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CLINICAL SURVEY OF AND PATHOGENIC APPROACH TO PARA-ARTICULAR OSSIFICATIONS IN LONG-TERM COMA

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Para-articular ossifications were recognized as a clinical entity in 1918 by Dejerine & Ceillier. We have surveyed a large group of patients with para-articular ossifications complicating long-term coma. The pathogenic factors of the disease are discussed.

MATERIAL

Twenty-six patients in long-term coma following cerebral traumatic lesions were surveyed (Table 1). A minimal limitation of passive joint mobility was sufficient for a decision to be made to investigate a joint roentgenologically. Para-articular ossification was found in seven out of 26 patients. Six other patients were added to this series, as they presented para-articular ossifications complicating long-term coma of a non-traumatic origin. For technical reasons, frequency of ossification in this group could not be determined accurately.

The age of the 13 patients (8 males and 5 females) ranged from 18 to 58 years. All of them presented intracranial lesions of various origins (seven traumatic, three vascular, one tumour, one infectious and one occurring after intoxication with amitryptiline).

The duration of coma ranged from 15 days to more than 3 years. In all cases, at least functional tetraplegia was observed during the coma, i.e. the patients were unable to perform conscious intentional muscle contractions, but involuntary responses to nerve stimulation or pain reflexes were possible. Consideration of functional plegia of a limb implies no (anatomical) interruption of the efferent nerve tracts. All patients were confined to bed for a long period of time and remained completely bedridden for from 3 months to more than 3 years.

Some patients, on recovering consciousness, had an anatomical tetraplegia or hemiplegia. Others presented a functional plegia. Para-articular ossification occurred at the earliest 1 month and at the latest 9 months after the onset of coma. All patients were still completely bedridden when ossification appeared. Seven patients were still comatose, but six others had already woken up from the coma.

Table 1. Characteristics of the patient material.

	Age (years)	Duration of coma m=months	Duration of the bedridden condition	Date of diagnosis of ossification after onset of coma	Neurological deficiency after coma R=right; L=left	Localization of ossification	Anatomical paralysis	Functional paralysis	No paralysis
1	18	2 m	3 m	2 m	hemiplegia R	Elbow R	+		
				2.5 m		Hip L			+
2	26	1 m	6 m	3.5 m	nil	Elbow L			+
3	27	1.5 m	5 m	2.5 m	hemiplegia L	Elbow L	+		
				4.5 m		Hip L	+		
4	29	7 m	10 m	9 m	hemiplegia L	Elbow L	+		
5	31	> 8 m	> 8 m	3 m	hemiplegia R	Shoulder R	+		
				4 m	functional hemiplegia L	Elbow L		+	
6	40	0.5 m	7 m	5 m	hemiplegia R	Elbow R	+		
7	23	> 6.5 m	> 6.5 m	4.5 m	tetraplegia	Elbow L	+		
8	25	2.5 m	5 m	3.5 m	hemiplegia R functional paralysis of the leg	Hip R	+		
9	41	> 8 m	> 8 m	1 m	tetraplegia	Elbow R	+		
				5 m		Elbow L	+		
10	50	3.5 m	4 m	3 m	hemiplegia R	Elbow R	+		
				1.5 m		Elbow L			+
11	58	> 4 m	> 4 m	2 m	tetraplegia	Elbow R	+		
						Elbow L	+		
12	20	> 3 y	> 3 y	7 m	tetraplegia	Elbow R	+		
						Elbow L	+		
13	26	2 m	3.5 m	6 m	functional tetraplegia without paralysis	Hip R		+	

Figure 1. Roentgenograms of the right elbow of Case 1. Early stage with posterior localization of the ossification.

Figure 2. Roentgenogram of the right elbow of Case 1, one month later than in Figure 1. The ossification is more homogeneous but no enlargement of the lesion is observed.

In the 13 patients, para-articular ossification was found encircling 20 joints. A high frequency of elbow involvement (15 of the 20 joints) must be emphasized; furthermore one shoulder and four hips were implicated. In the elbow region (Figures 1 and 2) roentgenograms revealed ossification on the posteromedial aspect of the distal end of the humerus. The para-articular ossification resembled a triangle, with the base localized at the olecranon and the apex in the mass of the triceps muscle (Figure 1). Later an anterior ossification in the proximal part of the forearm was seen (Figure 2). In all cases of elbow involvement, posterior ossifications were present.

Around the shoulder, the demarcation of the anterior localization at the proximal humeral epiphysis was not clearly defined. Ossifications localized in the hip extended from the anteromedial border of the femoral neck to the pelvis in the adductor region (Figure 3), or from the posterolateral border of the greater trochanter proximally in the gluteal region (Figure 4).

In all but one case, roentgenological lesions were already present at the moment of clinical diagnosis. Roentgenological evolution was carefully followed and can be summarized in a few words; in the early stages, ossification is diffuse, irregular and not very homogeneous but the final delimitation is immediately marked. Later the ossification becomes more homogeneous but no increase in the

Figure 3. Right hip of Case 13; ossification from the anteromedial border of the femoral neck to the pelvis in the adductor region.

Figure 4. Left hip of Case 3, posterolateral ossification from the greater trochanter to the gluteal region.

size of the original area involved occurs (Figures 1 and 2). It is very important to note that in five cases, ossification occurred in a limb which was not anatomically paralysed, although functional plegia of the involved limbs was present in the earliest stage of coma.

DISCUSSION

In this study para-articular ossification emerges as a frequent complication of long-term coma in adults. The reported frequency (7/26) is higher than that described in children (6/112) by Hoffer et al. (1971). Para-articular ossification is probably often overlooked in patients who cannot easily be examined clinically, as is certainly the case in coma.

The pathogenesis of para-articular ossification is still unknown and very inconsistent hypotheses are presented. Most authors suggest the occurrence of metaplasia of the intermuscular and perimuscular con-

nective tissue. The origin of the metaplasia is unknown. Two groups of causative factors are proposed in the literature: neurological components (Dejerine et al. 1919) and local factors, mostly related to the neurological factors (Benassy et al. 1960).

We think that all aetiologic forms of the affection have two factors in common: 1) a prolonged completely bedridden condition and 2) a paralytic or functional immobility of several limbs. The immobility is considered to be paralytic when an anatomical defect of the efferent nerve tracts from the cerebral cortex exists. Extensive paralysis will lead to complete immobility and a completely bedridden condition. When the efferent tracts from the cerebral cortex to the muscle fibres are unaffected, agents which disturb the normal dynamic and static muscle contraction can lead to functional immobility and a completely bedridden condition. Among these agents pain, which occurs during muscle contraction in extensive burn lesions, must be an important factor. We would also like to mention defects in the afferent tracts to the cerebral cortex, as are found in coma and in cerebral lesions, preventing the stimulus to voluntary contraction from reaching the cortical motor centre. Functional or paralytic immobility and a completely bedridden state possibly involve local circulatory and metabolic disorders inducing metaplasia.

Approaching the different diseases in which para-articular ossifications are observed, we in fact found arguments for this theory. Para-articular ossification is most frequently encountered in para- and tetraplegia subsequent to cord lesions. In these cases ossification is only present in paralytic regions (in paraplegia only the knees or the hips are involved; in tetraplegia ossifications can also occur at the elbow and shoulder level). Paralytic immobility is certainly present in these cases. Liberson (1953) reports that para-articular ossification occurs more frequently in cervical than in lumbar lesions. We have noticed that immobility and the bedridden condition are more complete in cervical lesions. Stehman (1959) reported ossifications complicating six cases out of 25 with multiple sclerosis. All six patients were at an advanced stage of the disease with a complete quadriplegia and were absolutely immobile and bedridden. In addition, para-articular ossification is described complicating hemiplegia following cerebral vascular lesions. The frequency of ossifications is lower in these cases and varies between 0.8 and 3 per cent (Schott et al. 1959, Stehman 1959). These patients are in fact mobilized earlier, the mobility of the healthy limbs is maintained and the period of complete immobility and the

bedridden state is much shorter. It is important to note that various authors (Benassy 1957, Stehman 1959, Renier & Cheguillaume 1966) reported ossification on the non-paralytic side of patients with hemiplegia, who were kept in bed for a long period of time for other reasons.

Para-articular ossification is never described in peripheral nerve lesions, but these patients are never kept in bed nor are they strictly immobilized for a long period of time. In poliomyelitis, however, para-articular ossification has been described with a frequency of 0.3 per cent (Stoikovic et al. 1955). In the 14 cases found in the literature (Costello & Brown 1951, Freiberg 1952, Hansson & Austlid 1955, Stoikovic et al. 1955) complete tetraplegia was present (except for one case with a paraplegia up to the navel). The low frequency of ossification in this affection can be explained by the fact that very few patients with poliomyelitis reach a sufficiently advanced stage of the disease and survive. Thus it seems that ossification is not merely induced by a lesion of the nerve system, but that complete immobilization is also required.

Fifteen cases of para-articular ossification complicating tetanus are reported in the literature (Gunn & Young 1959, Warter et al. 1965, Renier et al. 1966). Ossifications occur in the early stage of this affection (sometimes after 2 or 3 days) and the roentgenological lesions are often different from those observed in other diseases. The possibility exists that in tetanus, the roentgenological lesions should be considered as ossification of intramuscular bleedings rather than as para-articular ossifications. The two patients, described by Renier et al. (1966), showing the classic picture of para-articular ossification, were both curarized, followed by complete paralysis and immobilization.

In burns, ossification only occurs in patients kept in bed for a long period of time with very extensive lesions (more than 22 per cent) (Evans 1966). Here also functional immobility is a very important factor.

We found 27 cases of para-articular ossifications complicating long-term coma in the literature (Garcin et al. 1959, Schott et al. 1959, Stehman 1959, Wharton & Morgan 1970, Hoffer et al. 1971). We have assembled 13 cases of para-articular ossification complicating long-term coma. Long-term coma can finally result in tetraplegia, but as already described in the literature (Benassy 1957) we also found ossifications in patients with no remaining paralysis. Here too, functional immobilization is probably an important inducing factor. In our

patients coma continued for at least 2 weeks; during this period a paralytic or at least a functional immobility was present. Although all patients were regularly mobilized passively, ossifications occurred nevertheless. In most patients who woke from the coma, para-articular ossification occurred after the recovery of consciousness, but it must be remembered that all patients were kept in bed for a further period and that ossification occurred before they became ambulant again. It is clear that a prolonged bedridden state, for at least 3 months, is very important in this study. In four patients residual paralytic tetraplegia was found after coma (cases 7, 9, 11, 12), one patient had a functional tetraplegia (case 13), seven patients presented residual paralytic hemiplegia (cases 1, 3, 4, 5, 6, 8, 10), in one of the seven, functional plegia was found on the other side (case 5) and in one patient no residual plegia was observed (case 2). We thus surveyed six patients with paralytic or functional tetraplegia and six patients with hemiplegia. Contrary to reports found in the literature, where frequency of para-articular ossification is observed to be higher than 20 per cent in tetraplegia and lower than 1 per cent in hemiplegia, we found as many patients with residual hemiplegia as patients with residual tetraplegia having para-articular ossifications.

We think that neither the nature of the nerve lesions, nor the type of paralysis is important in the induction of ossification, but the role of coma, of long immobility and the bedridden condition must be stressed. Neurological sympathetic, trophic and sensitive factors may be less important, motor (anatomical or functional) factors, on the other hand, are essential for the occurrence of ossification. Another pertinent finding must be mentioned. Although para-articular ossifications occur mostly in paralytic regions, we found ossifications in five patients (cases 1, 2, 5, 10, 13) in limbs which were not paralytic and in which the integrity of the efferent nerve tract could be demonstrated. In three of the five cases no functional plegia was observed after the period of coma (cases 1, 2, 13).

Even if the aetiopathogenesis of para-articular ossification still remains unknown, we can conclude that besides an individual promoting factor, a prolonged complete immobilization seems to be an inducing agent. A bedridden state alone is not sufficient since ossification does not occur in all the diseases associated with continued bedrest, but a functional or anatomical immobility seems to be an aggressive agent. The immobility can induce secondary vasomotor, metabolic and trophic disorders, which can give rise to metaplasia.

SUMMARY

1. Thirteen patients with para-articular ossification complicating long-term coma are presented. In a series of 26 patients with long-term coma following cerebral traumatic lesions, seven cases were found with para-articular ossification.
2. The high frequency of elbow involvement is emphasized, and in all these cases posterior ossifications were present.
3. In five patients, ossifications were observed in limbs which were not paralytic and in which integrity of the efferent nerve tracts could be demonstrated.
4. The importance of functional or paralytical immobility and of a completely bedridden condition in the patients is emphasized.
5. The aetiopathogenesis of para-articular ossifications still remains unknown, but a prolonged complete immobilization possibly induces vasomotor, metabolic and trophic disorders, which can give rise to metaplasia.

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