Measurement of spinal mobility

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In the assessment of deterioration or improvement in spinal stiffness it is important to have a measure of spinal range of movement which is reproducible, little subject to observer error, and takes only a short time to perform. In a study of patients with ankylosing spondylitis by one of us (FDH), which has continued since 1946, measurements by existing techniques were at first unsatisfactory and unreliable. After 3 years, however, Dunham (1949) reported the use of his spondylometer and since 1950 this has been in constant use in our clinic. We have now records of spondylometry using this instrument over a period of 23 years and have found it reliable, quick, and

subject to little observer error whether used by one or several assessors.

The spondylometer is an instrument consisting of two angled rods measuring 40.6 cm. long, bent 12.6 cm. from their free ends through an angle of 35°. The two rubber cushions of the protractor are placed over the sacrum so that the upper one is just below the 5th lumbar disc and the knob at the top is placed over the vertebra prominens (Fig. 1a and b). The rods are of brass, 0.6 cm. in diameter, connected at a hinge joint. A protractor is jointed to the free end of one rod at the mid-point of its base and this rod also carries a pointer moving over the protractor scale

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FIG. 1 *The spondylometer in use*

(Hart and MacLagan, 1955; Sturrock, Wojtulewski, and Hart, 1973).

Theory of the method

THE SPONDYLOMETER

Fig. 2 shows the spondylometer in relation to the vertebral column, (a) in the extended and (b) in the flexed position.

With the spine extended the protractor is placed on the sacrum S and the movable arm on the vertebra prominens at P. The reading of the protractor is α . Suppose ϕ is the angle between the base of the protractor, *i.e.* the sacral reference line, and the line SP. When the spine is flexed as in (b), if the distance SP remains unchanged, the figure PQHRS is unchanged and angle PSR remains the same.

However, the angle α decreases to the value α' and angle ϕ increases to ϕ'

$$\therefore \alpha + \phi = \alpha' + \phi'$$

$$\therefore \alpha - \alpha' = \phi' - \phi$$

i.e. the change in angle measured by the protractor is the change in direction of the line SP.

This may be regarded as a reasonable measure of the extent to which a patient can bend forward from the hips. In practice the distance SP changes very little for a given patient during flexion and extension, despite corresponding changes in the shape of the vertebral column.

The method is unaffected by hip rotation which only changes the direction of the sacral reference line.

Results

The Table (overleaf) shows the progress of 27 patients, 24 male and 3 female, as observed by FDH over periods from 10 to 26 years (average 18.74). The ages at onset varied from 13 to 41 years (averaging 25.8). Onset occurred below the age of 18 years in three patients, all males.

Although painful episodes may cause considerable temporary reduction in range of spinal movement, whether because of exacerbation of disease, trauma, or a period of immobilization due to intercurrent illness, or because of mental depression, on the whole measurements are fairly constant over the years. Allowing for the fact that most patients attended the clinic initially because of active disease and were therefore more disabled than when they were later under treatment, there is in most cases no steady decline in range of movement and, even though they are on average 18.7 years older, fourteen of the 27 now have measurements as good as, or better than, they had at their first attendance (Table). This finding has also been borne out by serial photographs over the same years, none of which showed obvious progressive deterioration; five, Cases 2, 5, 7, 9, and 22, were extremely stiff and had minimal movement at their first attendance. In two cases tuberculosis was initially diagnosed, and these patients were immobilized which caused temporary worsening of the condition in one case and a more progressive deterioration in spinal range in the other. Other causes for temporary worsening of range of movement were mental depression and the development of gastric ulceration, periods of enforced immobility, and cessation of routine exercises and current drug therapy. The two deaths (Cases 13 and 14), which were due to carcinoma of the bronchus and pulmonary embolus respectively, were unrelated to therapy and caused little change in an already considerably restricted range of spinal movement.

In only eight of these 27 cases in which serial measurements over the years have been repeatedly recorded has a slow steady deterioration in spinal range of movement been seen. Spinal range, as we

FIG. 2 Diagrams of spine in extension and flexion, showing angles α and ϕ

Table *Particulars of 27 patients followed for from 10 to 26 years*

Case no.	Sex	Present age or age at death (yrs)	Age at onset of disease (yrs)	Duration of disease (yrs)	Period of observation (yrs)	Initial reading (°)	Present reading (°)	Range over observed period (°)
1	M	63	33	30	18	32	25	17 – 32 = 15°
2	M	59	22	37	20	Zero	Zero	Zero = 0°
3	M	54	36	18	20	65	68	64 – 80 = 16°
4	M	35	17	18	11	85	107	75 – 107 = 32°
5	M	48	18	30	10	11	15	8 – 26 = 18°
6	F	53	20	33	24	35	67	35 – 83 = 48°
*7	M	70	41	29	14	6	1	7 – 1 = 6°
*8	M	54	23	31	26	50	30	12 – 50 = 38°
9	F	52	22	30	24	Zero	Zero	Zero = 0°
*10	M	50	25	25	22	84	45	35 – 84 = 49°
*11	M	54	30	24	21	30	20	13 – 30 = 17°
*12	F	67	41	26	11	25	11	11 – 28 = 17°
*13	M	52 D	37	15	11 D	10	15	10 – 40 = 30°
*14	M	52 D	39	13	12 D	20	20	6 – 22 = 16°
*15	M	47	18	29	22	60	60	60 – 70 = 10°
*16	M	49	15	34	21	48	17	7 – 60 = 53°
*17	M	44	18	26	21	34	36	25 – 40 = 15°
18	M	51	35	16	17	78	55	38 – 78 = 40°
19	M	36	21	15	17	35	35	8 – 60 = 52°
20	M	43	13	30	16	75	95	75 – 95 = 20°
21	M	36	14	22	17	66	54	50 – 66 = 16°
*22	M	54	23	31	21	5	9	5 – 9 = 4°
23	M	50	20	30	14	70	74	48 – 78 = 30°
*24	M	59	35	24	21	20	6	6 – 20 = 14°
*25	M	52	28	34	24	23	25	15 – 30 = 15°
*26	M	60	27	33	26	47	55	35 – 60 = 25°
*27	M	50	25	25	25	74	69	53 – 93 = 40°

* Deep x-ray therapy given to spine.

noted previously (Sturrock, Wojtulewski, and Hart, 1973), tends to diminish earlier in extension than in flexion and to a relatively greater degree; this is perhaps true of most joint stiffening in orthopaedics.

Discussion

In the past other methods of measurement of spinal movement have been used (Schober, 1937; Loeb1, 1967; Macrae and Wright, 1969; Moll and Wright, 1971). With the exception of Loeb1, who uses an inclinometer devised by himself, these methods depend on measurements from different anatomical landmarks. Such measurements, using fixed anatomical points, plumb-lines, and tape measures, are often time-consuming and in some cases subject to error. In clinical measurements speed, accuracy, and reproducibility are all-important, and we have found over the last 23 years that Dunham's spondylometer meets these requirements admirably. It measures stance and posture, and the degree of extension and flexion of spinal movement. In the past methods of assessing spinal movement by the distance of the fingers from the floor with the spine fully flexed were measuring hip flexion as much as anything else and were useless in assessing spinal mobility. Initially, with the assistance of Dr. Peter Hansell and the Department of Medical Photography at Westminster

Hospital, we photographed all patients erect, in spinal extension, and in flexion, on triple exposures (Fig. 3), but over the years changes have in most cases not been great enough to show demonstrable improvement or deterioration by this method. Both Moll and Wright (1971) and Sturrock and others (1973) have shown in normal subjects a considerable reduction in spinal movement with ageing, the former finding as much as a 50 per cent. reduction between youth and old age. It is of interest that in our spondylitis ageing has not always been associated with deterioration. These results may reflect the virtues of a programme of activity with spinal and breathing exercises, aided where necessary by anti-inflammatory/analgesic drugs, indomethacin and phenylbutazone being the most commonly used. Deep x-ray therapy had been given early in the therapeutic programme in fifteen cases.

Summary

Range of spinal movement in 27 patients with ankylosing spondylitis (24 males and 3 females) has been followed by one observer (FDH) for from 10 to 26 years. Measurements were performed with a Dunham's spondylometer, the uses and advantages of which are discussed. In only eight was there progressive deterioration, fourteen having measurements

FIG. 3 Triple exposure photograph of a man with ankylosing spondylitis

as good as, or better than, those at their initial attendance. In no case were periods of immobility ordered or braces fitted, therapy being based es-

entially on encouragement to lead an active life, with daily spinal exercises and anti-inflammatory/analgesic drugs as required.

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