A CLINICAL STUDY OF BEAT KNEE

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Beat knee is defined as "a subcutaneous cellulitis or acute bursitis arising at or about the knee" in the First Schedule to the National Insurance (Industrial Injuries) (Prescribed Diseases) Regulations, 1948. The cases considered in this paper all fell within this definition.

Our continued observation of many miners with beat knee who attended medical treatment centres at mines suggested that there were well-defined clinical patterns not described in the accepted broad classifications of previous writers (Collis and Llewellyn, 1924; Watkins, 1951; Atkins and Marks, 1952; Watkins and Hunt, 1954).

With the object of confirming this suggestion, a systematic study was undertaken for 18 months in 1954-55 of cases of beat knee occurring in a large group of mines, mainly in the North Derbyshire coal fields, employing 17,899 men underground. A total of 899 cases of beat knee occurred in this period, and were included in the study; there was no selection. It was also felt that a detailed clinical study might throw more light on the relationship of beat knee to the working environment of the miner. The clinical findings in each case were recorded separately, with relevant personal and environmental data. The state registered nurses in charge of medical treatment centres were given intensive tuition in the recognition of the different clinical types of beat knee, and issued with a set of photographs illustrating each main type. Any case in which the classification was doubtful was examined and classified by a medical officer. After checking for completion, the records were transferred to Powers-Samas punched cards for statistical analysis.

The Knee in Coal-miners

It is frequently impossible for the coal-miner to work standing, and in some places he must work lying down. He is often compelled to work in the kneeling position during the whole of his shift of seven hours because of the low height of the coal-face. His kneeling posture varies according to the

task in which he is engaged, and according to personal preference; but kneel he must, and while kneeling, he transmits his body weight through his knees on to the floor of the coalface, which is carpeted with coal fragments. Changes in the kneeling posture distribute the body weight through different angles, and pressure may therefore be exerted at different points in the knee area.

In the past the emphasis in causation of beat knee has been placed mainly on abrasions of the skin caused by sharp coal particles, with subsequent infection of the underlying tissues. The effects of continued and repeated local pressures have received less attention.

Clinical Classification

Pain is the predominant symptom in all cases. It brings the miner for treatment and sends him off work. The chief clinical features of beat knee are a bursitis and a cellulitis in the region of the knee, existing separately or together. Our belief that these were separate clinical types of beat knee was confirmed, and it was found that all cases could be included in three main clinical groups. Further division of these enabled 11 clinical types of beat knee to be identified. The main groups and their seven subdivisions are shown in Table 1, which also gives the number of cases in each category.

TABLE 1
CLINICAL TYPES OF BEAT KNEE

Main Clinical Type	Subdivision	No. of Cases	% Total Cases		
Simple bursitis	Suprapatellar Prepatellar Infrapatellar	$\left. \begin{array}{r} 41 \\ 389 \\ 202 \end{array} \right\} 632$	70.3		
Cellulitis	Diffuse Local	$\left. \begin{array}{r} 5 \\ 98 \end{array} \right\} 103$	11.5		
Combined Bursitis and cellulitis	Diffuse	$\left\{ \begin{array}{r} \text{Suprapatellar} \\ \text{Prepatellar} \\ \text{Infrapatellar} \end{array} \right.$	$\left. \begin{array}{r} 3 \\ 35 \\ 27 \end{array} \right\} 164$	18.2	
		Local	$\left\{ \begin{array}{r} \text{Suprapatellar} \\ \text{Prepatellar} \\ \text{Infrapatellar} \end{array} \right.$		$\left. \begin{array}{r} 7 \\ 46 \\ 46 \end{array} \right\}$
	Total ..		899		100.0

Simple Bursitis.—The bursae were clearly defined when they were distended with fluid and the overlying skin showed no sign of inflammation. Three anatomical types could be clearly differentiated on clinical examination and together formed 70.3% of the total beat knee cases.

(1) The suprapatellar bursa extends upwards from the upper margin of the patella deep to the quadriceps.

(2) The prepatellar bursa lies mainly in front of the patella and its ligament. When it is distended with fluid this bursa can usually be distinguished without difficulty from the infrapatellar bursa which lies in front of the tibial tubercle and the tendon insertion. In the majority of cases the clinical differentiation can be made by the simple test of placing the finger immediately across and below the line of the lower border of the patella, thus defining the position of the distended bursa.

(3) There is also a deep infrapatellar bursa, small and of little importance, lying between the patellar tendon and the upper part of the tibial tubercle. When enlarged, it protrudes along the lateral margins of the patellar tendon. This is grouped clinically with infrapatellar bursitis as it is rarely seen alone.

Cellulitis.—Diffuse cellulitis spreading over the front of the knee was unmistakable. Local cellulitis differed in extent only, and often merged imperceptibly into a boil or an infected abrasion. This group represented only 11.5% of the beat knee cases.

Combined Bursitis and Cellulitis.—Cellulitis was present in a local or diffuse form together with enlargement of the adjacent bursa in 18.2% of the total cases.

Recurrence

During the 18-month period of our study 80 men had between them 92 recurrences of beat knee. Eleven men had two recurrences, and one had three. Of the 80 men who experienced recurrences, 59 had simple bursitis in their first attack. Eleven of the recurrences in these 59 were due to cellulitis. The remaining 21 had cellulitis in their first attack, and 15 of the recurrences in this group were also due to cellulitis.

It is interesting to note that of the 59 recurrences in the simple bursitis cases, 48 recurred at the same site. This may have been due to the fact that a miner, who is compelled to kneel at his work, establishes by experience and possibly advice from his colleagues a kneeling posture which, once he has accustomed himself to it, remains with him as an established working posture.

Relation to Environment

The incidence of beat knee in our series varied widely between collieries, the lowest being 13.25 per 1,000 men underground, and the highest 105.4 per 1,000 men underground. This wide variation suggested that environmental differences might be important.

Occupation.—When the cases were classified by occupation it was found that 96% occurred in coal-face workers who represented only 54% of the total underground labour force (Table 2). Coal-getters comprised only 25% of the total underground labour force, but contributed 57.1% of the cases.

TABLE 2
OCCUPATIONAL ANALYSIS OF BEAT KNEE CASES

Occupation	No. of Cases	% Total Cases
Coal-face workers:		
Coal-getters	513	57.1
Drillers	25	2.8
Shotfirers and deputies	39	4.3
Conveyor shifters	25	2.8
Coal cutter men	24	2.7
Rippers and packers	174	19.3
Other faceworkers	66	7.3
Other underground workers	33	3.7
Total	899	100.0

Rippers and packers together comprised about the same number of faceworkers as coal-getters, yet they produced only 19.3% of the cases compared with 57.1% among coal-getters. This is presumably due to the fact that rippers and packers do not kneel as long as the coal-getters.

Coal-face Height.—The incidence of beat knee at the pits included in our study varied according to the height of the seam at the coal-face. We could find no inter-relationship between the occupation of the miner, his age, and the seam thickness.

TABLE 3
PERCENTAGE OF CASES BY CLINICAL CONDITION AND COAL-FACE HEIGHT IN COAL-FACE WORKERS ONLY

Seam Height	No. of Beat Knee Cases	% Cases in Each Clinical Type				
		Simple Bursitis			Cellulitis	Combined Cellulitis and Bursitis
		Suprapatellar	Prepatellar	Infrapatellar		
Less than 4 ft.	662	5	41	23	9	22
4 ft. and over	204	3	50	19	19	9
Total	866	4	44	22	11	19

FIG. 1.—Inception rates of beat knee by seam height in faceworkers only in 18 months at 16 collieries.

Collieries not using predominantly the most common method of mining are circled.

Fig. 1 and Table 3 indicate that the incidence of beat knee is related to seam height. They show the increased incidence of cases of beat knee in the thinner seams. Seventy-six per cent. of all cases in the series reviewed occurred in men working in heights less than 4 ft., while only 63% of the total man shifts were worked in these heights. The findings emphasize the importance of coal-face heights as an environmental factor in the causation of beat knee. The reason is the difficulty which the coal-face worker in low seams has in adopting, for working comfort, any other posture than kneeling.

Protective Equipment

The varieties of knee pads worn by faceworkers were of four main types: (a) Rubber-lined cup, (b) felt-lined pads, (c) bursa pads, (d) trouser pads. Eight hundred and twenty-one faceworkers in the cases under review during the period wore knee pads; 45 faceworkers did not. Rubber-lined cups and felt-lined pads were those most commonly used;

TABLE 4
CLINICAL CONDITION AND TYPE OF KNEE PAD WORN
BY FACEWORKERS ONLY

Clinical Condition	No Pads Used	Bursa Pads	Rubber-lined Cups	Felt-lined Pads	Trouser Pads	Total
	Cases	Cases	Cases	Cases	Cases	Cases
Simple bursitis	32	145	233	195	3	608
Cellulitis	8	18	31	39	—	96
Combined bursitis and cellulitis	5	37	67	53	—	162
Total..	45	200	331	287	3	866

only a few men used trouser pads. No association was found between clinical condition and the type of pad worn (Table 4).

It is evident that these types of knee pads do not prevent beat knee in coal-miners who must work in a kneeling position.

Age

Table 5 shows that younger men are more susceptible to beat knee than older men. Two reasons might account for this: one, that the knee, through constant use, adjusts itself to withstanding the pressures of coal-face work in a limited height; the second, that getting coal is the most physically arduous task as well as the occupation most susceptible to beat knee, and this is

TABLE 5
AGE-GROUP ANALYSIS

Age Group	No. of Under-ground Workers on Books	No. of Cases of Beat Knee	No. of Cases per 1,000 Men on Books	No. of Shifts Lost	Average No. of Shifts Lost per Case
<i>All Cases:</i>					
Under 21	1,785	126	70.6	594	4.7
21-25	1,634	141	86.3	785	5.6
26-30	2,050	182	88.8	562	3.1
31-40	4,268	218	51.1	1,341	6.2
41-50	4,054	150	37.0	1,016	6.8
51-60	3,073	70	22.8	719	10.3
61-64	762	11	14.4	101	9.2
65 and over	273	1	3.7	—	—
Total for all ages	17,899	899	50.2	5,118	5.7
<i>Coal-face Workers Only:</i>					
Under 21	506	123	243	594	4.8
21-25	1,159	137	118	745	5.4
26-30	1,583	177	112	533	3.0
31-40	3,171	215	68	1,322	6.2
41-50	2,551	143	56	987	6.9
51-60	1,337	61	46	622	10.2
61-64	193	10	52	92	9.2
65 and over	23	—	—	—	—
Total for all ages	10,523	866	82	4,895	5.7

usually performed by men in the younger age groups. Fig. 2 gives the beat knee inception rates by age for coal-face workers in three different colliery areas for the period of the survey.

Period of Incapacity

There are many factors which influence the length of time a miner suffering from beat knee may be off work; as in other disabling states, social and personal factors may play their part. Our experience during this review has shown that the presence at a mine of facilities for early diagnosis and adequate treat-

FIG. 2.—Inception rates of beat knee by age in coal-face workers only.

ment considerably reduces the number of shifts lost per case (Table 6).

TABLE 6
PERIOD OF INCAPACITY IN RELATION TO TREATMENT CATEGORY

Treatment Category	No. of Cases	% Total Cases	No. of Shifts Lost	Average No. of Shifts Lost per Case
A. Reported to and treated at colliery medical treatment centre	557	62.0	1,174	2.1
B. Reported to own doctor but treated at colliery medical treatment centre	143	15.9	1,247	8.7
C. Reported to medical treatment centre but treated elsewhere	95	10.6	1,141	12.0
D. Reported to and treated elsewhere	104	11.6	1,556	15.0
Total	899	100.0	5,118	5.7

The clinical type of beat knee influences the time lost. For example, a swollen infected bursa often takes longer to resolve than a localized cellulitis limited to the skin and subcutaneous tissues.

The age of the miner suffering from beat knee is of significance. Our results show (Table 5) that in all the cases of beat knee studied, and in those among faceworkers only, the time loss sustained in shifts was greater at the higher ages. One explanation for this may be that for the older person the disability offers the opportunity for a needed rest, not previously acknowledged. We have sometimes found that when persons suffering from beat knee were absent for a long period, the causative factor was social in origin, such as "illness in the home".

The treatment of beat knee is not described here, but we believe that the form of treatment is an important element in determining the amount of

time lost. A definite régime was followed in the majority of cases treated in medical treatment centres at collieries (Fernandez, 1958). The value of this régime was proved by the fact that while the average shift loss for all cases was 5.7 shifts, for those treated entirely at medical treatment centres at collieries it was only 2.1 shifts (Tables 5 and 6).

Discussion

Collis and Llewellyn (1924) stressed the importance of the infective element in beat knee; Atkins and Marks (1952) believed systemic infection to be an important factor in the causation of beat knee. In our series, however, 70.3% of the cases showed no evidence of infection. This may be due to the fact that the vast majority of men (94.4%) wore knee pads, and had bathing facilities at 15 of the 17 collieries reviewed. Thus, the majority of men had facilities for keeping the skin of the knees clean.

Collis and Llewellyn also reported the bursa "over the shin bone" to be most commonly affected, while we have found that the prepatellar bursa was the commonest, 44%, against only 22% of infrapatellar bursa cases among coal-face workers (Table 3).

Our results show that the coal-face worker most frequently affected is the coal-getter, this group having three times as many cases as the next group, rippers and packers. The coal-filler moves far less on the coal-face than men in the other occupations, and this probably explains why he is more susceptible; his knees are subject to more continuous pressure than those of other coal-face workers.

When a miner kneels, the floor presses against the tibial tuberosity, yet the commonest affected bursa is the prepatellar, an area he does not kneel on; this

may be due to redistribution of pressure due to knee pads.

We have seen many cases of enlarged bursa aspirated in the early phases, and in the majority of cases altered blood has been drawn off. We believe that the simple, painful bursitis of sudden onset is due to haemorrhage into the bursa, and that this occasionally becomes infected. Where there is no enlargement of the bursa but only infected skin, it is our view that the condition originates in abrasions of the skin which subsequently become infected. Painless enlargement of the bursae is sometimes seen. Such enlargements often persist for long periods, and we agree with Collis and Llewellyn's view that they are harmless. Chronic, painless bursal enlargements probably arise from persistence of an unresolved acute condition.

Summary

Eight hundred and ninety-nine cases of beat knee occurring in coal-miners at a large group of mines are reviewed. Definite clinical patterns were seen and 11 distinct clinical types are described. Simple bursitis was far more common than the infective condition. The clinical signs were determined by the relative extent of the bursitis element and the infective element. Pain was the dominant symptom.

Beat knee was commonest among young coal-face workers, especially the coal-getter.

Four types of knee pads were worn by coal-face workers at the collieries under review; they were ineffective in the prevention of beat knee.

An average of 5.7 shifts was lost per case; in those cases reporting at, and receiving treatment at, medical treatment centres, only 2.1 shifts were lost per case. In cases not reporting or treated at medical treatment centres, 15 shifts were lost per case. The recurrence rate of beat knee cases during the 18 months of our study was 10%.

Coal-face height was the most important environmental factor in causation.

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REFERENCES

- Atkins, J. B., and Marks, J. (1952). *Brit. J. industr. Med.*, 9, 296.
Collis, E. L., and Llewellyn, T. L. (1924). *Spec. Rep. Ser. med. Res. Coun. (Lond.)*, No. 89.
Fernandez, R. H. P. (1958). *Brit. J. industr. Med.*, 15, 110.
Watkins, J. T. (1951). *Practitioner*, 167, 257.
—, and Hunt, T. A. (1954). *Med. Press*, 232, 5.