

## THE TREATMENT OF BOWLEG IN RICKETS

BY  
ERIK GUDIYSEN

The application of orthopedic surgery to rachitic deformities of the extremities cannot be said to have its start much before the middle of the last century. Before that time one relied almost exclusively on the use of mechanical-orthopedic, supporting or correcting apparatus.

During the first attempts with regular surgical treatment (*Guérin* (cit. *Gernand*), *Mayer*, *Volkmann*) it was generally preferred, before antiseptic methods of operation had been universally adopted, to use bloodless operations, manual or instrumental osteoclasis, rather than osteotomy and resection.

Open bone operations naturally involved an immense risk in the days before Lister. It was therefore considered a significant advance when *v. Langenbeck* in 1854 advocated the subcutaneous osteotomy. The method was originally developed for war surgery, but was soon transferred to general practice where, both by *Langenbeck* himself as well as by *Billroth*, *Marsh* and several others, it was in fact first applied to rachitic deformities of the leg.

The first decades of modern surgery saw the publication of numerous cases of these rachitic deformities treated by open osteotomy. Especially remarkable were the excellent results which in great detail were reported from the clinics of *Volkmann*, *Billroth* and *v. Bergmann* (*Gussenbauer*, *Gernand*, etc.).

A very large material was at the disposal of *Macewen*, and he, as well as several other British surgeons like *Jones* and *Hagyard*, could report on the satisfactory effect of the surgical

treatment. In France it was first of all the successful osteotomies of *Boeckel* that aroused interest.

Most of the authors from this period gave special attention to the actual operative technique which, both with regard to instruments and methods, reached a high standard as early as then.

Since the beginning of the nineties it has been a common feature for numerous papers to devote a great deal of attention to the indications for surgical treatment and, in that connection, the question of possible spontaneous cure.

Most authors seem to agree that some rachitic deformities show a tendency to straighten out in time, but some divergence of opinion is evident as to the question of which deformities may be expected to develop favorably, and, moreover, to what extent improvement generally may be in prospect.

In the discussion of the prognosis in genu valgum in non-operated cases the difference of opinion became especially pronounced, but also the ordinary curvatures of the leg below the knee, which alone will be dealt with in the present paper, were frequently the center of argument.

When the first enthusiasm over the results of the osteotomy had subsided, we find a more reserved attitude towards operative therapy, more emphasis than before being laid on the chances of spontaneous cure.

Among the advocates of a far reaching expectative treatment we shall first of all mention *Bergmann* and his co-workers *Schlange* and *Voit*, who very frequently are quoted. According to the Bergmann school the rachitic deformities of the extremities diminish unaided, so long as the patient is not retarded in growth.

A similar point of view is expressed by *Kamps* in a publication inspired by *Bruns*: "Über die spontane Geradestreckung der rakitischen Unterschenkelverkrümmungen", 1895. It is here maintained that the legs in by far the most cases straighten themselves out or at least are improved without special treatment, and that this occurs before the 6th year. If, on the other hand, considerable deformity should remain after the 6th year, spon-

taneous cure must be considered out of the question. From these theses *Kamps* draws the conclusion that the treatment should be conservative until the patient is 6 years old—after that surgery may be required.

At first only a few voices were lifted against the views of the optimistic clinicians. Thus at a meeting of Berlin surgeons in 1892 *J. Wolff* was alone in expressing a certain scepticism regarding the widespread belief in natural cure.

For a long period about the turn of the century it actually looked—as pointed out by *Aberle*—as if the ideas formulated by *Kamps* were the gospel with regard to the treatment of curvatures of the leg in rickets. We have testimony to this effect, not only from the authors already cited, but also from such men as *Grisel*, *Reuter*, *Kölliker*, *Poort*, *Taylor*, *Eiselsberg* and several others, though *Hoffa*, for example, at the same time announced himself as supporting the early operation.

In 1907 *F. Lange* gave a lecture before practicing physicians where he strongly opposed the prevailing conservative ideas, claiming that spontaneous cure did not occur in the majority of cases and that it was not without importance to the results whether the orthopedic-surgical treatment was applied during early age or, as then advocated, not until the patient had passed his 6th year.

In the opinion of *Lange* the special treatment, in case of children aged 1 to 2 years, where the bones still are relatively flexible, should be confined to the use of night splints; if this has not straightened the curvature at the time when the bones begin to get firmer, osteoclasis must be applied, or, if that fails, osteotomy.

In a paper from the clinic of *A. Lorenz* in 1910 *Aberle* agreed with this point of view. On the basis of his clinical experiences he refused to accept the great expectations attached to spontaneous cure and argued in favor of an individualizing treatment with no fixed rules; he moreover warned against operations and the use of orthopedic apparatus during the florid stage of the disease.

The same year *G. Krauss* published a comprehensive paper

in which he professed to a similar view of the question, and, for example, directly opposed *Kamps* with a critical survey of the results which had been published in the above mentioned paper. It was Krauss's idea that *Kamps* had not been sufficiently strict in what he required of the cases which he listed as cured. Krauss moreover argued emphatically in favor of the special point of view that mechanical-orthopedic therapy was the sovereign remedy for rachitic deformities of the extremities and in by far the most cases could make operative treatment superfluous.

During the congress of the German Orthopedic Society in 1921 *Hohmann* submitted the whole problem to renewed examination. After having referred to the importance of antirachitic treatment side by side with the special therapy, he summed up the experiences of himself and others in a few main points.

First it is argued that of the rachitic deformities the arcuate curvatures of the leg are almost alone in showing a tendency towards spontaneous straightening. Moreover, that complete cure with no trace left of previous deformities only occur as very rare exceptions.

Then attention is called to the unfortunate consequences of even minor deformities—it is here partly a question of looks, partly of various static detriments which appear in the course of time.

On the basis of these and other facts *Hohmann* submitted some weighty objections to the thesis of the late operation and made himself the advocate, like *Aberle*, of a treatment determined according to evaluation and observation of the individual case. With regard to concrete methods he supported the principles already laid down by *Lange*.

But *Hohmann's* contribution did not put an end to the discussion. At the very same congress *Stoffel* appeared as a defender of ideas which in several respects resembled those of *Bergmann* and *Bruns*. For instance, he warned against any kind of mechanical-orthopedic treatment while the children were small, and especially as long as the florid stage had not been passed. Most of his own patients had been operated upon after the 5th year.

Stoffel called for more comprehensive data on patients, operated upon or treated with plaster of Paris casts according to Anzoletti, where the treatment had been early, *i.e.*, at the age from 2 to 5 years. In such cases he feared to find relatively many relapses.

The statements made by Stoffel soon brought *Gaugele* into the current discussion, giving almost complete support to Hohmann.

Aside from the discussion regarding spontaneous cure and indications for operative treatment, the literature of deformities of the extremities in rickets has in the last 20 to 30 years contained numerous papers on technical therapeutic problems, including, for example, a long series of special operative methods (*Perthes, Springer, Loeffler, Bentzon, Orth, Roepke, Rabl*, etc. etc.).

Of clinical papers from recent years those published by *Schmidt* and *Norrby* may be mentioned. Both investigators observed their patients for a long time after the operations. In by far the most cases the results were good. *Norrby*, however, mentions 2 cases of pseudo-arthritis after osteotomy and has also observed relapse in a boy who was operated upon for bowleg at the age of 6 to 7 years.

A turning-point in the treatment of rachitic deformities of the extremities has undoubtedly been reached with the new medical aids directly aimed at the general rachitic condition. While it was still eagerly discussed, as late as 20 years ago, what attitude one should take to the deformities at the florid stage, this question is no longer of any special interest. The reason is that it is now undoubtedly rare that a florid case of rickets cannot be arrested by means of concentrated vitamin preparations when it has once been diagnosed. For the same reason the question of relapse after early operative treatment is now looked at in a different light.

It is another matter that some cases perhaps may indicate the choice of the florid stage, when the bones are especially yielding, as the proper time for osteoclasis, perhaps successive adjustments or the introduction of a treatment according to the

special "bone-softening" methods which have been suggested by *Auzoletti, Roepke* and *Rabl*.

---

The material to be described in the present paper comprises patients with rachitic deformities of the leg below the knee, but inasmuch as numerous changes of shape may be included within this term it is probably best to consider in more detail how these cases previously have been described.

The ordinary deformity is, as a rule, characterized by a more or less arch-shaped curvature, the vertex of which is approximately at the transition between the central and distal third of the leg below the knee, with the convexity disposed laterally.

*Volkman* has already mentioned this type as the one most commonly described, though adding that he himself had seen several distinctly angular bends immediately proximal to the ankle.

Many authors have later maintained that the laterally convex curvature in many cases also is turned somewhat forward, not infrequently with a twist of the tibia and fibula, causing the foot to be inverted.

According to *Mikulicz* a rachitic deformity of the leg just below the knee in children will practically always have the character of a valgus bowing and thus be included in the picture of genu valgum, as a rule accompanied by a corresponding valgus transformation of the distal end of femur.

*Krauss* and others teach that besides the already mentioned ordinary curvature of the extremities a type is frequently found which is distinguished by a uniform curvature evenly distributed over all regions of the leg below the knee. Other deformities like curvatures with posteriorly or medially disposed convexities have been described, but are relatively rare.

During the years 1920-1940 700 patients with rachitic deformities of the leg have come to the Orthopedic Hospital in Copenhagen. Many of these patients also showed other rachitic

deformities, mostly flat feet, but also the usual deformities of femur, thorax, head and spine.

In by far the most cases the deformities of the legs seemed to be of the ordinary type, bilateral with curvatures laterally or laterally-anteriorly disposed. Only a few of the case records, however, give detailed description.

As a rule, the degree of the deformities was measured as the largest distance between the legs, determined in standing position, with the feet together and parallel. A rough estimate shows that about  $\frac{2}{3}$  of the cases have been mild, the complaint chiefly being that of appearance. In the remaining third the curvatures were either more pronounced (largest distance between the legs 5-7 cm or more) or detriments were found beyond those of appearance.

Judging by the routine clinical examination the rachitic processes were still active in a large number of the patients at the time when first entering the hospital, though in most cases the disease seemed to have passed the florid stage. It should here be observed that the average age at the first consultation was about 3 years.

Only 9 patients were below 1 year, 24 above 10 years. The material comprised 380 girls and 320 boys.

Within the period considered—1920 to 1940—there was in the main a continued decrease of the number of patients, though with strikingly large variations from year to year. The number of patients with other rachitic deformities showed a similarly falling curve.

In the majority of the cases (about 630) the treatment was conservative, *i. e.*, with prescriptions of cod-liver oil, good and ample diet, baths, stay in the country, etc.

When signs of florid rickets were found care was taken to have the patient given special anti-rachitic treatment. In severe cases, or when social conditions made it desirable, the children were placed for a more or less extended period of time in the orphanages of the institution.

Many of the patients who in addition to the deformities of the legs suffered from flat feet were supplied with arch sup-

ports, and attention was naturally given to other possible deformities. Except for the arch supports no orthopedic apparatus or bandages were employed.

Of the approximately 630 patients not operated upon, 226 were later seen—of these about 150 were more than 5 years of age at the time of the latest examination. The average time of observation for the post-examined patients in this group amounted to almost 3 years.

At the last observation only a minority of the group showed any considerable remnants of the deformities, though it should be added that positive records of complete or almost complete cure were not made in more than about 25 instances. None of the patients in this group has later turned up because of functional disturbances.

A systematic later examination of the conservatively treated patients would have been highly desirable, but could not be carried out under the prevailing conditions.

Operative treatment was given to 68 patients, *i. e.*, almost 10 per cent, including 39 girls and 29 boys. The average age for this group was 3 years at the first consultation, 4 years at the time of operation. Thus, as a rule, the operation was preceded by a long period of observation, on the average about 1 year, during which period it was endeavoured to form an idea of the tendency of development of the deformities, the period at the same time being used for a general treatment fitted to each individual case.

When an operation was decided upon it was always with due consideration to the changes noticed during the period of observation. Unsatisfactory spontaneous straightening, slight growth in length, or persistent functional disturbances have in many cases been the deciding factors when an operation was considered necessary, but first and last it was the nature and the degree of the deformities, from an anatomical point of view, that decided the question of treatment.

Thus it can be said, generally, that only relatively severe curvatures, and preferably such as experience shows are but rarely cured spontaneously, have been subjected to operation. The curvatures in question were especially those with a more

or less anteriorly disposed convexity, and moreover the cases where the deformity approached an angular bend.

With a single exception the operation was always bilateral. In general, osteotomy was applied to the tibia at the top of the curvature, frequently with resection of a small wedge, whereupon the fibula was fractured manually.

Manual adjustment was applied in 3 cases. There was 1 case of regular osteoclasia with the aid of the osteoclast.

2 patients were operated upon according to the method of *Springer* (subperiosteal, temporary resection of the deformed bone section which was put back after segmentary sawing through), and 1 according to *Löffler* (mincing of temporarily resected bone tissue which again was placed in the periosteal tube). Once osteotomy was performed at two different places of the tibia in the same operation.

Following the operation the patients were in bed for 8 weeks with plaster of Paris casts. In some cases where the retention of the fragments caused difficulties, the necessary correction was made after about 4 weeks with subsequent bandaging for another 4 weeks. The adjustment of the foot to a slightly equinus position was occasionally found useful, when tightening of the Achilles' tendon maintained a dislocation of the bone cut through.

Several authors have stated that osteotomy, without involving any great risk, always leads to complete correction of the deformities, but in reality it seems that such statements regarding the prognosis for patients operated upon are but rarely supported by prolonged systematical checking of the material.

In case of the present investigation it has been endeavoured to make up for the lack of such documentation by a regular post-examination of the surgically treated patients. This has been possible, though, only in the case of 60 of the 68 patients in question, to which should be added that the hospital has not been in direct contact with 10 of the patients, who, at the hospital's request, have been examined by their own physicians. The results of the latter examinations have very kindly been placed at the hospital's disposal.

The 60 post-examined patients have on the average been

observed during a period of 12.5 years. Of the remaining 8, whom it was impossible to trace, 2 had previously been checked  $\frac{1}{2}$  year and 1 as late as  $2\frac{1}{2}$  years after the operation.

At the post-examination many of the patients still showed signs of having suffered from rickets. More or less pronounced flat feet were thus common and there also occurred moderate degrees of bowleg and knock-knee.

It was found, however, that about  $\frac{1}{3}$  of the patients showed no trace of the deformities of the legs, while  $\frac{1}{3}$  showed only insignificant curvatures, frequently so inconspicuous that under other conditions one would not suspect anything abnormal.

The remainder of the patients operated upon could not be said to be free from reminders of the earlier deformities, though in most instances it was only a question of a slight departure from the normal.

5 to 6 patients at the most showed curvatures which had to be considered unquestionable defects from the point of view of appearance. Among these were 2 with convexities anteriorly disposed.

Only 2 patients showed functional disturbances and static difficulties which reasonably could be attributed to the leg deformities or the operation performed.

One of these patients, a young man of about 22, was treated, at the age of 3 years, for a medium-strong bilateral *crus varum*, the treatment involving osteoclasis. During the preceding year he had been subjected to conservative treatment. When re-examined 18 years later he showed distinct remnants of the curvatures; he moreover complained of pains in the knee. The investigation of the knee joints, including X-ray examination, disclosed no special changes beyond some degree of *genu varum*. Undoubtedly, however, there is reason to fear a later onset of arthrosis in the knee joints due to the mechanical disproportion.

The other patient with functional disturbances had at the age of 6 been subjected to bilateral osteotomy of the leg with good result. However, when she reached her 16th year it was found necessary to perform osteotomy on both femurs, because of severe deformities of these bones. The post-examination, which

took place 16 years after the first operation, showed complete straightening of the curvatures of the leg below the knee. There was found, however, right-sided genu valgum and left-sided genu varum, and a little lateral laxity of the left knee joint. The patient had a feeling of rickety joint in the left knee. The femurs were disproportionally short and still somewhat curved.

In this case it was a question of widespread deformities of the lower extremities, and the crural curvatures were of secondary importance in comparison with the severe changes of the femurs and knee joints which quite apparently were responsible for the functional disturbances of the patient.

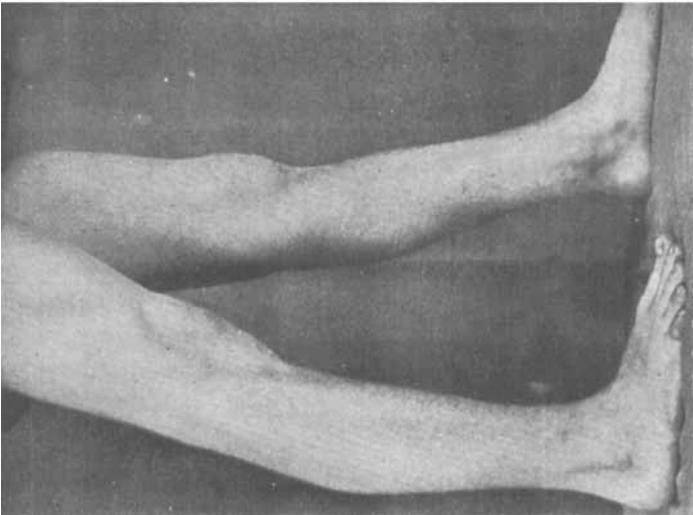
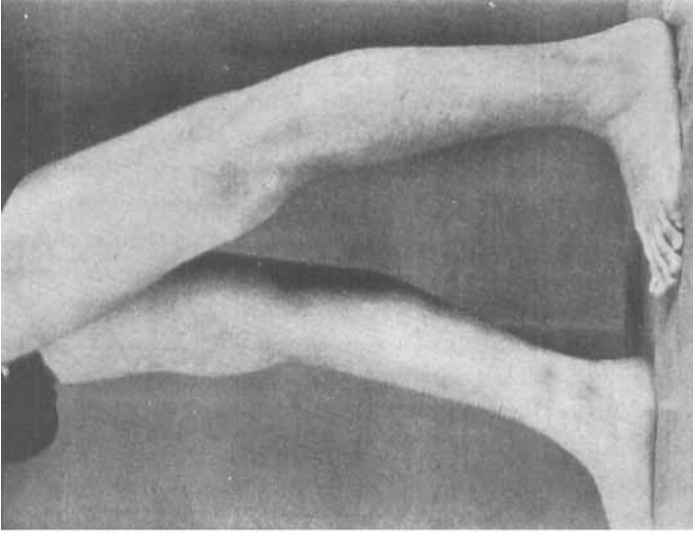
Serious complications in connection with the operations have not occurred, nor any instances of actual relapse.

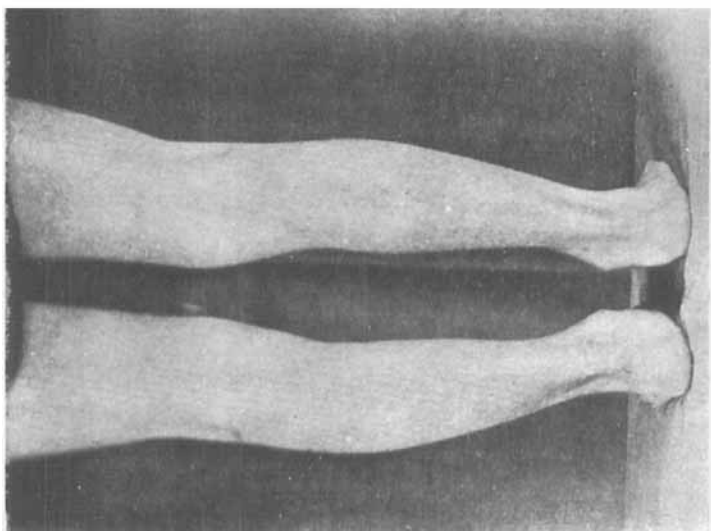
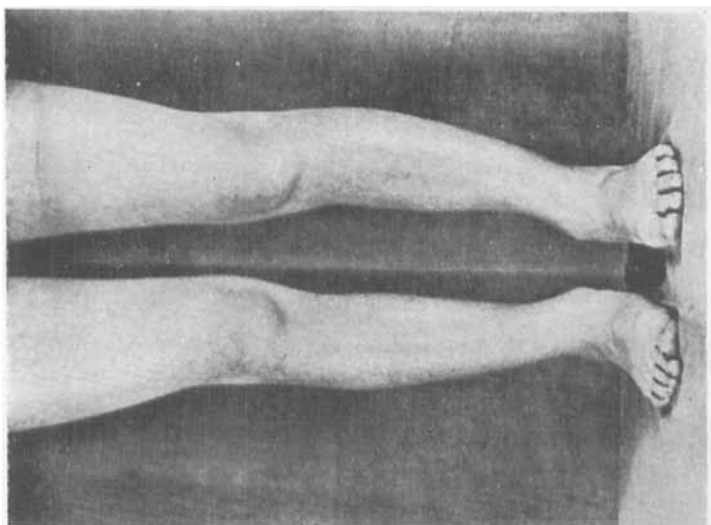
There were no instances of pseudoarthrosis after the osteotomies within the category of patients dealt with here. This should not be taken to mean, however, that the risk of this operation would be just as small in the case of adult patients.

In order fully to evaluate the significance of the operative treatment in the material at hand it would not even suffice to have carried out a thorough control of all patients, those treated conservatively as well as those operated upon, since the latter group represents all the most severe cases, thus making a direct comparison of the two groups impossible.

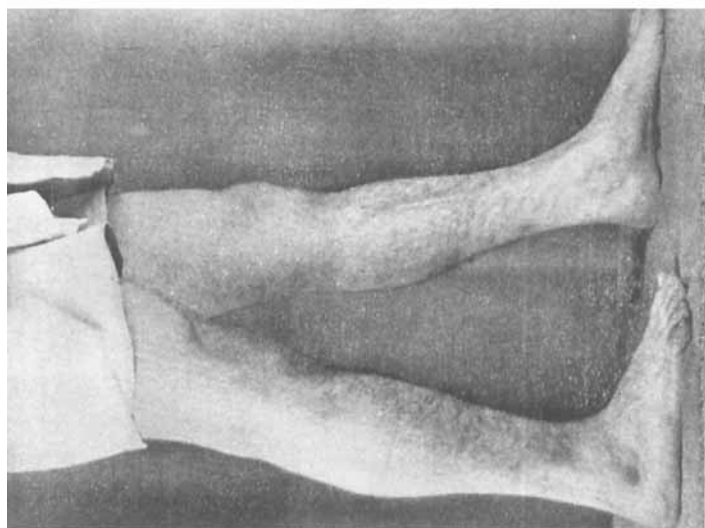
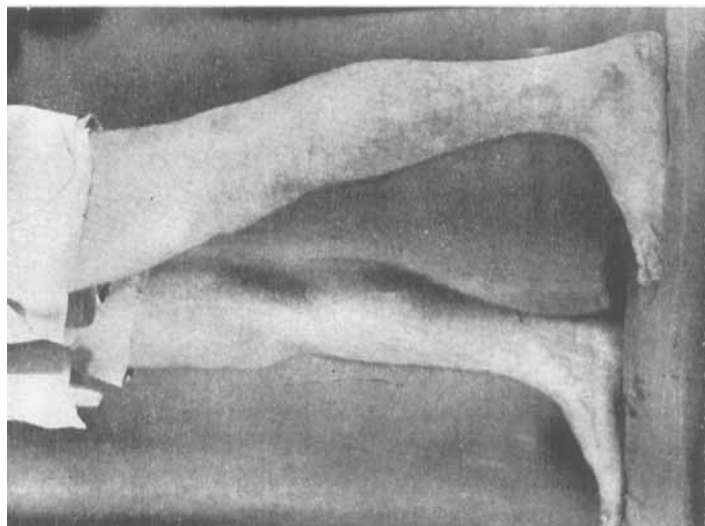
Therefore, if one is to get an idea of what the operative treatment of these rachitic deformities may yield beyond the results obtainable by other therapy it becomes a matter of judgment based on clinical knowledge and personal experience.

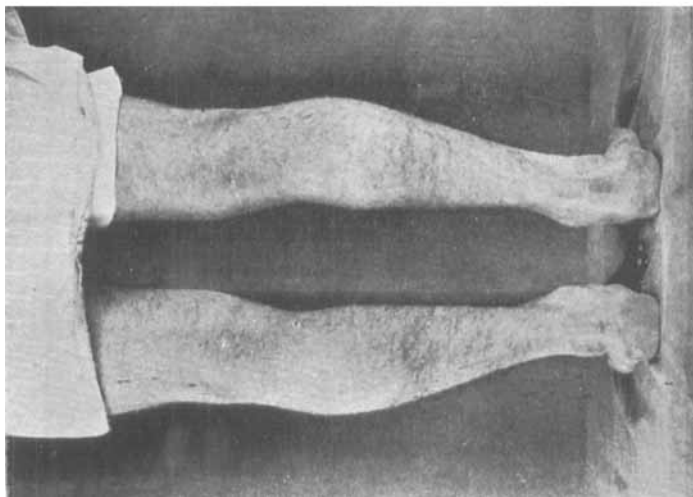
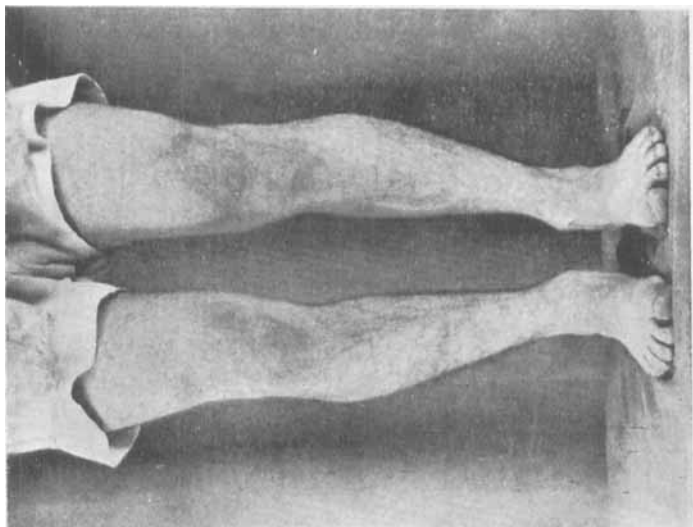
It may be said, however, that the general impression gained from the material included in the present paper is that operative treatment is required in a number of cases which may be determined according to the guiding principles pointed out in the paper.





. No operation. Unsatisfactory result.  
1866/28. ♀. 2½ years old at the time of first consultation. Severe deformity. Florid rickets. Conservative treatment. Patient examined again when 14 years of age.



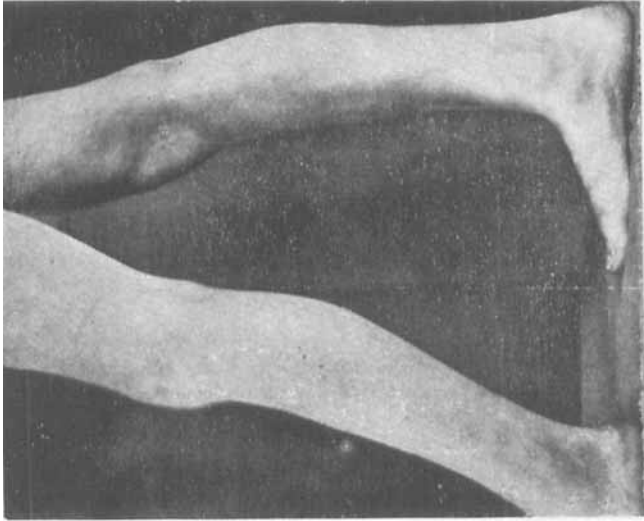


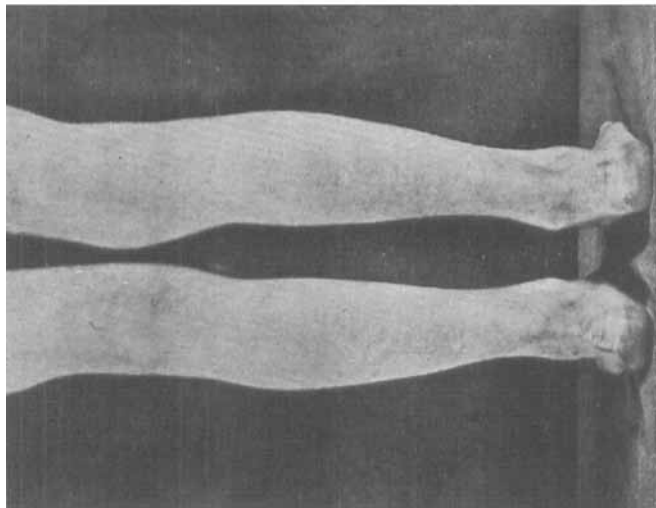
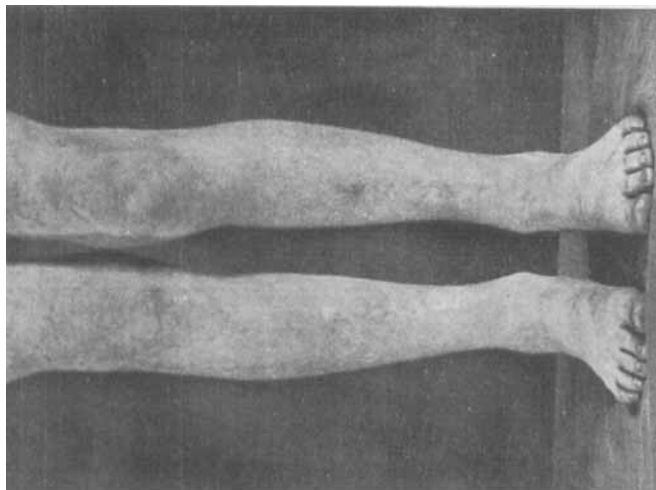
Poor result, as regards appearance, after operative treatment.

692/21. ♂. 4 years old at the time of first consultation. Severe deformity. 6 months of conservative treatment.

When 4½ years old, osteotomy tibiae utr. Patient examined again when 22 years of age.

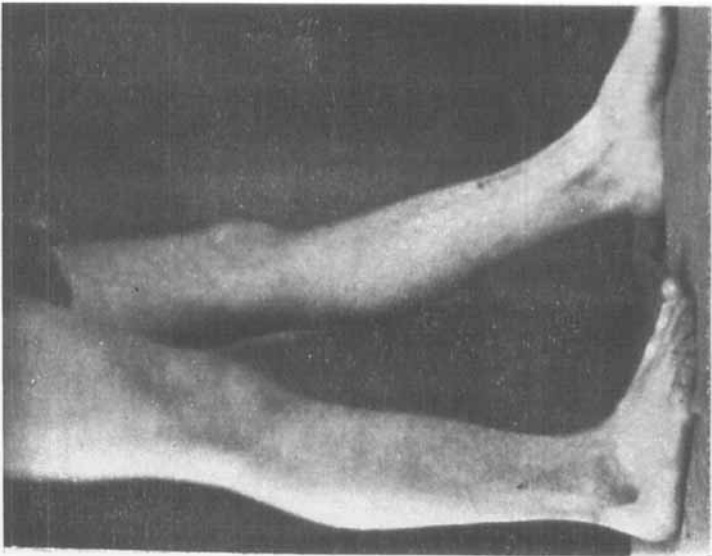
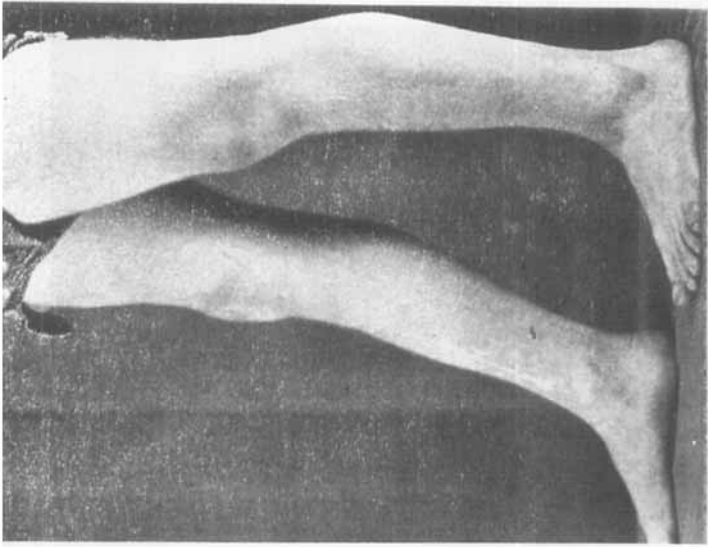
No functional disturbances.

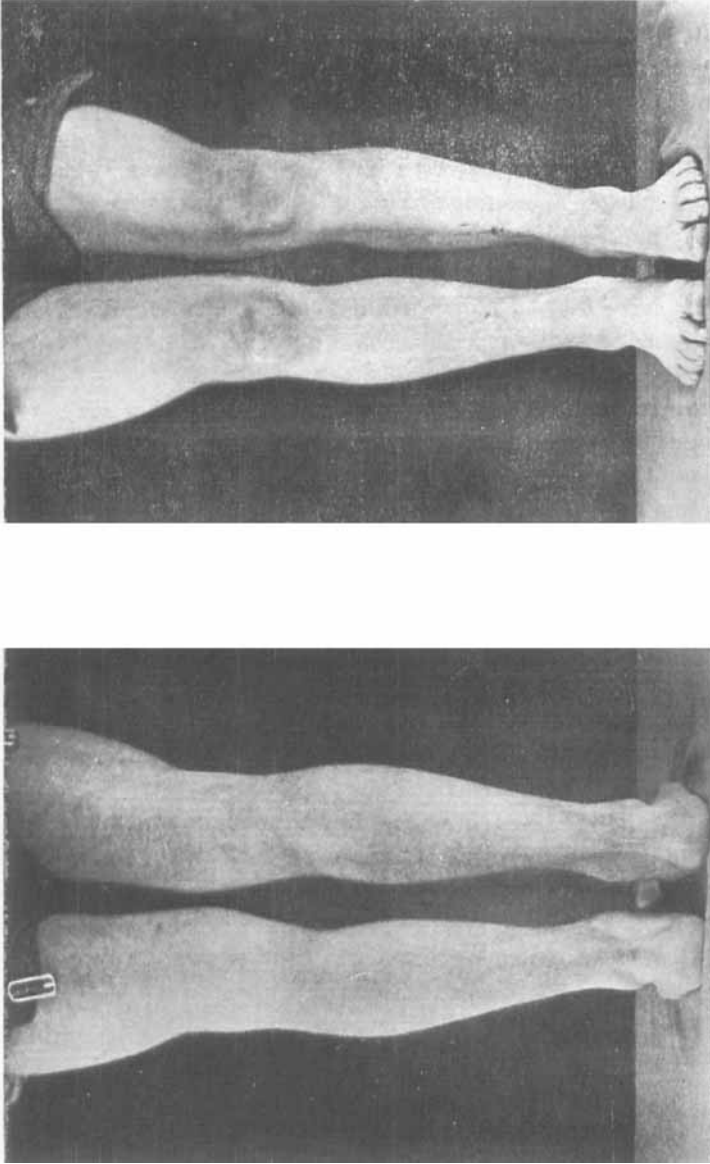




Not entirely satisfactory result of operative treatment.

1693/29. Q. 1½ years old at the time of first consultation. Medium severe deformity. Conservative treatment. When 4 years old, osteotomia tibiae utr. Patient examined again when 12 years of age. Some tendency to tired feet.





Good result of operative treatment.  
638/28. ♂. 4½ years old at the time of first consultation. Medium severe deformity. 2 months later osteostomia tibiae utr. Examined again when 14 years of age. No complaints.

## SUMMARY

Of about 700 patients with rachitic curvatures of the leg 630 have been treated only conservatively while 68 (or approximately 10 per cent) also have been given operative treatment.

About  $\frac{1}{3}$  of the conservatively treated patients have been observed for a period averaging 3 years. As far as appearance is concerned, the results seem satisfactory in the majority of the cases. 25 patients had no trace of deformity left.

Operations have been performed only in the case of severe deformities, principally when it has been a question of anteriorly disposed curvatures or angular bends.

The operations have nearly always been preceded by a long period of observation (average 1 year) during which conservative treatment has been applied.

The rule has been bilateral osteotomy of the tibia with small wedgedshaped resection.

The average age of the patients at the time of operation has been 4 years.

60 of the patients operated upon have been examined at a later stage, on the average 12.5 years after the operation.

In about  $\frac{1}{3}$  of these patients no trace could be found of the deformities—a number of others showing slight curvatures, most frequently of no practical significance.

Not more than 5-6 patients have shown what may undoubtedly be called disfiguring deformities of the legs.

Functional disturbances have occurred in two cases only where, besides the usual curvature, other deformities of the lower extremities were involved.

## RÉSUMÉ

Sur environ 700 malades présentant une incurvation rachitique de la jambe, 630 avaient subi un traitement uniquement conservateur, alors qu'un traitement opératoire avait été pratiqué dans 68 cas (soit dans approximativement 10 % des cas).

Environ  $\frac{1}{3}$  des malades soumis au traitement conservateur avaient été suivis pendant une période moyenne de 3 ans. En ce qui concerne l'apparence, les résultats semblent satisfaisants dans la majorité des cas.

Des opérations n'ont été pratiquées que dans les cas de déformité grave, principalement lorsqu'il a été question d'une incurvation antérieure ou d'une angulation.

Les opérations ont presque toujours été précédées par une longue période d'observation (en moyenne d'une année) durant laquelle le traitement conservateur a été appliqué.

En général, on a pratiqué une ostéotomie bilatérale du tibia, avec de petites résections cunéiformes. L'âge moyen des malades au moment de l'opération était de 4 ans.

60 des malades opérés ont été examinés plus tard, en moyenne 12 ans et demi après l'opération.

Chez environ  $\frac{1}{3}$  de ces malades on n'a pu trouver de traces de la déformité. Un certain nombre d'entre eux présentaient une légère incurvation, n'ayant le plus souvent aucune importance pratique.

On a trouvé chez 5 ou 6 malades au plus des déformités de la jambe que l'on pouvait qualifier de défigurantes.

Des troubles fonctionnels ne se sont manifestés que dans 2 cas et seulement quand, à côté de l'incurvation usuelle, il y avait aussi d'autres déformités des membres inférieurs.

### ZUSAMMENFASSUNG

Von ungefähr 700 Patienten mit rachitischen Krümmungen der Beine wurden 630 ausschliesslich konservativ behandelt, während 68 (oder annähernd 10 %) auch einer operativen Behandlung unterworfen wurden.

Ungefähr  $\frac{1}{3}$  der konservativ behandelten Patienten wurden während eines Zeitraums von durchschnittlich 3 Jahren beobachtet. Dem Augenschein nach sind die Resultate in der Mehrzahl der Fälle befriedigend.

Operationen wurden nur in den Fällen, wo ernstliche De-

formitäten vorlagen, vorgenommen, wesentlich wenn die Krümmung nach vorne gerichtet war oder wo winkelige Biegungen bestanden.

Den Operationen ging fast immer eine lange Beobachtungsperiode (von durchschnittlich 1 Jahre) voraus, während welcher konservative Behandlung angewandt wurde.

In der Regel wurde bilaterale Osteotomie der Tibia mit einer kleinen keilförmigen Resektion vorgenommen.

Das Durchschnittsalter der Patienten zur Zeit der Operation war 4 Jahre.

60 von den operierten Patienten wurden später, im Durchschnitt 12,5 Jahre nach der Operation, untersucht.

Bei ungefähr  $\frac{1}{3}$  dieser Patienten war keine Spur der Deformitäten zu finden. Einige andere zeigten geringfügige Krümmungen, meist ohne praktischen Belang.

Nur 5-6 Patienten wiesen entschieden entstellende Deformitäten der Beine auf.

Funktionelle Störungen kamen nur in zwei Fällen vor, in welchen ausser der gewöhnlichen Krümmung noch andere Deformitäten der unteren Gliedmassen vorlagen.

#### REFERENCES

- Aberle, R.*: Wien. med. Wch.schr. 58. 391. 1908.  
*Bentzon, P. G. K.*: Acta orth. Scand. 9. 210. 1938.  
*Billroth, Th.*: Arch. f. klin. Chir. 2. 651. 1862.  
*Boeckel, J.*: Revue de Chir. 2. 463. 1882.  
*Eiselsberg*: cit. *Saxl, A.*: Wien klin. Wch.schr. 20. 547. 1907.  
*Gaugele*: Arch. f. orth. Chir. 20. 430. 1922.  
*Gernand, J.*: Diss. Mainz. 1882.  
*Grisel, P.*: Thèse. Paris. 1900.  
*Guérin*: cit. *Gernand*: Diss. Mainz. 1882.  
*Gussenbauer, C.*: Arch. f. klin. Chir. 18. 1875.  
*Hagyard, R.*: Lancet. 1297. 1890.  
*Hoffa, A.*: Lehrbuch d. orth. Chir. 1902.  
*Hohmann, G.*: Verh. d. deutsch. orth. Ges. 16 Kongr. 298. 1921.  
*Jones, Th.*: Lancet. 235. 1877.  
*Kamps, G.*: Beitr. z. klin. Chir. 14. 243. 1895.  
*Krauss, G.*: Z. f. orth. Chir. 26. 193. 1910.

- Kölliker, Th.*: Arch. f. klin. Chir. 69. 48. 1903.  
*Lanze, F.*: Münch. med. Wch.schr. 54. 655. 1907.  
*Langenbeck, B.*: Deutsche Klinik. 6. 327. 1854.  
*Loeffler, F.*: Deutsch. med. Wch.schr. 46. 1274. 1920.  
*Macewen, W.*: Die Osteotomie. Stuttgart 1881.  
*Marsh, H.*: Med.-chir. trans., publ. by the Royal Med. and Chir. Soc. 57. 145. 1874.  
*Mayer, A.*: Deutsche Klinik. 8. 119. 1856.  
*Mikulicz, J.*: Arch. f. klin. Chir. 23. 561. 1879.  
*Norrby, S.*: Acta orth. Scand. 8. 208. 1937.  
*Orth, O.*: Z.bl. f. Chir. 50. 989. 1923.  
*Perthes, G.*: Z.bl. f. Chir. 1614. 1921.  
*Poort, K.*: Münch. med. Wch.schr. 49. 2006. 1902.  
*Poulsen, K.*: Z.schr. f. orth. Chir. 28. 1. 1911.  
*Rabl, C. R.*: Jahrb. f. Kinderheilk. 116. 63. 1927.  
*Reuter, W.*: Diss. Kiel. 1899.  
*Schlange*: Berlin. kl. Weh.schr. 30. 124. 1893.  
*Schmidt, W.*: Deutsche Z. f. Chir. 209. 326. 1928.  
*Springer, C.*: Beitr. z. kl. Chir. 132. 692. 1924.  
*Stoffel, A.*: Verh. d. deutsche orth. Ges. 16 Kongr. 315. 1921.  
*Taylor, H. L.*: Journ. Am. Med. Assoc. 39. 901. 1902.  
*Veit, W.*: Arch. f. klin. Chir. 50. 130. 1895.  
*Volkman, R.*: Beitr. z. Chir. 224. 1873 (ed. 1875).  
— Berlin. kl. Wch.schr. 591. 1877-78.  
*Wolff, J.*: Berlin. kl. Wch.schr. 30. 125. 1893.