SUMMARY

Based on the publications to date a well-defined opinion of a possible relationship between a hypertrophy of the labial fraenum – midline diastema and fraenectomy – spontaneous closure of the diastema, cannot yet be formed. On the one side there is the point of view, predominantly assumed by orthodontists, that fraenectomy should be delayed until the permanent canines have erupted; on the other hand there are very many authors who place preventive value upon fraenectomy in a much earlier stage of eruption of the dentition.

An extensive longitudinal investigation, in order to bring the problems regarding midline diastema, fraenum and fraenectomy, nearer to solution, seemed to be justified.

In Chapter I the working-scheme of the present study is discussed. It consists of 4 parts, each having a starting-point and an aim of its own:
- a microscopic examination, dealing i.a. with the possible presence of muscle tissue and/or tendinous structures in the fraenum and with the course of the bundles of fibrous tissue;
- an investigation regarding the question whether or not a relationship can be demonstrated between a hypertrophied fraenum and a midline diastema. Quite a series of other factors, possibly contributing to midline spacing are also included in this investigation;
- a comparative examination of three groups of children, each group having been treated by a different operation method. It was hoped that the following questions might be answered:
  - is fraenectomy of positive influence on closure of the diastema?
  - what type of surgical method gives the best results?
  - if it should appear from this study that a certain method of fraenec- tomy is the best one, will this method give these good results under all circumstances or has the method of fraenectomy to be adapted to the circumstances, such as width of the diastema or phase of eruption of the dentition?

162
an investigation of the alterations in the widths of the diastemata in groups of children showing a hypertrophied fraenum but who have never been treated neither surgically nor orthodontically; these groups can be considered to be control-groups.

Chapter 2 deals with the embryology and anatomy of the fraenum and its surrounding structures. At birth the attachment of the fraenum lies at the lower border of the jaw (fig 2.3.). Influenced by the eruption of the deciduous teeth the jaw is growing i.a. in a vertical direction; in normal cases the attachment of the fraenum remains at its original level, so that it will lie 'higher' on the jaw at the end of the growth period.

The fraenum resembles a double mucosal fold in which loose connective tissue is present labially. Because of its flexibility a fraenum cannot easily be measured.

On the eruption of the deciduous incisors diastemata may normally be present; according to Baume (1950) they do not change before the permanent incisors have erupted. With this eruption another stage of growth of the jaw sets in, as a result whereof also diastemata may occur, which, however, can gradually disappear later on (Brodie, 1950, 1956; Broadbent, 1954). Diastemata in these stages of eruption can also be considered to be normal.

In Chapter 3 a description is given of the microscopic anatomy of fraenum and adjacent tissues. Our investigation included the examination of fraena only, as well as fraena in conjunction with the interdental papilla and the anterior third part of the incisive papilla. This part of the investigation was especially aimed at the course of the bundles of connective tissue and possible presence of tendon-like and/or muscle tissue. For comparative purposes also normal fraena with adjacent interdental papilla and incisive papilla were examined from persons, who had no midline diastema (figs. 3.1. to 3.3. inclusive). It appeared that the transepithelial fibres, as found in normal cases, were completely missing in case of hypertrophied fraenum and midline diastema. Distinct, ventrodorsally running bundles of connective tissue were found indeed (figs. 3.4. and 3.5.). The latter may be (partly) the cause that the midline diastema does not close. Tendinous structures and/or muscle tissue were not found in hypertrophied fraena. Yielding elastic fibres were not seen more frequently in hypertrophied fraena than in normal cases.
In Chapter 4 factors are described, which may be contributive to the incidence of midline diastemata in general and which are often mentioned in the literature. The following factors are dealt with: heredity, racial occurrence (figs. 4.1. and 4.2.), disturbed eruption, reduction and agenesis, supernumerary teeth (fig. 4.3.), occlusal disturbances, too wide or too narrow apical base, persistence of the intermaxillary suture, interfering soft tissues (i.e. hypertrophied fraenum, see chapter 5), oral habits, orthodontic treatment, traumata and periodontal diseases.

In Chapter 5 the hypertrophied fraenum is considered as a possible cause of a diastema (fig. 5.1.). The important question is whether the hypertrophied fraenum is cause or result of the median diastema. In the literature we come across widely varying opinions. A good definition of what exactly is to be understood by the qualification 'hypertrophied fraenum' could not be found in the literature.

Based on the presence of ventrodorsally running fibrous bundles, as described in chapter 3, the diagnosis hypertrophied fraenum might be made. Unfortunately, however, this is a retrospective diagnosis. In many cases the hypertrophied fraenum, the interdental papilla and the anterior part of the incisive papilla will become anaemic when stretching the fraenum by lifting the upper lip. This test was already described by Ketcham (1907), who called it 'blanching-test'. That tissue becomes ischaemic may point to a ventro-dorsal course of the bundles of collagenous fibres. With regard to the answer to the question in which way a hypertrophied fraenum might be contributive to or maintain a midline diastema, the opinions encountered in the literature, can be summarized in the following five headings:

- **bundles of collagenous fibres** running from the fraenum to the interdental papilla keep the diastema open, because they do not atrophie under the influence of the normal, mesially directed, drift of the teeth (Angle, 1907; Stones, 1951; and others);
- the bundles of connective tissue of the fraenum extend into the intermaxillary suture, thus preventing closure of this suture, with the result that the diastema is also persisting (a.o. Chapman, 1935; Korkhaus, 1939; Eschler, 1952; Movers, 1963). According to Ketcham (1907) and Adams (1954), on the contrary, it is irrelevant in case of a midline diastema, whether the suture is open or closed;
- the **movements of the lip** are conducted via fraenum and interdental
papilla to the teeth, resulting into an open diastema (a.o. McCoy, 1946; Curran, 1950; Mead, 1954);
- under the influence of traction by the hypertrophied frenum and the alveolar process bone-apposition along the intermaxillary suture is stronger than in normal cases; this excessive quantity of bone prevents closure of the midline diastema (a.o. Gillies, 1935; Hemley, 1953; Hennis, 1964).
- by the predominantly ventro-dorsal course of the bundles of collagenous fibres from the frenum to the incisive papilla, the transeptal fibres between the central incisors cannot develop. As these fibres are missing the diastema will persist (Adams, 1954; Baum, 1966).

Nobody, however, has proved a causal relationship between a hypertrophied frenum and a midline diastema. Also the problem as to which is primary, the hypertrophied frenum or the midline diastema, has not yet been solved. Unfortunately this investigation could not answer this question either.

In Chapter 6 a description is given of a longitudinal investigation regarding incidence and behaviour of a midline diastema, of 198 school-children. In this study the following possible causative conditions of median diastemata were investigated and examined: hereditary factors, thumb- or finger-sucking, mouth breathing, open maxillary suture, supernumerary teeth, agenesis or reduction of lateral incisors, rotation of permanent lateral incisors, premature loss of deciduous lateral incisors, wide apical base, hypertrophied frenum, discrepancy in size of teeth and jaw, vertical overbite and finally axial inclination of the upper central incisors in relation to the spina plane.

Tables illustrate these findings.

Table 6.1. shows the total number of midline diastemata per age-group. It appears from this table that with an increase of age of the children the number of diastemata is decreasing.

Table 6.2. indicates the number of diastemata per age-group, divided up into boys and girls. It appears that the number of diastemata per age-group is greater in boys than in girls; this difference might be explained by a delayed eruption in boys.

Table 6.3. shows the percentages of midline diastemata per phase of eruption, according to the widths of the diastemata. It appears from this
table that on further eruption of the dentition both number and width of the diastemata are decreasing.

*Table 6.4.* shows the percentages of midline diastemata per phase of eruption, according to the widths of the diastemata, divided into boys and girls. By comparing the percentages of median diastemata per phase of eruption the difference between boys and girls as to the growth, would be eliminated. Yet the boys appeared to have a higher percentage of diastemata than girls; this might possibly be explained by the fact that growth in boys will continue longer than in girls, so that more space can be created for teeth in the maxilla.

*Table 6.5.* shows the percentages of midline diastemata, subdivided into width-groups and classed according to cause during eruption of the permanent lateral incisors. These were examined to find out whether there were significant differences in percentages in groups of children with and without any possible causative factor. It appeared that only in the case of a hypertrophied fraenum more midline diastemata were found.

*Table 6.6.* is identical with 6.5., but now after eruption of the permanent second molars. The difference in percentages of diastemata in the cases with a hypertrophied fraenum at the moment of eruption of the lateral incisors was found to be no longer significant at the moment of eruption of the second molars. No other significant differences were found either.

In Chapter 7 the different methods of surgical treatment as described in the literature, are discussed. These methods are varying widely, from: loosening of the attachment of the fraenum from the alveolar process and resuturing it at a higher level, to complete removal of the fraenum, the interdental papilla and the anterior third part of the papilla, followed by removal of the septal bone up to about the level of the apices of the central incisors. The wound-treatment, as described in the literature, is also discussed. Because it was impossible to evaluate all methods of surgical treatment described in the literature on a sufficiently large number of children and so that the findings could be compared with each other, a choice had to be made so that, as far as possible, the theoretical backgrounds (see chapter 3) of the methods discussed in the literature were met.

In the Department of Oral Surgery of the Groningen University three non-selected groups (consisting of respectively 93, 123 and 112 children) were treated according to the methods, in short discussed below.
Operation technique 1: the fraenum is dissected from the lip and the attachment on the alveolar process is circumcised; hereafter the fraenum is removed in toto (figs. 7.3. to 7.6. inclusive);

Operation technique 2: the fraenum is dissected from the lip down to the bone of the alveolar process, 3 or 4 mm above the alveolar buccal sulcus. From the extreme lateral corners of this wound converging vertical incisions are made across the alveolar process to the gingival sulcus of the central incisors, where the buccal surface changes into the approximal surface. Then a transverse incision is made at the palatal side through the anterior third part of the incisive papilla. By means of an excavator (Ash no. 125/126) the tissue is elevated from the bone and moved between the teeth to the ventral side. By making all incisions down to the bone the tissue can easily be removed together with the periosteum. The removed piece of tissue is about hour-glass shaped, reason why this technique is often called hour-glass technique. Figs. 7.7. to 7.11. inclusive show examples of this operation-method.

Operation technique 3: the first part of this method is the same as described in method 1. After that the septal bone between the central incisors is removed by a fissure bur, adapted to the width of the diastema, up to about the level of the apices. A thin lamella of bone along the roots of the incisors is kept intact in order to prevent damage of the periodontium (figs. 7.12. and 7.13.).

Post-operative complications are hardly mentioned in the literature. In our clinic post-operative bleeding from the incisive papilla was seen sporadically. No other post-operative discomfort occurred.

In Chapter 8 incidence and behaviour of the midline diastemata in 328 children to be operated, are described. An extensive documentation was made of these children, all having a prominent fraenum and a midline diastema. The age-distribution at the time of the first examination is shown in table 8. The stages of eruption of the dentitions were subdivided into 6 groups (table 8.2.). The numbers and percentages of children treated per stage of eruption are given in table 8.3. The relation age – width of the diastema can be read from table 8.5. It appears from this table that with an increase of age there is a decrease in width of the diastema. The relation stage of eruption – width of the diastema is shown by table 8.7.: it appears that in each next later stage of eruption the width of the diastema is relatively decreasing.
Arithmetical operation of the collected data has been done by electronic computer. In this way it could be examined whether there were factors, such as familial occurrence, thumb-sucking and so on, which might have a widening influence on the diastemata. Groups of children with and without any possible harmful conditions were compared as to the widths of their diastemata. It appeared that none of the factors mentioned influenced the diastemata unfavourably.

In Chapter 9 the result is discussed of the comparative examination of groups of children treated according to one of the three methods of surgical treatment already mentioned in the foregoing. It was investigated whether fraenectomy had a positive influence upon the narrowing of the diastemata. Therefore the physiological narrowing of the diastemata in a period of 6 months previous to the fraenectomy was compared with the contraction in a period of 6 months after the fraenectomy. Operation methods 2 and 3 showed a significant difference, in other words, these two methods of fraenectomy had a positive accelerated influence on the closure of the diastemata. This was different in the cases method 1 was used. The degree of success of the fraenectomy was subdivided into 3 classes.

We speak of success grade 1 when the diastemata have closed completely, of success grade 2 when the diastemata are closed but for a rest of 0.5 mm maximally and of success grade 3 in case of a contraction to 1.0 mm. By means of this classification the degrees of success of the three methods of fraenectomy could be compared with each other. The percentages of success per operation method after 6 months (S₁T, S₂T and S₃T) and after 30 months (S₁, S₂ and S₃) can be read from the tables 9.1. and 9.2. Operation method 2 appears to be always more successful, both after 6 months and after 30 months post-operatively, than the methods 1 and 3. Also in the cases of very wide diastemata removal of interdental bone by bur appeared not to be more effective than the 'hour-glass' excision (see tables 9.3. and 9.4.). So removal of bone by bur with all the connected risks and disadvantages, can be omitted.

It is important to know what stage of eruption is most favourable for the closure of the diastema. The stages of eruption were divided into 6 phases again. It appeared that operation method 2 in phase of eruption 4, in which phase the central and lateral incisors have fully erupted, gave the best result in comparison with the methods 1 and 3 in the same phase, after 6 as well as after 30 months post-operatively (see tables 9.7. and 9.8.). Based on these findings it might be stated that fraenectomy should
be done according to operation method 2 in phase of eruption 4. It appeared also, however, that method 2 showed no differences in success between the stages of eruption which have been investigated (see tables 9.9, and 9.10.). So based on the present investigation it is impossible to indicate the phase of eruption which is the most favourable for a fraenectomy according to method 2. From this part of our investigation it has appeared that operation method 2, the 'hour-glass' excision, has to be preferred to method 1 and to method 3, followed by removal of septal bone by bur. It can be imagined that there might exist factors interfering with the closure of the diastemata. Factors like sex, familial incidence of midline diastemata, thumb-sucking and so on, have been investigated. In our material, however, they could not be demonstrated to be unfavourable.

In Chapter 10 the control-groups are discussed. An ideal control-group i.e. a group of children, remained untreated, with prominent fraena and midline diastemata, who could be documented until after eruption of the permanent canines, could not be formed. The major difficulty of such a control-group is that we let intentionally pass what we think is the most appropriate moment for a simple treatment of an anomaly, to which the attention is continuously drawn, without being certain that a great part of these diastemata will close spontaneously in the course of the control-period. In those cases in which the diastemata have not closed spontaneously after the control-period, it might be tried to make them as yet close by means of 'hour-glass' excision, but when surgical treatment should appear not to be effective, it should be followed by orthodontic treatment. Partly in connection with the ages it may turn out that in a number of cases a good result by a removable orthodontic appliance cannot be achieved, so that treatment will have to change to fixed appliances, requiring much time and manpower. It might turn out that a control-group after a period of observation is resulting quantitatively in an orthodontic problem, which cannot easily be solved. For these reasons we had to decide, within the scope of this investigation, not to form an ideal control-group. Instead, however, we succeeded in finding two other, substituting control-groups:

- the untreated group of children (198) of the school-examination, already mentioned in chapter 6.
- in 80 per cent of the group of children (93), treated according to
method 1, the diastema persisted during a control-period of 2.5 years after fraenectomy. Part of these children could be re-examined at the age of 17. Based on the findings in this group 40 per cent of the diastemata will persist.

It appears from these percentages of persisting midline diastemata that a child with a hypertrophied fraenum and a midline diastema has rather a fair chance that the diastema will persist when the child is growing older.

In Chapter 11 some fixed and removable orthodontic appliances are discussed, which may be used to close a midline diastema (see figs. 11.1. to 11.5. inclusive).

The final conclusions are described in Chapter 12. It has appeared from the present investigation that a simple excision of the fraenum in itself is ineffective. Removal by bur of bone from between the roots of the central incisors is unnecessary, it does not increase the rate of closure in such a way that it balances the enhanced chance of complications. Moreover, the use of a bur is an unnecessary mental load for the child. The 'hour-glass' excision is by far preferable to the two other methods, as is evident from the statistical evaluation of the results of treatment. It is a simple operation which does not take too much time (fig. 12.1.).

It is not possible to mention factors, which indicate in an early stage that the hypertrophied fraenum and the midline space will persist; therefore it is difficult to give a well-defined indication for fraenectomy.

For children, who are not considered or cannot be considered for orthodontic treatment, for instance for financial reasons or due to shortage of manpower, the following indications may be mentioned:

- a wide interdental space and a prominent fraenum without further orthodontic anomalies;
- a wide midline diastema and a prominent fraenum, together with imminent lack of space for the permanent canines; the space obtained by closing the midline diastema, will go to the canines;
- a wide midline diastema and a prominent fraenum in the cases we want to do something to improve the cosmetic aspect of the upper front, notwithstanding the fact that, strictly speaking, orthodontic treatment is indicated.
In all these cases fraenectomy has to be postponed until the permanent lateral incisors have fully erupted and preceding eruption of the canines.

In these cases the mesially directed forces provided by the canines, still to erupt, can be used, and moreover, unnecessary fraenectomy is prevented.

For children who are treated orthodontically the following indications may be mentioned:

- midline diastemata, which cannot easily be closed permanently by orthodontic treatment;
- accumulation of interdental tissue during orthodontic treatment, which fails to resorb;
- very wide diastemata; to support orthodontic treatment;
- discrepancy between size of jaw and teeth; maintaining a median diastema, the treatment of which is predisposed to relapse.

In all these cases the time of extirpation has to be adapted to the orthodontic treatment.

Specific contra-indications regarding surgical treatment as such cannot be given, because the 'hour-glass' excision is a fast and simple method of treatment without almost any risk.