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THE ETIOLOGY OF ARTHRITIS DEFORMANS IN CHILDREN *

ALBERT H. BYFIELD, M.D.
IOWA CITY

That the deforming types of arthritis have been existing from earliest historic times can scarcely be doubted. In mummies exhumed from Roman tombs, the disease has been definitely recognized, as is, for example, described by Moore.[1] In the treatise of Sudhoff,[2] however, the declaration is made that the disease was extraordinarily common in Egypt and also among Germanic tribes along the Baltic, probably because of the dampness of the climate. In England, gout and chronic joint conditions have long been almost endemic, although the former is far less common now-a-days. On the continent, however, there was formerly less mention of the disease and Trousseau[3] commented on its rarity. At present the disease is usually encountered sporadically, although Beek[4] found a region in Siberia where from 6 to 46 per cent. of the population, chiefly children between 8 and 13 years, have a chronic osteoarthritis.

When one attempts to find reference to the disease in children in the early medical literature, one is struck with the almost complete lack of data on this subject. Whether this is owing to the fact that the disease did not exist in the first decade of life, which is unlikely, or whether such joint diseases were not carefully differentiated, cannot be stated definitely. Deforming arthritis does not receive mention in the Kinderbuch of Felix Wurtz,[5] although reference is made to other joint affections. Meissner,[6] in his pediatric bibliography with its list of titles of papers published previous to 1850, was also silent on this subject. The first case in children is supposed to have been

* From the Department of Pediatrics, College of Medicine, State University of Iowa.

1. Moore: Rheumatic Arthritis from a Roman Tomb, Tr. Path. Soc. London **34**:286, 1882-1883.
2. Sudhoff, K.: Translated by Stockman, F. J. Ann. Med. History **1**:111, 1917.
3. Trousseau: Clinical Medicine: New Sydenham Society **4**:408, 1871.
4. Beek, E.: Ueber Osteoarthritis Deformans, Arch. f. Klin. Chir. **86**:662 (March) 1918.
5. Wurtz, F.: Translated by Fox, A. L.: An Experimental Treatise in Surgery, 1656.
6. Meissner, F. L.: Grundlage der Literatur der Pediatrik, Leipzig, 1850.

recorded by Cornil[7] in 1864, and after him Charcot[8] was able to refer to two cases in children less than 12 years of age. Barthez and Rilliet[9] stated that gouty rheumatism was of such rarity in childhood that it might conveniently be passed over in silence. In the monograph of Moncorvo[10] we find the first adequate treatment of the subject, although in the historical discussion this author is struck with the dearth of literature, and in correspondence with his teacher, Bouchut, was informed that the latter had not seen six cases in twenty years, wherefore, he made no reference to it in the fifth edition of his work. He also quoted Niemeyer (1869) who stated that infants enjoyed an absolute immunity from nodular rheumatism, one of the terms commonly applied to the disease under discussion. The difficulty at that time and previously in distinguishing the various types of hyperplastic joint disease in children, owing to the lack of the finer diagnostic tests, led to confusion on the subject, and this confusion, similar to that existing in the classification of the disease in adults, was mirrored in the terminology. Thus, while Charcot's[11] rheumatisme noueux was used by many, one encountered also the term "benign hyperplastic synovitis" in the article by Von Wahl[12] in Gerhardt's Handbuch, and rheumatoid arthritis of English authors. Von Wahl stated that this disease was extremely rare in childhood and had been seen by him only following the acute polyarthritis of infectious diseases. In this country, reference was made by Louis Smith[13] to a case of arthritis deformans seen in 1871, and he spoke of it as being "one of great rarity." Twelve cases were collected by Lacaze-Dori[14] and a few of the more striking facts were mentioned, such as the self-limited nature of the affection and the better prognosis in children than in adults. Chlorosis, humidity and cold were considered as contributory etiologic factors. In his opinion, a cure took place after a period of about one year. From that time on occasional references to the disease appeared in the literature.

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7. Cornile: Memoire sur les Coincidences Pathologiques du Rheumatisme Articulaire Chronique, Mem. d. l. Soc. d. Biol. **1**:3, 1864 (Fourth Series).

8. Charcot: Lecon Cliniques sur les Maladies des Viellards et les Maladies Chroniques (1866), Paris **8**:262, 1890.

9. Barthez and Rilliet: Maladies des Enfants **2**:114, 1866.

10. Moncorvo: Estudo Sobre ö Rheumatismo Chronico Nodosa na Enfancia e seu Tractamento a Proposito de una Caso Observado em ema Menina de 2 annos. etc., Rio De Janeiro, 1879.

11. Charcot: See reference No. 8.

12. Von Wahl: Gerhardt's Handbuch der Kinderkrankheiten **6**:416, 1880.

13. Smith, L.: A Treatise on the Diseases of Infancy and Childhood, 1876, Ed. 3, p. 309.

14. Lacaze-Dori: Etude Clinique sur la Rhumatisme Noueux Chez Lez Enfants, Thèse de Paris, No. 329, 1882.

A new interest was aroused by the masterly treatise of Still[15] with its report of cases of chronic joint disease of a special type. Still wrote of a chronic progressive enlargement of the joints and enlargement of the glands and spleen, the onset usually taking place before the period of second dentition. The tissue change seemed to be around the joint rather than in it. In Still's cases the hands were rarely involved. Muscle wasting took place early. It seemed impossible, according to him, to find a definite cause for the slight fever which usually existed. Adherent pericardium was noted in five cases. It is important to emphasize the fact that the author clearly understood that he was not dealing with rheumatoid arthritis which also occurred in childhood and which resembled the rheumatoid arthritis of adults, for the term "Still's" disease has been applied rather loosely to all cases of chronic arthritis and periarthritis of childhood.[16]

Reports of cases of deforming arthritis of the type described by Still commenced to appear after the publication of the original article. Koeppe[17] spoke of three cases which showed pericardial adhesions, and in the one case which came to necropsy no evidence of tuberculosis was found. Weber[18] believed that Still probably took too gloomy a view of the prognosis. Valvular disease was present in his cases, but no cultures were obtained from the joints. In one case, a positive reaction was obtained with Koch's tuberculin. In Edsall's[19] case a positive tuberculin reaction was obtained, and tubercle bacilli were found in the lymph nodes.

Poncet,[20] as a result of studies made since 1897, believed that chronic arthritis was the consequence of a general and attenuated infection, and that these larval infections might have their beginning in infancy or adolescence, and while they might be caused by syphilis, nevertheless, the most common cause must be tuberculosis. This conception of a "rheumatisme tuberculeux" has been the subject of lively controversy, but has not found general acceptance. Garrod[21] and

15. Still, G. F.: On a Form of Chronic Joint Disease in Children, Med. Chir. Tr., Edinburgh **80**:47, 1897.

16. In the Surgeon-General's Catalogue, all cases of arthritis deformans were classified under the heading "Still's Disease."

17. Koeppe, H.: Jahrb. f. Kinderh. u. Physische Erziehung, Vienna and Leipsic **76**:707, 1912.

18. Weber, F. P.: Still's Type of Chronic Joint Disease in Children and the So-Called Tuberculous Rheumatism, Brit. J. Child. Dis. **2**:208, 1905.

19. Edsall, D. L.: Concerning the Nature of Still's Type of Chronic Polyarthritis in Children, Arch. Pediat. **21**:175, 1904.

20. Poncet: Arthrites Chroniques et Rheumatisme Tuberculeux, Presse méd. **21**:244, 1913.

21. Garrod: Allbutt's System of Medicine, Ed. 2, **3**:17, 1908.

Ibrahim[22] express special doubt as to the justification of regarding "Poncet's disease" as a separate clinical entity.

The same difficulties, although possibly in less degree, have been encountered in attempts at classification. Rachford[23] mentions three types: the first, with hypertrophic changes predominant; the second, with atrophic changes prominent, and the third, Still's disease. One of the most complete clinical studies of the disease is that of Spitzy.[24] He reports cases and gives an excellent bibliography.

The question of the etiology of arthritis deformans in children has gone through the same stages of development as it has in adults. For a long time, and in spite of the fact that acute arthritis had been known to belong to a group of metastatic phenomena following tonsillar infection, chronic joint troubles were believed to be due to metabolic disturbances, although Still considered the possibility of infection as a cause of the type of disease which he observed. In addition to errors in metabolism, the nervous system and the ductless glands were also considered in attempting to assign a cause of the disease.

Royal Whitman,[25] in an interesting philosophical discussion of the disease, stated that "if rheumatoid arthritis is to be considered as of infectious nature, its distinction over ordinary forms of infection, whether local or general, is certainly marked. . . . One must presuppose a focus of infection within the body which is constantly active." Billings[26] and his co-workers were among the first to put this view into practical application. Rosenow[27] examined the lymph glands which drain the affected joints and found streptococci in them. He also found endothelial proliferation of the blood vessels which might have led to the trophic changes commonly seen. Lindsay[28] reported nineteen cases of rheumatoid arthritis in children and emphasized foci of infection as being etiologic factors. While he recommended that there should be a systematic examination of all the orifices of the body — mouth, nose, ears, rectum and vagina — and urged that the infected focus, if found, be eradicated, he did not say that by such eradication the patient was benefited.

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22. Ibrahim: Handb. d. Kinderh., Pfaundler and Schlossmann, Ed. 2 **2**: 401, 1910.

23. Rachford: Diseases of Children, 1912, p. 408.

24. Spitzy: Zur Chronischen Arthritis der Kinder, Ztschr. f. orthop. Chir. **11**:699, 1903.

25. Whitman, R.: A Report of Final Results of Two Cases of Polyarthritis in Children of the Type First Described by Still, Together with Remarks on Rheumatoid Arthritis, Med. Rec. **63**:601, 1903.

26. Billings, F.: Chronic Focal Infections and Other Etiological Relations to Arthritis and Nephritis, Arch. Int. Med. **9**:484 (April) 1912.

27. Rosenow, E. C.: Etiology of Arthritis Deformans, J. A. M. A. **62**:1146 (April 11) 1914.

28 Lindsay, J.: Rheumatoid Arthritis in Children, Edinburgh M. J. **10**:332, 1913.

Hammond's[29] experience with tonsillectomy in arthritis deformans did not lead him to feel encouraged as to the effectiveness of this operative measure. This is in accord with our own experience. A possible relationship between sinus infection and arthritis deformans in adults has been assumed by workers following the suggestions of Billings and his co-workers. The results of operation on the sinuses have not been uniformly satisfactory. It is interesting to note that chronic sinusitis was found in one instance in a series of cases of arthritis deformans in swine studied by Segikuchi and Irons.[30]

Experience in this clinic[31] early demonstrated that mere removal of the tonsils and adenoids was not sufficient to control the symptoms and signs of the disease, or to arrest its progress; therefore, it became necessary to institute a search for another focus of infection, especially as it was usual for such manifestations as slight elevations of temperature, leukocytosis, exacerbations of pain and even involvement of new joints to persist. No trouble was found in the teeth in the cases studied, and attention was then directed to the nose and especially to the accessory nasal sinuses, the details of the work being reported elsewhere by Dr. L. W. Dean,[32] whose investigations and operations have made this article possible. A brief summary of the cases studied since 1916 is appended herewith.

REPORT OF CASES

Case 1.—D. M., aged 5 years, was admitted in September, 1916, having had "joint" trouble for two years previously. In this case the spleen was palpable. Elbows, hips, ankles, dorsal spine and to some extent the hands and fingers on both sides were involved. The tonsils and adenoids were removed two months after admission, but improvement was extremely slow and a few slight exacerbations were noted. Sinus operation was not done because at this time the relationship between nose infection and joint trouble was not realized. After three years there was a distinct recurrence of the trouble. The patient now shows distinct evidence of chronic infection which can only be situated in the nasal sinuses as present examination shows.

Case 2.—J. B., aged 1½ years, had been ill four months before admission to the hospital in May, 1917. The onset of the disease was subacute, the arms, elbows and knees being involved. The spleen was not palpable, and no lymph glands were felt. The joints were distinctly tender, and there was painful

29. Hammond, R.: The Rôle of the Nose, Throat and Accessory Sinuses in the Etiology of Chronic Infectious Arthritis, J. A. M. A. **65**:1091 (Sept. 25) 1915.

30. Segikuchi and Lyons: Chronic Arthritis in Swine, J. Infect. Dis. **21**:526 (Dec.) 1917.

31. Byfield, A. H.: Systemic Manifestations of Chronic Nasal Sinus Infection in Childhood, J. A. M. A. **71**:511 (Aug. 17) 1918.

32. Dean, L. W.: Infections of the Paranasal Sinuses in Infants and Young Children with Special Reference to Adenoids and Chronic Tonsillitis as Etiologic Factors, Ann. Otol., Rhinol. & Laryngol. **27**:534 (June) 1918; Dean, L. W.: Nasal Sinus Disease in Infants and Young Children, Including Bacteriologic Study, Ann. Otol., Rhinol. & Laryngol. **28**:454 (Sept.) 1919.

limitation of motion. A leukocytosis of 21,800 was observed. The highest temperature noted was 99.8 F. Three weeks after admission an operation for removal of tonsils and adenoids was performed. Improvement was very marked and rapid and by July 11 (five weeks later) pain and tenderness had practically disappeared. Some ankylosis persisted. There were no recurrences.

Case 3.—J. N., male, aged 11 years, had been sick fourteen months before coming to the hospital in July, 1917. The onset was subacute, and at the time of admission the spleen was not felt. There was marked pain on handling, marked deformity and limitation of motion of many joints. The test for tuberculosis was practically negative. Six months after admission, the tonsils and adenoids were removed, but the benefit was not great. Seven weeks later a nasal sinus operation was performed and a very striking diminution of pain was observed in less than one week. The anorexia so often present in these cases diminished and the patient's general health improved. A second operation on the nasal sinuses was found necessary three months following the first. Again, improvement was noted within a day. From that time until the present there has been no exacerbation, and the patient, while still having bony deformity, must be regarded as having had his trouble definitely arrested. An older brother, not treated, is in an unbelievably crippled condition.

Case 4.—F. R., aged 7 years, had been ill three years before admission in September, 1917. The onset was with sore throat, with progressive involvement of the joints following this. On admission there was torticollis, the cervical lymph glands enlarged, the spleen was very slightly palpable but not reaching beyond the costal margin, and there was marked involvement of many joints with swelling, deformity, limitation of motion and distinct pain on handling. The tonsils were removed three weeks after admission. Following this operation only slight improvement was noted. The sinuses were operated on only a short time after the tonsil operation. In this case the temperature elevation persisted, rising as high as 103 F. with a leukocyte count of 25,000. When the child was seen again about six months later, the fever had disappeared and no acute or subacute condition was present in the joints. A final observation in 1919 showed that the disease was distinctly arrested with only a residue of joint involvement undergoing orthopedic treatment. In this case, the operation on the nasal sinuses did not give as quick results as were seen in other cases, but the benefit to the joints was very great. The final result must be regarded as eminently satisfactory in view of the fact that there was a complete cessation of the recurring attacks, together with a partial return of function. The fact that the temperature elevation persisted even after the sinus operation suggests that a complete removal of infected tissue was not effected.

Case 5.—M. R., aged 9 years, was admitted to the hospital in October, 1917, after seven years of recurring joint attacks. The usual findings of joint deformity and tenderness were present. The tonsils and adenoids were removed and sinus operations were done on the same day, and while there was a marked improvement, it was impossible to clear up the nasal infection even six months after admission. The patient, however, was without joint trouble for nearly two years, when he was readmitted with a recurrence. It should be mentioned, however, that in addition to the arthritis deformans, there were present a nephritis and a recurring colitis as complications. Furthermore, the child reacted very strongly to the intradermal tuberculin test. We must regard this case as one in which the patient was benefited but not cured. The complicating infection may have been responsible for the unsatisfactory result.

Case 6.—F. B., aged 12 years, was sick one year before admission to the hospital in July, 1917. This case is reported mainly to emphasize the fact that removal of the tonsils and adenoids is insufficient to control the disease. This patient had only one or two of the larger joints involved and because of improvement in his general condition following the removal of the tonsils and adenoids, with arrest of the arthritic process, he was discharged, as it was

believed that the respiratory infection had worn itself out. The incorrectness of our assumption was shown by the fact that the patient returned to the hospital seven months afterward with many joints involved and with much resultant crippling. Operation on the sinuses was performed but the boy was removed from the hospital before it was possible to determine the permanent benefit obtained, although the immediate improvement was striking. In the light of our experience during the past three years, it seems fair to believe that had more radical treatment of the nose been instituted at once, spread of the disease could have been prevented.

CASE 7.—W. F., aged 11 years, had been sick three years before coming here in July, 1918. The onset was insidious. Few joints were involved and the existing deformity was slight. An incomplete tonsillectomy had been performed two years before admission and it was necessary to remove the tonsil stumps. This last operation was followed with infection of some joints previously free. Pain on handling and limitation of movement were quite constantly present during the three months that the patient was under observation. Frequent examinations were made. Operation on the nose was then done, following a submucous resection and this was followed in a week by unmistakable local and general improvement; from this period until the present there has been no recurrence and the patient has needed only orthopedic correction of the deformity already present.

CASE 8.—E. T., aged 3 years, was sick four months before admission in November, 1918, beginning with tonsillitis and marked multiple joint involvement, with very distinct tenderness and deformity. Tonsillectomy was performed shortly after admission, and the patient has had no recurrence after one year. The improvement was rapid and continuous.

CASE 9.—H. H., aged 8 years, when admitted in March, 1919, had been sick one year previously. The onset in this case was rather sudden, following tonsillitis. Few joints were involved, but there was trouble in the wrist and in some of the small bones of the left hand. A tonsil operation had been done; but, one year after this it was necessary to have the tonsil stumps removed and a nasal sinus operation was performed at the same time. There was moderate improvement for four months when there was a recurrence and a torticollis developed in addition to trouble in the hand and in the foot. The girl was put in bed and observed for nearly a month. A cast was applied to the foot, but the condition remained unchanged. While the distress and pain were not great, it was continuous and distinctly affected the girl's general health. There was limitation of motion in the neck and pressure on the hands was painful enough to cause crying. A second and more complete nasal operation was then done, and within a few weeks the torticollis had entirely disappeared, movement of the hands was possible, with practically no pain and the foot was much improved. The effect of this operation on the general health of the patient was a surprising one, even to those who have had occasion to share in the observations made in the past.

CASE 10.—I. H., aged 3 years, was sick one year before admission to the hospital in March, 1919. The tonsils and adenoids were removed and this was followed with rapid improvement and no recurrence.

DISCUSSION

In these patients a uniformity in the constitutional signs and symptoms was manifest, there being present emaciation of varying degree, anorexia and irregularity of temperature with frequent rises to 100 F. and occasional rises to 103 F. A leukocytosis of from 11,000 to 25,000 was present. At the time of admission to the hospital the spleen was

practically never found to be enlarged. A positive tuberculin test was seen in one case only. A rheumatic history was obtained in a few cases, but in only one instance (Case 3) was more than one member of the family similarly affected. The teeth were examined in every case and only once were they found to be diseased. No benefit followed extraction. Blood cultures were taken in two cases and were negative.

The disease tended to have its onset in the larger joints, usually the knee or the ankle, while the bones and articulations of the wrist were affected later. In two patients the affection remained monarticular for so long a period as to suggest a diagnosis of tuberculosis of the joints. With the progress of the disease to other joints the true nature of the trouble was indicated and appropriate treatment instituted.

The cases under discussion, therefore, do not appear to belong to the group described by Still, but resemble more nearly those cases which are commonly referred to as rheumatoid arthritis. In one case (Case 5) a very positive Mantoux reaction was obtained so that a diagnosis of Poncet's disease might have been considered. Since, however, two operations on the sinuses were followed with a subsidence of joint swelling and pain, it seems more probable that we were dealing with a case of deforming arthritis in an individual affected with tuberculosis. Convalescence in this case was slower than in most of the others; it may be possible that the presence of the tuberculous infection tended to delay improvement. In view of the fact that there has been considerable discussion as to the nature of Poncet's disease, this case is worthy of note.

There is no great choice of therapeutic measures in arthritis deformans in children if the infectious nature of the disease is admitted and if it is granted that the accessory sinuses of the nose are the commonest seat of the etiologic focus. General supportive measures, with orthopedic treatment of the joints alone, produce too little and too slow improvement to be regarded as efficacious. Furthermore, an extension of the disease cannot be thus avoided. Removal of the tonsils and adenoids is followed by slow improvement, but does not guarantee that there will not be a relapse. Intravenous and intramuscular injection of foreign proteins has not been made here, except in two cases (Cases 3 and 6) and in neither of these was the improvement striking. That one injection was not sufficient to prevent a very marked extension of the disease was shown in Case 6. It should be stated, however, that without a more careful trial, a definite opinion cannot be given. In the children in this series less than 3 years of age, removal of the tonsils and adenoids alone has seemed to be sufficient to cure and arrest the progress of the disease. It appears, therefore, that the younger patients with this malady may be spared nasal intervention. In older children, however, removal of the tonsils and

adenoids is definitely insufficient to accomplish this end, and in them the surgical intervention on the nasal sinuses, as practiced by the nose and throat department, is indicated and has yielded results which are eminently satisfactory.

It will be admitted that in estimating the benefits following on operative treatment of the nose, there is a considerable personal element: improvement, like beauty, may be in the eye of the observer. Past experience, however, with cases of arthritis deformans which were treated expectantly, with plaster casts, or by tonsillectomy, made tolerably clear the fact that where improvement did take place, it was slow and slight. It was this observation which led to the request that a search be made for other possible foci of infection, since it was believed that the older methods of treatment were unsatisfactory.

In spite of the fact that the disease has been termed a periarthritis from a pathologic standpoint, there is little question that the joint tissues adjacent to the cartilage show an extensive involvement,[33] and it can scarcely be expected, therefore, that a complete restitution to normal is possible, especially when the disease has existed for a number of years. Furthermore, the difficulty of complete elimination of foci of infection is also undeniable. When, however, nasal operations were almost invariably followed within a week by unmistakable subsidence of symptoms and signs, when "flare ups" occurred, if at all, only at very long intervals, when a very rapid improvement was noted in the general health of the child as well, it could scarcely be denied that there must be some direct connection between the operation and the improvement achieved. The results were immeasurably better than were those following the usual methods of treatment.

It should be borne in mind, also, that orthopedic treatment is definitely indicated where marked deformity and marked joint pathology exists, but the extent to which restitution may take place when the infection is controlled, is surprising even if casts are not applied. Five patients have been free from recurrence for at least two years.

CONCLUSIONS

From a study of the cases reported it may be concluded that:

1. Arthritis deformans in children results chiefly from a chronic infection situated in the tonsils and adenoids and in the accessory sinuses of the nose.

2. In children less than 3 years of age the portal of infection seems to be limited to the tonsils and adenoids. After this time removal of tonsils and adenoids is ineffective in arresting the progress of the disease.

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33. Axhausen: Die Deformierende Gelenkentzündung (Arthritis Deformans) Im Lichte Neuer Forschung, Berl. klin. Wchnschr. **52**:1205, 1915.

3. A sinus infection should be suspected as an etiologic factor if, after the tonsils and adenoids are removed, there remains elevation of temperature (even if slight), leukocytosis, poor appetite, together with a slowness of the joints to become less painful and swollen. Relapse and exacerbations are definite indications of the need of nasal treatment.

4. Poncet's disease is probably no more than arthritis deformans in an individual infected with tuberculosis.

5. Although supportive and orthopedic measures are helpful, surgical treatment of the nasal sinuses is to be regarded as the most important therapeutic measure indicated in arthritis deformans in children.

6. The prognosis in uncomplicated cases is good as far as arrest of the disease is concerned. The deformity and functional disability may persist for a considerable time.