Hand orthosis for various finger impairments—the K U finger splint*

H. WATANABE, K. OGATA, T. OKABE and T. AMANO
Department of Orthopaedic Surgery, Kumamoto University Medical School, Japan

Introduction
The dynamic hand orthosis which has so far been in use varies in structure, function and material. Commonly it takes too long to manufacture, it is difficult to adjust and there are many types that are unsatisfactory in durability, comfort and cosmesis.

Hence a new kind of hand orthosis that can be easily manufactured from simple parts and common materials is needed. It should be cheap, easy to adjust, improve the activities of daily living and both cosmesis and comfort should be acceptable.

Kumamoto University has developed the K U finger splint which attempts to meet these aims as closely as possible. It has been in use since 1971.

Description
The K U finger splint can be divided into two types; the W type in which piano wire is chiefly used, and the S type that makes use of fishing line (string).

W Type (Figs. 1 & 2)
Piano wire is connected to U-shaped metal or plastic troughs, the other end of the wire is


Fig. 1. 40-year-old male. Right radial nerve palsy (deep branch) secondary to fracture of the head of the radius. The K U finger splint, W type, was applied for two months after surgery. The post-operative course was uneventful and the palsy recovered satisfactorily.

Fig. 2. K U finger splint, W type.
inserted in the wire holder(s) attached to a wrist cuff. The wire holder is made of two metal half-cylinders fixed to the cuff. The wire can be positioned as required through the holes in the half-cylinders. A clip is fitted between the wire holders to retain the wire and permit some degree of excursion. Rotation of the wire may be prevented by fitting a triangular wire at the end, in which case only one wire holder is required. The metal trough is shaped from aluminium which is plastic coated for comfort and water resistance.

The most convenient sizes of wire are 0.8 mm, 1.0 mm and 1.2 mm in diameter which can assist or resist finger movements in the power ranges 1–70 gm, 4–180 gm and 7–300 gm respectively.

The direction and range of power of the W splint can be adjusted easily depending upon the diameter of wire used, the manner in which it is bent and the positioning in the wire holder.

**S type (Figs. 3 & 4)**

A thin, well fitting glove is put on the patient, tiny vinyl tubes are arranged along the tendon which requires support and fishing line is run through the tubes. The end of the fishing line is attached to an S-shaped ring which is fixed to the wrist cuff by a rubber band or coiled spring.

The vinyl tube should avoid the area of the finger joint so that smooth joint movement can be achieved. The tube can be attached to the glove by glue, adhesive tape or it can be sewn on.

When using the S orthosis to assist finger flexion the fishing line is set along the line of action of the flexor digitorum profundus tendon; for assisting flexion of the thumb the line is adjusted along the line of action of tendon flexor pollicis longus. When assisting apposition

---

Fig. 3. 36-year-old male. Right posterior interosseous-nerve syndrome due to soft tissue tumour of the forearm. The K U finger splint, S type, was applied in order to assist the thumb and finger extensor muscles. The paralysis recovered three months after surgery.

Fig. 4. K U finger splint, S type.

Fig. 5. S type splint with outrigger to assist apposition of the thumb.
of the thumb a simple outrigger is used to pull the line in the same direction as the action of opponens pollicis tendon (Fig. 5).

The S orthosis can be used not only to assist finger flexion but also for extension, in which case another type of outrigger is helpful to extend the finger and thumb in the desired direction (Fig. 6).

Indications and use

Radial nerve palsy at the wrist level

When the W type orthosis is used, the trough should be placed over the proximal phalanx of each finger and the metacarpo-phalangeal (MCP) joint should be pulled towards extension, and when the thumb cannot give adequate extension or abduction either, the piano wire should be fixed to the wire holder so that the power can work in that direction (Fig. 1).

When the S type orthosis is used, small vinyl tubes should be placed along the long axis at the centre of the dorsal side of each finger and the fishing lines led through them (Figs. 3 & 6). The T-shaped outrigger should be set at the cuff on the wrist joint and by careful choice of the 4 or 5 truss studs which are fixed on this outrigger, in order to fit the line of finger extensors, extensor pollicis longus, extensor pollicis brevis, abductor pollicis longus tendon and so forth, the movement of tendons can be fairly assisted. The fishing lines should be fixed to the proper truss stud at the wrist joint by means of the S-shaped ring and rubber bands of the correct tension.

In case of the S type orthosis, a finger cuff made of vinyl or leather instead of vinyl tubes can be fixed to the proximal phalanx and the MCP joint can be given extension with fishing line (Fig. 7). In this case there is no need to wear a glove.

Median nerve palsy at the wrist level

The main symptom in this case is the disability of apposition of the thumb generally called "ape hand". When using the W type orthosis for this palsy, the trough is put on the proximal phalanx of thumb and the piano wire is placed to pull the thumb into apposition.

In this case the wire holder should be set at the palm side on the wrist joint (Fig. 8). The piano wire can also be connected to the block of the
opponens bar and C-bar, and set to the wire holder in the direction of apposition (Fig. 9).

In the case of using the S type orthosis, extend the fishing line so as to reach the first metacarpal head through the small outrigger that is attached to the wrist cuff. The fishing line should be pulled with a rubber band, so assisting the movement of the thumb towards apposition (Fig. 5). If there is weakness of thumb flexor or finger flexor muscles, place vinyl tubes along the tendon of flexor pollicis longus and flexor digitorum profundus, and then let the fishing line run through them (Fig. 10).

Ulnar nerve palsy

Mostly in case of isolated ulnar nerve palsy, the ring finger and the little finger will present claw finger deformity, and flexion of the MCP joints and extension of the IP joints will become difficult. The S type orthosis can be used for this condition. The fishing line can be pulled round from the dorsum of the proximal phalanx toward the palm, choosing the proper truss stud, and fixed to the cuff of the wrist joint on the palm side with a rubber band to assist flexion of the MCP joint. On the other hand, the W type orthosis is used for extension of the IP joints. In this case the trough may be placed at the middle or the distal phalanx of the fingers (Fig. 11).

Other pathological conditions of the fingers

The W type and S type orthoses can be used as a dynamic orthosis before and after surgical operation for tendon rupture of the finger and for the maintenance of correction of ulnar drift.
Hand orthosis for various finger impairments—the K U finger splint

Fig. 12. For correction of ulnar deviation, W type. (Fig. 12) after finger arthroplasty. They can also be used for the purpose of static splinting to hold the correction of finger contracture. These orthoses can give help to each tendon in its assisted active movement and resisted movement according to its own muscle power.

Discussion

Various kinds of hand orthoses have been made to date, but most of them have not been good enough to give satisfaction to the patients. Of course, Swanson's splint (1971) leads others in function but it is rather poor in its cosmesis and it is not light in weight, so it is not easy to wear it for a long period. Bunnell (Boyes, Ed. 1970) invented several wire splints such as the knuckle bender splint, reverse knuckle bender splint, finger-bender splint etc. These wire splints are excellent from the functional viewpoint, but there is some degree of limitation in hand and finger activities because of the protruding wire frame and rubber bands. The Thomas suspension splint and Oppenheimer splint have no provision for adjustability of the individual fingers.

Four kinds of finger orthoses have been produced by the Steeper Company (Hugh Steeper Limited, 237–239, Roehampton Lane, London SW15 4LB), the main one among them being the spider splint. These are superior to the others in their external appearance, being light in weight, excellent in adjustment and also have the feature of not hindering the action of holding things in the palm of the hand. But structurally the power to push the finger towards the ulnar side is strong, and so, in case of a rheumatic patient, there is the risk of making ulnar drift worse. In addition the indications for these orthoses is quite limited; they are suitable only in the case of low radial nerve palsy.

The first trials of the K U finger splint were based for the most part on the W type, followed by trials made based primarily on the S type (Watanabe, 1973). These two orthoses are made of several simple materials (Fig. 13) and are able to be applied to various cases of finger troubles. By adjusting the piano wire and fishing line, it is quite convenient to change the power of the orthosis according to the progress of the disease. If the materials are stored as a kit or in a half-made form, a doctor or occupational therapist can at once put them together

Fig. 13. Components and materials of the K U finger splint.
according to the need and let the patients use them. If the patient understands the purpose of splinting, he himself can in some degree adjust the orthosis. This hand orthosis can freely regulate the direction, the range, the distance that the power works, and is also light in weight, easy to put on, and its cosmesis is not bad. In case of using the S type orthosis at the palm side, it does not cause any disturbance when holding things as the former orthoses did, and it is convenient in activities of daily living, too.

The problem of the K U finger splint is that the orthosis reaches the wrist joint and so it may cause limitation in the movement of the wrist joint. However in the cases in which this orthosis has been used there have been no troubles at the wrist joint. In case of the S type orthosis, the simplest way of applying it is to fix the parts and materials to the glove, the wearing of which may sometimes give a patient trouble. When the patient does not like to wear a glove, it is possible to use a thin sack-like vinyl instead (Fig. 14).

The indications of the K U finger splint are (1) radial nerve palsy (low level), (2) median nerve palsy (low level), (3) ulnar nerve palsy, (4) injuries of flexor or extensor tendons of thumb and/or fingers, (5) contracture of thumb or fingers, (6) ulnar deviation of the fingers at M P joint, (7) pre- and post-operative conditions of various finger impairments.

Summary

The K U (Kumamoto University) finger splint has been manufactured for the purpose of developing an effective hand orthosis for various finger impairments using simple parts and materials. By combining the W type orthosis for which piano wire is mostly used, and the S type for which fishing line is mainly used, it has been used to good effect on patients with several kinds of finger impairments. The fabrication and adjustment of the orthosis is simple and if the material is in kit form, a doctor or an occupational therapist can at once construct one and give it to a patient. For this reason, the patient will not lose the chance of timely treatment.

Work is continuing to find a way to simplify and widen the use of the K U finger splint.

REFERENCES

