Facial Growth From Fetal Life To Adulthood

JAMES H. SCOTT, M.D.

Belfast, Ireland

INTRODUCTION

In a previous article (1958) the construction of the facial rectangle was described and it was suggested that this could be used in the analysis of facial growth. In this present contribution the results of such an analysis are described.

MATERIAL

The material used consisted of tracings, from various sources, of lateral cephalograms of children showing normal occlusions or Class I malocclusion. The most important sources were the Bolton Foundation collection at Cleveland; King's College Hospital, Dental School, London; Royal Dental Hospital, London; University of Michigan Dental School; Dental School at Liverpool, and the Belfast Dental Hospital. For the fetal material midsagittal sections of the skull were cut, stained, and enlarged photographically (Fig. 1).

METHOD

The facial rectangle is constructed as follows (Fig. 2). The upper side is the familiar sella nasion line (SN) extending from the middle of the pituitary fossa to nasion. From nasion, and from the pituitary midpoint, two lines are drawn parallel to one another and at right angles to the SN line. These are the anterior and posterior facial planes (NA and SP). The lower side of the facial rectangle is drawn parallel to the SN line and through the lower border of the chin (gnathion) and can be called the gnathial plane (AP). The position of the point gnathion along

this plane varies and can be expressed by the angle SNG, which is a measurement of mandibular position in the anteroposterior plane relative to the

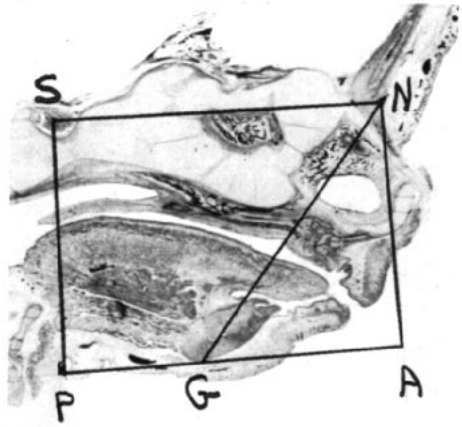


Fig. 1

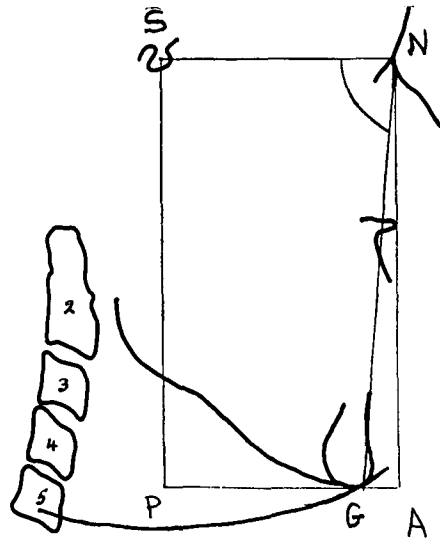


Fig. 2

Anatomy Department, Queens University

cranial base. With the midpituitary point as the center, an arc is drawn through gnathion cutting the vertebral column. This enables one to estimate mandibular growth relative to that of the vertebral column.

The facial rectangle alters in shape between fetal life and adult life and this is, of course, an expression of a change in facial proportions. This can be readily expressed by the simple formula $SP \times 100/SN$.

In this study three features are investigated, (1) changes in facial proportions as expressed by the facial rectangle, (2) the position of the mandible (gnathion) relative to the anterior cranial base (SN line), and (3) the length of the mandible (as measured by the line SG) relative to the vertebral column).

FINDINGS

The Facial Rectangle.

During midfetal life (3-6 months) the average value of the facial rectangle ($SP \times 100/SN$) is 96; that is, facial

depth (SN) is greater than facial height (SP or NA). The range of variation, however, is considerable varying from 78 to 126, giving a standard deviation around the mean of 13.4 (Table 1).

Between the midfetal period and the 1st-3rd year age group, there occurs a marked change, $SP \times 100/SN$ rising to an average of 132 with a range of variation of 123 to 141 (SD 6.2), the amount of variability showing a considerable reduction. There is obviously need for further study of the changes in facial form taking place between the middle of fetal life to the end of the first year after birth.

Throughout childhood and adolescence there is a steady change in the form of the facial rectangle, $SP \times 100/SN$ increasing from an average of 132 to an average of 166, the most rapid period of change being up to, and including, the fourth year. Up to adult life the face increases in height more than in depth, downward growth being greater than forward growth, but while

TABLE 1

Age	No.	Facial Rectangle		Angle SNG	
		Average	S.D.	Average	S.D.
Fetal	20	96	13.4	64	4.2
1-3 yrs.	10	132	6.2	75	3.3
3-4 yrs.	25	140	8.7	75	3.1
4-5 yrs.	30	149	9.1	75	4.4
5-6 yrs.	30	150	6.7	76	3.9
6-7 yrs.	30	151	8.3	75	3.9
7-8 yrs.	25	153	9.0	75	3.2
8-9 yrs.	30	154	8.3	75	3.2
9-10 yrs.	25	155	7.7	76	4.0
10-11 yrs.	30	154	8.7	78	3.9
11-12 yrs.	25	155	8.0	77	4.2
12-13 yrs.	20	160	10.8	77	4.3
13-14 yrs.	25	161	9.4	78	3.4
14-15 yrs.	25	160	10.1	76	3.4
15-16 yrs.	25	163	10.5	78	4.2
16-18 yrs.	25	165	10.2	80	3.8
18+ yrs.	25	166	9.5	79	3.0

the trend is unmistakable, the range of individual variation is considerable. At five years the average value of $SP \times 100/SN$ is 150 with a range of 136-167. At 18+ years it is 166 with a range of 148-189. Superimposed upon the general tendency of a progressive increase in facial height, some faces grow forward, as well as downward, to a greater extent than others. For each age group it can be stated that the "long" faces are those above the average value for the group and the "short" faces are those below the average for the group. Table 2 shows the change occurring in ten individual cases from three years to adolescence. While in the majority the greatest change occurs from three to ten years, in a few (Cases 9 and 10) there is as much, or even a greater amount of change after ten years.

The Angle SNG.

This angle is a measure of the position of the mandible relative to the cranial base in the anteroposterior dimension. As with the facial rectangle there is a marked change between mid-fetal life (showing an average of 64°) to the 1-3 year group (showing an average of 75° , Table 1). There is little further change until about the 10th year when there is a slight increase in the angle. The total change in the average value of SNG angle between the 1-3 year group to the 18+ group (from 75-79) is not, however, very great. All that can be said is that there is a progressive tendency towards the lower jaw coming forward to some extent relative to the cranial base. Study of individual cases from three years to adolescence (Table 2) shows this general tendency with, however, in some cases a marked increase (Cases 2 and 8) and in others a slight decrease as in Case 4. This variability in opposite directions, which does not show itself in the "average" change (Table 1), indicates the im-

TABLE 2

Case No.	Age	Facial Rectangle	Angle SNG
1	3 yrs.	130	72
	10	146	75
	17	152	75
2	3	135	71
	10	161	74
	15	167	79
3	3	137	74
	10	152	76
	14	159	77
4	3	137	79
	10	154	78
	19	169	78
5	3	143	77
	10	152	80
	18	155	83
6	3	143	74
	10	163	76
	16	170	78
7	3	133	75
	10	145	73
	18	153	77
8	3	130	72
	10	151	74
	17	159	81
9	3	141	74
	10	148	73
	17	160	77
10	3	162	80
	10	166	80
	13	170	82

portance of individual case histories as well as group studies in the analysis of facial development.

Mandibular Growth relative to the Vertebral Column.

This was studied only in postnatal material (Table 3) and only in some of the cephalograms examined. Up to five years of age the greatest number of individuals showed the sella-gnathion arc cutting the vertebral column at the level of the 6th cervical body, between the 5th and 6th bodies during the 6th year, and the 5th body from 7 to 18+ years with, however, an increasing tendency to reach the 4th cervical body as age increased. Growth of the mandible and vertebral column, of course, goes on throughout the whole of the period

of time studied, but mandibular growth tends to lag behind vertebral growth.

DISCUSSION

The purpose of this investigation is to confirm and extend our knowledge of the pattern of normal facial development. From fetal life to adulthood the face increases in height more rapidly than in depth with two extreme types: the long and shallow and the short and deep, and all grades of intermediacy between. The direction-determining factors are probably the cartilage of the nasal septum in the upper facial skeleton, and the cartilage of the mandibular condyle in the lower facial skeleton. The actual amount of growth will depend on the combination of cartilage growth potential, sutural growth, and surface deposition especially at the alveolar processes. The mandible grows at a greater rate than the cranial base as measured from sella to nasion, but at a lesser rate than the cervical segment of the vertebral column. The greatest period of growth and of change in facial proportions is during the pe-

riod from midfetal life to about the 5th year during which time the facial rectangle changes from 96 to 150, a quite dramatic change compared with the change between the 5th year and adulthood (150-166). The relative forward movement of the mandible (angle SNG) shows its maximum period of change from fetal life to about the time of birth and is less extensive. There is need for further study of the later period of fetal life and the earlier stages of prenatal growth. As Brodie and others have pointed out, an appreciation of individual variation is an essential and often neglected feature in the full understanding of the concept of normal facial growth which is often lost sight of in group studies and an excessive reliance on statistical methods.

I wish to thank all those who kindly put their cephalometric material at my disposal, and Mr. L. Johnston who helped in the preparation of the Tables.

REFERENCES

- Scott, J. H.: *Am. J. Ortho.* 44: 507-512, 1958.

TABLE 3
Mandibular position relative to cervical vertebrae

Age in Years	No.	4th Body	Between 4th & 5th	5th Body	Between 5th & 6th	6th Body	Between 6th & 7th	7th Body
3	(7)	0	0	1	1	5	0	0
4	(18)	0	0	5	2	9	1	1
5	(26)	0	0	7	6	12	1	0
6	(26)	1	1	7	10	7	0	0
7	(21)	1	2	10	4	4	0	0
8	(28)	1	4	19	3	1	0	0
9	(18)	1	1	8	5	3	0	0
10	(12)	0	2	6	3	0	0	1
11	(20)	2	5	11	1	1	0	0
12	(17)	3	0	11	2	1	0	0
13	(13)	0	0	10	2	1	0	0
14	(19)	2	4	12	1	0	0	0
15	(21)	0	4	14	3	0	0	0
16-17	(11)	1	4	4	2	0	0	0
18+	(19)	3	4	11	0	1	0	0