An Objective Measurement of Change in Morning Stiffness

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Summary. A new method of hand-grip assessment has been applied to the problem of quantitative evaluation of morning stiffness. Treatment with indomethacin (known to reduce morning stiffness in rheumatoid patients) was shown to cause significant improvement in grip parameters, particularly in the power output achieved during grip development.

Key words: Rheumatoid arthritis – Morning stiffness – Grip Strength Analyser

Introduction

Morning stiffness (MS) following sleep is a characteristic feature of rheumatoid arthritis [1, 2]. This symptom, which is quantitated subjectively by recording the time taken for the additional stiffness on awakening to recede to a plateau, is accepted as a useful parameter for assessing disease activity [3, 4]. The duration of MS usually correlates well with other parameters of disease activity [4]. In this paper an objective method of quantitating MS is described and the value of the method illustrated by demonstrating change after the use of an indomethacin suppository. Stiffness is shown to be reflected in the power developed during the establishment of hand grip [5].

Materials and Methods

We studied 11 hospital patients with classic or definite rheumatoid arthritis [6], of which 5 were men and the mean age was 53 years. All were experiencing MS that was relieved by using an indomethacin suppository at night.

Hand grip was assessed by recording maximum grip strength (MGS), work output (W), and power output (P) on the recently developed Meek Grip Strength Analyser [5]. This apparatus (Fig. 1) consists of a standard Davis folded sphygmomanometer cuff attached to a pressure transducer and microprocessor control unit. The operator is able to control the duration from the onset of grip to an audio signal at which the subject releases the grip. The amplitude of the transducer signal and mode of display (digital, pen recorder or cathode-ray oscilloscope) can be varied. The initial pressure of the bag is set at 30 mmHg. The bag is then squeezed as quickly and forcefully as possible until the signal for release is triggered. Bag pressure is measured, digitised and stored in a random access memory (2K-2102) every 20 ms under the control of a Z-80 microprocessor. The pressure-time array is then analysed by the microprocessor using a programme stored in memory (2758 EPROMS) and the results displayed. Power is related to the rate of establishment of the grip, i.e. Power = (dP/dT)_{max} \times 0.0385 W \text{ where } P = \text{pressure and } T = \text{time. Work is related to the MGS. For an initial bag pressure of } 30 \text{ mmHg, Work } = \text{MGS } - 30 \text{ mmHg} \times 0.0385 J.

Each hand was assessed three times in succession and patients were assessed twice – on one occasion after administration of an indomethacin suppository the previous evening and on another without this medication. Patients were seated in bed and held the
Davis bag with the unsupported arm. In one group (group I, five patients) measurements were made at 6.00 a.m. (upon being awoken) and again at 11.30 a.m. In another group (group II, six patients) measurements were made at half-hour intervals from 7.00 a.m. to 12.00 noon.

Results and Discussion

Typical grip recordings for a normal woman and a woman with RA (both middle-aged) are shown in Fig. 2. Both recordings are for the dominant (right) hand. MGS, work and power are all markedly reduced in the patient. Comparison of grip parameters found for groups of rheumatoid female outpatients and age-matched normal females have been presented elsewhere [5].

Mean values of MGS, work and power at 6 a.m. and 11.30 a.m. for the first group of patients in the present study are shown in the Table 1. All patients experienced a reduction in MS following the evening administration of an indomethacin suppository. This was reflected in the greater improvement in 6 a.m. grip achievement relative to that at 11.30 a.m. Improvement in the power output following administration of an indomethacin suppository was considerably greater than the improvement in work and MGS (91% compared to 57% and 33%, respectively).

Mean values of work and power output for patients in group II are shown in Figs. 3 and 4, respectively. These patients had been awake for 30–60 min before the first grip assessment was taken. Increases in MGS, work, and power were again seen in all of the patients after treatment. The improvement in work output was reasonably constant (25%–30%) from 7 a.m. to 12 noon. Power output in contrast was markedly improved at 7 a.m. (82%), but this improvement declined with time (less than 20% after 10 a.m.) a pattern similar to that found for patients in group I (91% at 6 a.m., 19% at 11.30 a.m., see Table 1). From Fig. 4 it can be seen that power gradually declined from a maximum at 7.30 a.m. following an indomethacin suppository to the same level as that achieved without treatment by noon. In Fig. 5, individual examples of the change in grip pattern following the administration of an indomethacin suppository are shown. The striking improvement in power (i.e. rate of rise of pressure with time during formation of grip) is demonstrated in both cases. Note the late achievement of MGS in the absence of treatment. Time to reach MGS is significantly longer for rheumatoid patients than for age-matched normal controls [5].

The spontaneous improvement in grip pattern between 7 a.m. and 12 noon in two patients without treatment is illustrated in Fig. 6. There was improvement in MGS, work and power.

The calculation of power output involves measurement of the rate of grip development [5]. We believe that the rate of grip development (power) developed while achieving maximum grip strength can be accepted as an objective measure of the disturbance in motor function, which is subjectively experienced as MS. Work output and MGS