Newer Clinical Signs of Early Rickets

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NEWER CLINICAL SIGNS OF EARLY RICKETS *

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Nearly three centuries ago, rickets was recognized and very ably described by a group of English physicians, Glisson, Bate and Regenmarter.[1] The first recorded death from this disease was in 1630.[2] Boötius,[3] in 1649, writing in Latin, said of rickets, "This malady is a sore affection in many thousand infants." An equal prevalence of rickets today warrants our interest in it, while our newer methods of study enable us to recognize even the milder cases of the disease. The Pacific Northwest, with its great number of cloudy days, seems a very fertile soil for this infantile dyscrasia.

Experimental evidence indicates that clinical manifestations of the disease occur first in the nervous system, secondly in the muscular system, and thirdly in the bony system.[4] This paper, however, will be confined to some of the more important skeletal signs. Guérin [5] considered that rickets was manifested first in the legs and worked upward. Barlow [6] in his study nearly a half century ago, asserted that the head and chest were

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* This paper, together with the papers by Dr. Leonard Findlay and by Drs. E. T. Wyman and C. A. Weymuller, constitute part of a symposium on rickets. The remaining papers by Dr. A. F. Hess and by Drs. L. R. De Buys and Ludo von Meysenbug, together with the discussion, will appear next week.

1. Glisson, Francis: A Treatise on Rickets, Ed. 2, London, 1650; translated from Latin by Phil Armin, London, 1668.

2. English Mortuary Tables for 1630, quoted by Trousseau in Clinical Medicine, London, the New Sydenham Society **5**: 47, 1872.

3. Boötius, quoted from the Latin by Haller (Bibliography Med. Pract., 1779), and by Jacobi in Pepper's System of Medicine **2**: 146, 1885.

4. Moore, C. U.: Experimental Studies of the A Vitamin, Tr. Sect. Dis. Child. A. M. A., 1922, pp. 136-149.

5. Guérin, Jules: Mémoire sur le rachitis, 1838, cited in Trousseau's Clinical Medicine **5**: 49-60, 1872.

6. Barlow, Thomas: Rachitis, in Keating's Encyclopaedia of Diseases of Children **2**: 224, 1889.

first affected. Recent findings of De Buys,[7] in New Orleans, and of Hess,[8] in New York, substantiate the latter view.

Both in animals [9] and in man, rickets develops during the period of the most rapid growth of that portion of the body affected. We should therefore expect the head to be affected first, the thorax second, and the extremities third. The limits of this paper will not permit the inclusion of detailed data concerning this point, but a careful study of a considerable number of these cases over a period of five years indicates that this is a satisfactory rule. It is often true that all parts of the body show signs of rickets at the same time. It is also true that the only osseous evidence of rickets in some cases is found in the cranium; in others, in the thorax, and in still others, in the upper or lower extremities. Only the most painstaking examination of every infant at frequent intervals will reveal rickets in its incipient stages. During the first four months of extra-uterine life, there is approximately a 20 per cent. increase in the size of both the head and the chest. It is during this early period that craniotabes or cranial rickets most frequently occurs. The head grows comparatively slowly during the latter half of the first year, which marks a period of healing.

Craniotabes was first discovered and named by Elsässer,[10] who described it as areas of parchment-like bone found chiefly on the occiput and parietals during early infancy. Repeated careful examinations of the head during the first four months have revealed this symptom in 60 per cent. of the winter-born babies in our section of the country. Associated with or following this softening of the cranial bones, one finds palpable parietal bosses and flattening of the posterior or posterolateral portions of the head. The mastoid fontanel is usually first to soften and last to harden. At birth, this has about the same consistency as the bones around it, but at from 3 to 8 weeks, palpable flexibility often appears. Occasionally, there is exten-

7. De Buys, L. R.: A Clinical Study of Rickets in the Breast-Fed Infants, Am. J. Dis. Child. **27**: 149 (Feb.) 1924.

8. Hess, A. F., and Unger, L. J.: Infantile Rickets—The Significance of Clinical, Radiographic and Chemical Examinations in Its Diagnosis and Incidence, Am. J. Dis. Child. **24**: 327 (Oct.) 1922.

9. Mellanby, Edward: Experimental Investigation on Rickets, Lancet **1**: 407 (March 15) 1919.

10. Elsässer: From Keating's Cyclopaedia of Diseases of Children **2**: 225, 1889.

sive softening, as is shown in Figure 1. This picture, taken December 22, when the baby was 9 weeks of age, illustrates the extent and location of flexibility. In this case, the mother was given a balanced diet, with a food

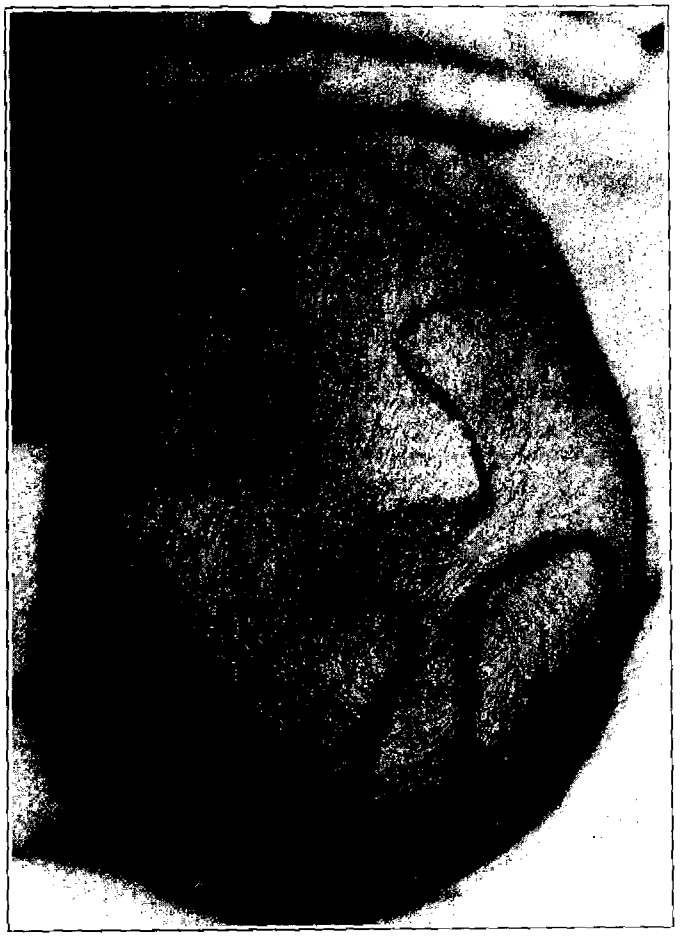


Fig. 1.—Cranial rickets in a baby 9 weeks old. Area within the lines was flexible. Softening also extended laterally along the parieto-occipital sutures to the mastoid fontanels.

ratio of one to seven, including an abundance of green vegetables. In addition, she was given 8 c.c. of cod liver oil daily. The infant received breast milk exclusively. Eleven weeks later (February 12) another

picture was taken. This shows complete recovery, except at two points: (1) An oval area 1 by 3 cm. along the sagittal suture, beginning posterior to the anterior fontanel but separated from it by 1 cm. of hardened bone; (2) a circular area 1 cm. in diameter at each mastoid fontanel. If one will outline with an eyebrow pencil the exact extent of the flexible area, he will often find it greater than expected.

The shape of a normal chest at birth is practically circular at a plane through the costochondral junction of the fifth rib. In a few weeks, there is frequently a change in its form at this plane. The three most com-

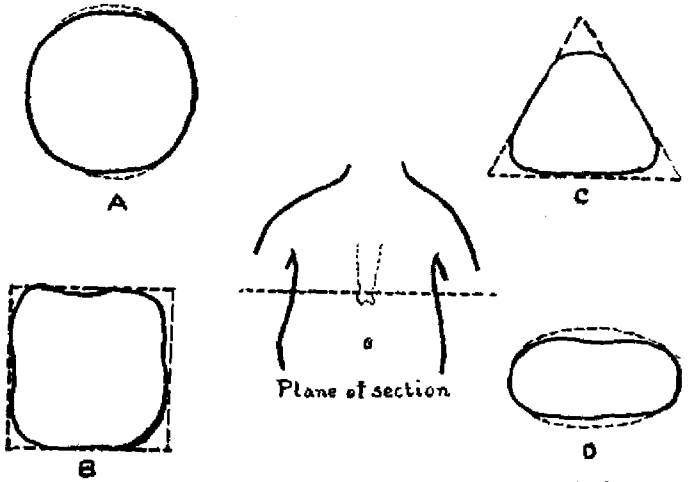


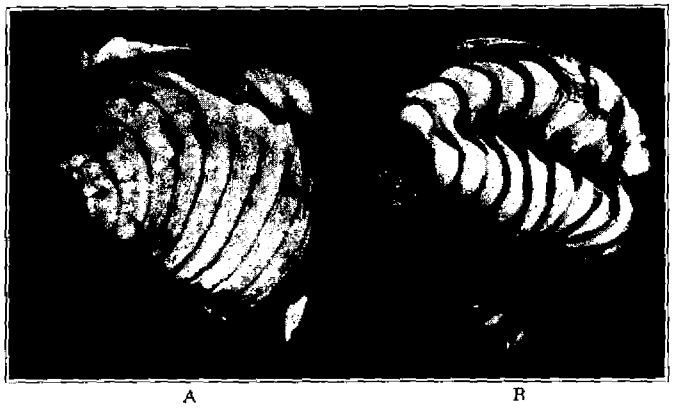
Fig. 2.—Forms of chests seen in transverse section through the costochondral junction of the fifth rib: *A*, normal chest; *B*, *C*, *D*, pathologic chests.

mon pathologic forms found during the first four months are, in the order of frequency: square, triangular and oval, or "flat." During the second four months of life, and later, this order gradually becomes reversed.

The square chest has its anterior corners or angles near and parallel to the mammary lines; its posterior ones, at the posterior axillary lines. The triangular chest has rounded posterior angles situated at the posterior axillary lines, and a flattened anterior angle which is usually wider than the sternum. The anterolateral sides of this triangle extend upward to the axilla and downward to the flaring costal margin. The oval chest is flattened anteriorly approximately to the anterior

axillary line, and usually has an inspiratory depression at the xiphoid. This depression may later become fixed, forming a typical shoemaker chest. In the square chest, the beading of the ribs is more external than internal, in contradistinction to the triangular and oval chests.

In the normal chest at birth, the bony and cartilaginous portions of each rib are, on palpation, approximately equal in hardness. During the first trimester, this often changes so that the anterior portion becomes noticeably softer than the remainder. This softening may be purely cartilaginous, or it may include the rapidly growing anterior end of the osseous rib. It is most frequently found near the sternal ends of the third to the sixth ribs. "Chondromalacia" of Marchand repre-



A B

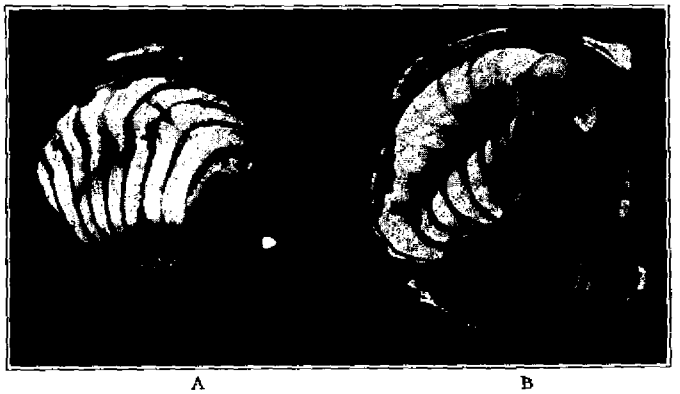
Fig. 3.—Photographs of rats' chests with the light shining through the thoracic wall: *A*, normal ribs; *B*, marked rickets before healing has commenced.

sents a different condition. The term "costomalacia," however, accurately expresses the meaning desired.

A study of the rachitic changes in the chest of experimental animals illustrates various degrees of abnormality. Photographs of our rats were made with the light shining through the thoracic wall, thus giving a translucent view simulating roentgenograms. A normal chest is shown in Figure 3 *A*, while Figure 3 *B* represents marked rickets before healing has commenced. A completely healed one-plus rachitic rosary is represented in Figure 4 *A*, only the sixth rib having been fractured; and a four-plus condition is shown in Figure 4 *B*. The fracture of each rib occurs at the insertion of the muscles about 2 mm. posterior to the costo-

chondral junction. Cases of similar severe rickets in human beings have been noted by many observers, but in our section of the country they are extremely rare.

Careful examinations of the head and chest in older children, and even in adults, frequently reveal the earmarks of this infantile malady. Craniotabes and costomalacia occur primarily during the first four months of life, but may appear at any time during the first year, depending somewhat on the season of birth and the weight at birth, as well as on heredity,[11] nutrition [12] and skin hygiene.[13] After the first few months, the head and chest grow proportionately more slowly than the extremities. Enlargement of the epiphyses



A B

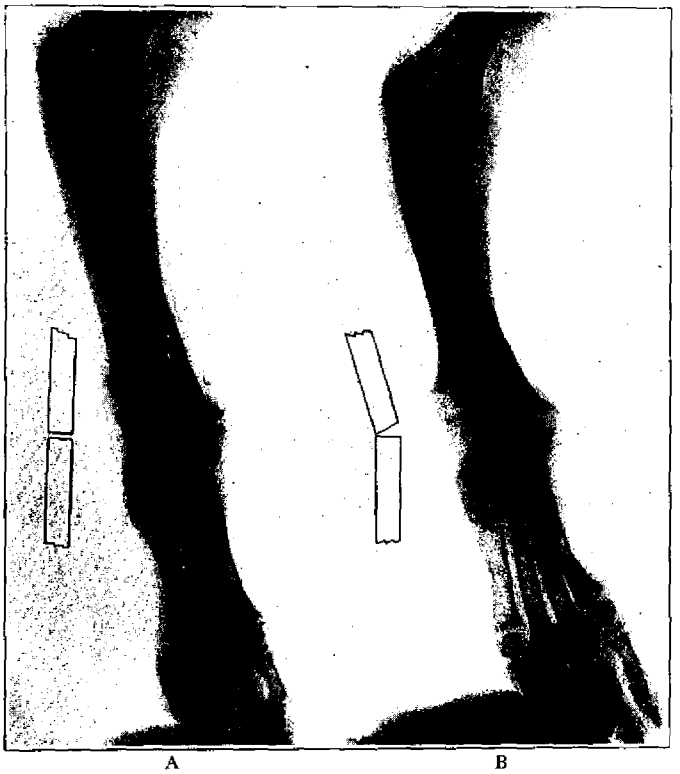
Fig. 4.—Healed thoracic rickets in rats, translucent view: *A*, a one plus rosary with one rib fractured; *B*, four plus condition with fractures of the ribs from 2 to 3 mm. from the costochondral junctions.

rarely occurs during the first half year of life. When a child begins to walk, bow-legs and knock-knees appear. If either craniotabes or costomalacia is observed, rickets of the extremities may be anticipated. As we all know, however, it is entirely possible to escape both cranial and thoracic rickets and still have loose joints and flat feet.

Perfect legs are straight, and parallel from the knee down. When one stands erect with the inner borders of the feet parallel and close together, the internal

11. Byfield, A. H., and Daniels, Amy L.: The Rôle of Parental Nutrition in the Causation of Rickets, J. A. M. A. **81**: 360 (Aug. 4), 1923.
12. Moore, C. U.: Nutrition of Mother and Child, Ed. 2, Philadelphia, J. B. Lippincott Company, 1924, Chapters I to IV.
13. Hess, A. F.: Rickets, in Abt's Pediatrics, Philadelphia, W. B. Saunders Company **2**: 916, 1923.

malleoli of the tibiae and the internal tuberosities of the femurs should be in approximation. To determine the degrees of deformity, the method used by tailors is satisfactory. Measurements can be made quickly if the child stands on a towel, on a flat, smooth surface, so that the feet can be moved freely by the examiner. In knock-knees, the number of centimeters between the



A B

Fig. 5.—Puppies' legs: *A*, close-knit, normal joints; *B*, loose, rachitic joints.

malleoli are measured when the knees are touching firmly. In bow-legs, the distance in centimeters between the knees is measured when the ankle bones are touching. When testing for genu valgum or varum, the child should stand in an easy, erect position, looking straight ahead. If he is looking downward, the knees are sometimes thrown backward and outward, giving

the appearance of bow-legs to legs that are, perhaps, perfectly straight.

During an experimental study of rachitic puppies,[4] it was noted that the distance between the bone ends at

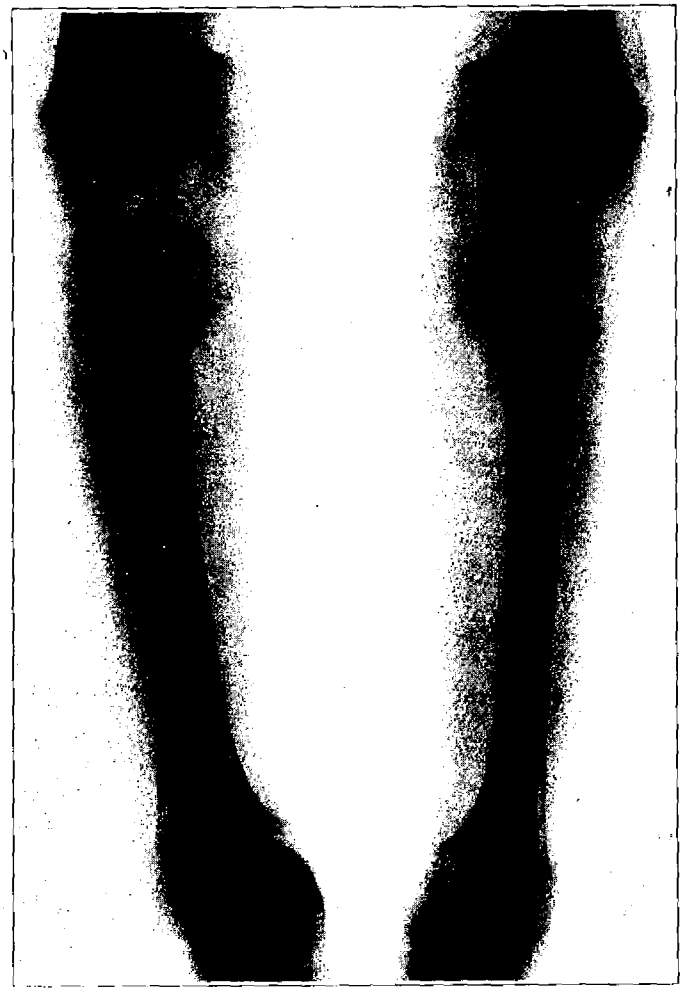


Fig. 6.—Rachitic legs in a child 22 months old, with the V-shaped joint lines at the knees.

the joints was much greater than normal, as shown in Figure 5 *A*. It is noticeable that in the normal leg, the joint line is narrow, definite and close-knit. In the rachitic leg (Fig. 5 *B*), on the other hand, the joint line

is very much wider at one side, the articular surfaces forming a V with the open end inward in cases of genu valgum. If one compares also the feet of these two puppies, he notices a remarkable difference in the bone ends. An arch made of units fitting firmly, as in Figure 5 *A*, would be strong and durable. It would, of course, be impossible for the open, loose joints of the foot in Figure 5 *B* to form a stable arch. Flat feet would, therefore, be inevitable.

Application of these findings to clinical practice has revealed similar conditions in children, as is shown in Figure 6. This child of 22 months had not yet walked alone. As the bone ends are more widely separated medially, knock-knees is easily anticipated. Lateral motility, or, if preferred, mediolateral motility, of the knees can be measured at any time after a child begins to support himself on his legs. Before that time, the tendons hold the knee more or less in a state of flexion, and the knee is apt to rotate while being moved laterally. Clinical observations show marked looseness of the lateral ligaments of the knee joint before either knock-knees or bow-legs have definitely developed. In time, one ligament becomes shortened and the other lengthened, while the epiphyses assume an abnormal position with reference to the shafts of the bones.

To test the lateral motility of the knee joint, the child should either be sitting or lying with the leg fully extended and the foot erect. The examiner grasps the leg at the knee with one hand, while with the other he holds the foot; with this position of vantage, he can move the knee back and forth laterally according to the degree of looseness. As the opposite ends of the bones strike together, an almost audible jolt can be felt. The amount of this lateral motility may be recorded approximately as from one to four plus. When the hips and the foot are held stationary, the amount of movement at the knee, although not great, is very definite if rickets is present. When the hips and the lower end of the femur are held stationary, the lateral movement of the heel is easily measurable While the hips of the child are held by the nurse, the physician grasps the femur with one hand and moves the foot back and forth with the other. After a little practice, results thus obtained are dependable.

To insure more accurate results, an apparatus called the "knee motility board" has been devised, which holds

the hips and femur immovable (Fig. 7). The child sits on the flat surface, while sliding side supports are adjusted tightly against the trochanters. Rapidly adjustable posts hold the leg firmly just above the knee.

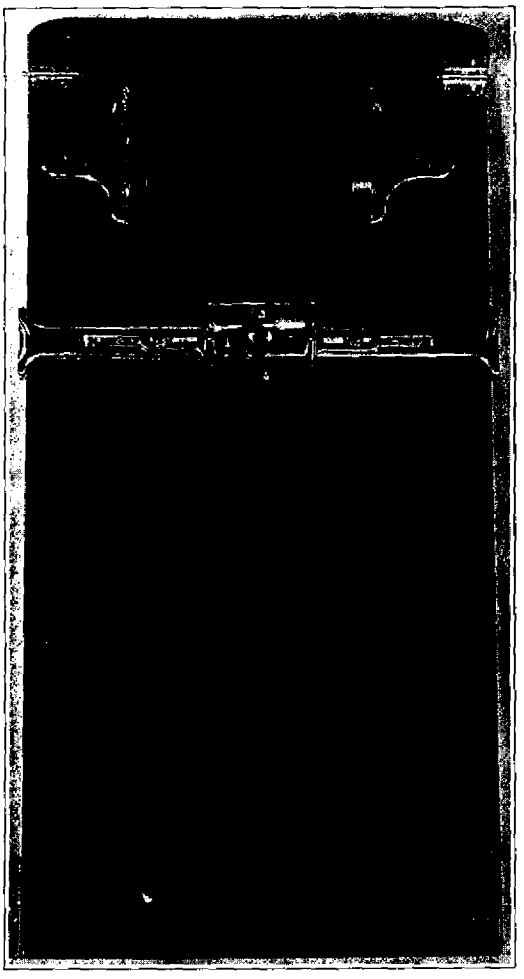


Fig. 7.—Apparatus for measuring knee motility.

When making measurements, it is important that the leg be in complete extension, the knee being pressed down close to the board by the hand of the examiner. In Figure 8 *A*, a child is shown in proper position for having the amount of genu valgum measured. In

Figure 8 *B*, she is sitting in an earlier type of knee motility apparatus, ready to be tested for the amount of motility in her left knee.

The lateral movement of the heel may be recorded in degrees, the center of the knee being used as the fixed point of the arc. It is simpler, however, to measure in

A B

Fig. 8.—Diagnosis: *A*, proper position for measuring knock-knees; *B*, for testing the lateral motility of the left leg with apparatus.

centimeters the movement of the foot sideways. The normal lateral movement of the heel was found to vary between 1 and 3 cm. The increased leg length of the older child is compensated for by the increasing breadth and stability of the knee joint. Normal knee motility for any age was found to be not over 3 cm., while the motility in pathologic cases runs as high as 7.6 cm.

In the same child there is a seasonal variation in knee motility, being greatest in the climate of Oregon during the late spring.

Abnormal knee motility is often the first clinical sign of rickets demonstrable in the legs. The value of measuring this motility is threefold: First, it reveals the very beginning of the wobbly knee, the precursor of genu valgum or varum, and thereby permits the early institution of preventive treatment; second, in cases of definite knock-knees or bow-legs, it aids in determining whether there is need for radical treatment; and third, it furnishes a means of measuring improvement during treatment.

SUMMARY

The prevalence of mild rickets in the Pacific Northwest has led to a search for early clinical signs.

The head and chest furnish the first skeletal evidence of the disease.

Craniotabes was demonstrated in 60 per cent. of our winter babies; its existence is most easily determined at the mastoid fontanel.

Among abnormalities of the chest indicating rickets are the square, triangular and oval forms, as measured at the plane of the fifth costochondral junction.

Costomalacia, or softening of the sternal ends of the ribs, appears during the first four months of life and is an important clinical sign.

Both genu valgum and genu varum are always preceded by abnormal lateral motility of the knee joint, which is often the first sign of leg rickets.

Knee motility can be measured approximately by hand or accurately by means of a very simple apparatus. Determining the amount of motility has proved valuable for both diagnosis and prognosis.