SHORT TERM CONTINUOUS PASSIVE MOTION

A FEASIBILITY STUDY

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Continuous passive motion (CPM) is an established method of preventing joint stiffness and of overcoming it. The optimum duration of treatment, however, is not known, though a period of one to three weeks is usual. This may be unnecessarily long and a programme lasting only three days has been tried in 34 patients: in 22 (Group A) treatment was designed to increase movement in stiff joints which had been operated on or manipulated, and in 12 (Group B) it was to prevent stiffness after an injury. A specially designed CPM device was used.

In Group A, the range by the third day of treatment was significantly greater than before manipulation or operation and this increase was maintained until the latest follow-up at an average of 24 weeks. In Group B, the pre-injury range was almost retained and thereafter there was a gradual increase. Patient compliance in the first 12 hours of CPM was relatively poorer than that described in previous reports, and in five patients treatment had to be discontinued.

Slow continuous passive motion (CPM) controlled by a motorised device was originally used to stimulate the healing of articular defects in rabbits (Salter et al. 1980). Since the experimental results were convincing, the method was subsequently widely investigated (Salter, Bell and Keeley, 1981; O'Driscoll, Kumar and Salter 1983a, 1983b; O'Driscoll, Keeley and Salter 1986; van Royen et al. 1986). In a feasibility study Salter et al. (1984) applied the CPM device immediately after operation while the patient was still under general anaesthesia, and usually continued it uninterrupted for a period of one to three weeks. Others used CPM for varying periods of time (Coutts et al. 1982; Greene 1983; Mooney and Stills 1987).

It seemed to the author that a short period of treatment might be sufficient to maintain joint movement and prevent stiffness, and would certainly be more economical. The acute reaction of traumatised tissue usually subsides in about three days and CPM applied for this length of time might be enough. Moreover it seemed reasonable to try intermittent rather than continuous

treatment, since this would be much more convenient for the patient. The present study was designed to test these views.

PATIENTS AND METHODS

Between March 1986 and February 1987, patients in the orthopaedic service of Srinagarind Hospital, Khon Kaen University, Thailand, who met the following criteria were included: a) they had had an operation or manipulation designed to increase movement of a joint; b) there was no anatomical restriction to movement and no serious instability; c) the patient understood the procedure and was willing to co-operate; and d) there were no underlying conditions contra-indicating treatment.

Patients were divided into two groups according to the goal of treatment: Group A when loss of motion had been present for some time and forcible effort was needed to improve joint mobility, as in old dislocations or in ankylosis; and Group B when mobility had been good until injury and the CPM was being used to maintain that mobility, such as in fresh fractures or joint injuries. **The CPM device.** Most CPM devices are specific for the upper or the lower limb and are expensive. The device we used – the "Ortho K KU Model" (Fig. 1) is electrically driven and was designed by the author. It can be used for either the upper or the lower limb (Fig. 2) and permits a

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Fig. 1

The continuous passive motion device – "Ortho. KKU. Model".

full range of movement of the hip, knee, shoulder and elbow, as well as supination and pronation.

The protocol of treatment. Regional, rather than general anaesthesia was preferred. CPM was started as soon as possible and while the anaesthetic effect was still present, so that as much movement as possible could be obtained from the very beginning. Additional regional anaesthetic was given in the ward only if insufficient movement was tolerated when general anaesthesia had worn off; alternatively the range was gradually increased by about 10° per hour until the maximum was attained.

Treatment was given in cycles of five hours duration; during each cycle except the first, which was continuous, a one hour intermission was allowed. A temporary pause was also allowed only for urgent toilet activities. The speed of CPM was adjusted to suit the patient's comfort, but was usually between one and three minutes per cycle.

A total of 72 hours was required for the CPM programme. During this time 400 mg of ibuprofen three times a day and a sedative before bedtime were prescribed routinely. Other analgesics were seldom required since if there was severe pain it was assumed that the joint was being moved excessively and this was immediately corrected. Before the patient was

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

The same continuous passive motion device, being used at the elbow (a, b) and the knee (c, d).

discharged from hospital he was taught active exercises which he was instructed to practise at home.

Assessments. The passive range of movement of the joint was measured with a standard goniometer. This was done before the initial treatment (except in two cases of acute trauma in which the range on the normal side was adopted), and every morning during the protocol. Compliance was judged by the patient's reactions and the need for analgesics (Table I).

RESULTS

A total of 34 patients were treated, 26 males and eight females. The mean age was 30 years (range eight to 50 years), and there were 24 elbows and 10 knees. Of these patients, 22 were classified as Group A and 12 as Group B. Five patients in Group A and two in Group B had their treatment terminated prematurely; five because of non-compliance, one because the machine broke down and one because the callus fractured. Twenty-three patients were followed up at an average of 23.9 weeks (range three to 61 weeks) from treatment; 13 were in Group A and 10 in Group B. By the time of their latest visit no patient had painful limitation of movement and no further follow-up was arranged.

The difference between the range of movement before treatment and after three days of CPM in the 27 patients who completed their treatment is shown in Table II. It can be seen that in Group A there was significant improvement of all movements. In Group B, where movement before the injury had presumably been normal, there was little difference – good range had been retained. Differences between the values on the third day and those at the latest follow-up in 23 patients (the four lost to follow-up are excluded) are similarly presented in Table III.

The compliance of all 34 patients was graded from the time the CPM was applied. During the first 12 hours 3%, 50%, 32% and 15% of patients had Grades 3, 2, 1 and 0 respectively. However, by the fifth period of treatment the number of patients in Grade 2 had decreased to zero, the proportion in Grade 1 had decreased to 15% while that in Grade 0 had increased to 85% (Fig. 3).

The analgesics given in each 12-hour period to each individual are shown in Fig. 4. The highest frequency was three times in 12 hours; this occurred only during the first period. After 12 hours more than 70% of patients in each period did not request any analgesics.

Complications. In three patients complications occurred which were related to the CPM treatment. One occurred during the second 12-hour period of treatment and consisted of a fracture caused by excessive rotational stress to two-month old callus in the ulna of a Monteggia fracture. The second was a delayed disruption of a lengthened quadriceps tendon; this developed gradually a few weeks after CPM treatment. A third patient, a 58-

year-old man developed severe irritability and disorientation on the third day of treatment.

DISCUSSION

There seems no doubt that CPM improves joint mobility and histologically enhances the healing of connective tissues (Salter and Minster 1982; van Royen et al. 1986). However, it may also cause further tissue trauma that, after the cessation of CPM, will finally lead to diminished movement.

In this study, three days CPM significantly improved joint mobility in patients who needed manipulation or operation for the treatment of stiffness (Group A); as there was no statistical difference between the range after three days of treatment and that at the latest follow-up, clearly three days treatment was enough. With Group B, in which the major purpose of CPM was to prevent loss of movement, there was no significant

Table I. Grading of patient's compliance to treatment with CPM

Grade 0	No pain or irritability; able to rest comfortably, CPM very well tolerated
Grade 1	Mild pain and/or irritability, able to rest most of the time; CPM fairly well tolerated
Grade 2	Moderate pain and/or irritability; difficult to rest; CPM barely tolerated
Grade 3	Severe pain and/or irritability, unable to rest; CPM not tolerated

Table II. Differences between range of movement before treatment and on day three of CPM

Groups	Movements	Differences (s.e.)	p-value
A (n = 17)	Flexion	+ 35.29 (1.73)	<0.001
	Extension	+ 11.47 (1.08)	<0.05
	Arc	+ 46.76 (1.90)	<0.001
B (n = 10)	Flexion	0.00 (1.47)	1.00
	Extension	- 9.50 (1.29)	0.06
	Arc	- 9.50 (2.02)	0.19

Table III. Differences between range of movement after three days of CPM and at latest follow-up

Groups	Movements	Differences (s.e.)	p-value
A (n = 13)	Flexion	- 0.77 (1.72)	0.90
	Extension	+ 3.08 (0.78)	0.31
	Arc	+ 2.31 (1.77)	0.73
B (n = 10)	Flexion	+ 13.50 (1.00)	<0.01
	Extension	+ 7.00 (1.10)	0.08
	Arc	+ 20.50 (1.46)	<0.05

difference between the range before treatment (which was usually normal) and that on the third day of treatment.

The reason CPM can be instituted immediately after extensive trauma without causing severe pain is not clear, though the gate control theory (Melzack and Wall 1965) may provide an explanation. The author did not, however, have the same experience as others (Coutts et al. 1982; Greene 1983) who were convinced that patients receiving immediate postoperative CPM were painless and comfortable, or even eager to return to it after

interruption. During the first 12 hours, half the patients in the present series were restless because of moderate pain or irritability. The most satisfactory regime was to start with only the amount of movement which the patient could reasonably tolerate when the anaesthetic effect had worn off; then to increase the range progressively by 10° per hour within the limits of discomfort. Another factor besides pain which contributes to compliance is the patient's understanding and willingness to co-operate; with at least four patients in this series CPM was withdrawn purely because of

Fig. 3

Distribution of patients with the highest grade of compliance during CPM application assessed in each 12-hour period.

Fig. 4

Distribution of patients and frequency of analgesics requested during the 72 hours of treatment with CPM, recorded at 12-hour periods.

irritability and unwillingness to continue, rather than pain.

In conclusion, it may be stated that the three-day protocol of treatment with CPM is usually satisfactory, comfortable and economical, but that it needs to be used with care.

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