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Technical note

Use of a gas spring contracture correction orthosis for the management of a fixed flexion contracture of the elbow

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Abstract

This paper describes the application of low level controlled torque to an elbow contracture through the use of an active orthosis. Over a period of twenty months the lack of elbow extension range was reduced from 105 degrees to 57 degrees. A description of the important orthotic design factors which led to significant functional improvement is provided.

Introduction

The use of gas springs incorporated into an orthosis in order to augment conventional stretching of hips and knees by physiotherapy has been reported previously (Moore *et al.*, 1990). One advantage of using adjustable gas springs is that the active torque can be closely controlled to match the clinical need. Other applications of dynamic or lively orthoses have been described (Chalmers and Hamer, 1985; Parker, 1987; Nuismer *et al.*, 1997) but in general the correcting torques are not noted. This is not surprising given that the use of elasticated members does not lend itself to precise settings and these settings change rapidly as soft tissue deformation takes place in a viscoelastic manner (Nordin and Frankel, 1980; Moore *et al.*, 1990). The general impression is that most systems are tensioned so as to provide the highest correcting force consistent with comfort and safety. This paper describes the application of a gas spring orthosis where torques needed to be restricted to very low values in order to cope with clinical conditions and reports on the outcome

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Patient and method

A female patient, in her mid-twenties, with an elbow contracture which had persistently failed to respond to conventional treatment was keen to co-operate with the examination of the effectiveness of a gas spring orthosis. The patient, suffering from a recurrent bilateral shoulder dislocation, had bilateral capsular reefing undertaken within the shoulder joints and, following this surgery and the rest period afterwards, had developed bilateral elbow contractures. Her left elbow had been very successfully straightened by routine physiotherapy. The right elbow, however, had failed to respond to this treatment and the patient was left with a range of motion which allowed her full flexion, but with extension lacking 105°. The restricted range prevented her from carrying out many tasks of daily living including ironing and tying shoelaces. Her referring orthopaedic consultant confirmed the suspicion that the restraint was due to soft tissue problems as opposed to bony deformity and that orthotic stretching could be applied. The main objective was to improve function by increasing the range of elbow motion through orthotic intervention.

Design criteria for the orthotic device included the need for the patient to apply the orthosis herself with one hand; that the forces applied through the orthosis must be tolerable and that it must be possible for these to be overridden so that any discomfort could be alleviated through

voluntary flexion of the elbow. Given that the cause of the initial shoulder problem was unknown it was decided that any applied correcting torque should be kept to a minimum.

The orthosis was constructed from above elbow and below elbow sections moulded in polypropylene lined with three millimetre "Evazote". The fastenings were "Velcro" through ring and return, and the above elbow and below elbow sections were joined by a single lateral stem with a freely hinged joint. The gas spring incorporated a pressure relief valve to allow precise setting of the restoring moment. To prevent the orthosis from fully extending when not being worn a strap to hold it in the flexed position was incorporated. Thus the donning procedure was as follows:

1. offer the orthosis to the arm;
2. apply the fasteners;
3. slightly flex the elbow to remove tension from the strap;
4. release the strap and relax the flexors to allow the desired function.

Doffing the orthosis was the reverse of this procedure.

The elbow extension torque which could be applied by the device and still be voluntarily overridden was recorded using a simple myometer with the force applied through a measured moment arm. This was used in determining the correct setting of the gas spring combined with the moment arm acceptable within the orthotic design. It was decided, with the aid of the myometer, that it would be safe to apply a corrective moment produced by a force of 10N applied at a distance of 200mm from the elbow joint (2Nm) and that this could actively be overcome by the patient's flexors. These figures were then designed into the orthosis and a force of 100N acting through a moment arm of 20mm resulted in an appropriate orthotic solution. It should be noted that the force applied to the upper and lower arm was distributed by the moulded sections.

After a period of becoming accustomed to the system the patient self-administered the treatment on a daily basis, wearing the device for most of the day. The available elbow extension range was monitored over a 20-month period.

Results

Attempts were made to review the subject on a regular basis but lifestyle limitations prevented this from taking place. Thus measurements of the elbow contracture were recorded on an irregular basis. The range of movement, shown in Figure 1, shows that initially full extension was reduced by 105° and during the first two months no improvement was noticed. When seen at month three it was found that the reduced extension had moved from 105° to 82°. This figure continued to improve to 78° at month four, but then increased over the next three months to 90°. Continued use of the orthosis led

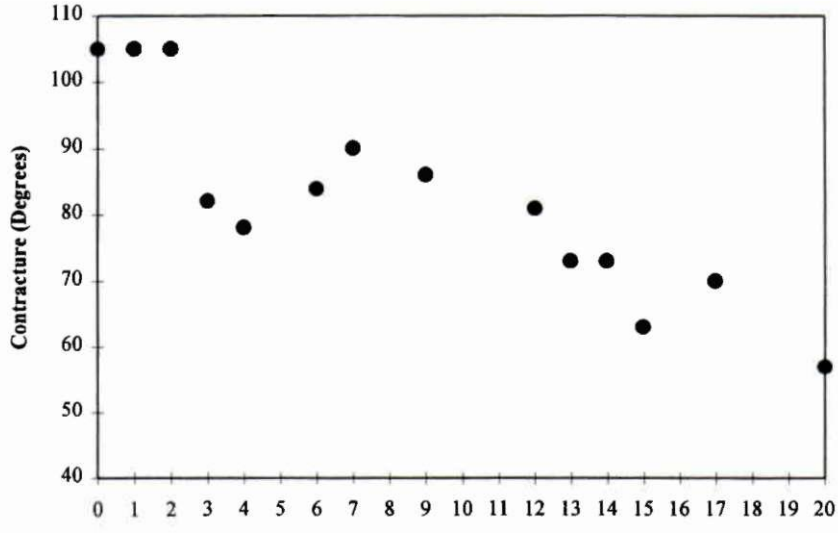

Fig. 1. Right elbow contracture results

to a range restriction of 57° at 20 months when many of the desired functions were achievable.

With regard to restoration of function the patient is now able to lift her young son from the floor; tie her own shoe laces and undertake a range domestic tasks, including ironing, all of which she had previously been unable to do. She has found these activities extremely important to her lifestyle and continues to use the device in the hope of achieving yet further improvement in her condition.

Discussion

The successful outcome of this intervention is quite surprising given the very low torque applied by the orthosis. This orthotic solution was only attempted since other conservative methods had failed and the clinic team was not very optimistic. Indeed with no change after two months use the decision had been taken to withdraw the orthosis if no change was seen by month three. The improvement at month three continued until the available range started to decrease for a period. On discussion with the patient, this was thought to be due to the fact that she was then in the late stages of pregnancy and found the orthosis rather tiring and unhelpful. After the birth of her child she continued once more to wear the orthosis and the improvement shown is clearly visible.

The extension of this technique to other conditions must be approached with caution since the original aetiology is unknown but the results are encouraging and suggest there is merit in using low torque devices where the action can be carefully controlled. An important implication of this work is that low torque applied in a consistent manner may be able to achieve correction of intransigent contractures. It therefore suggests that it may be possible to apply the techniques at the ankle.

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