INFLATABLE SPLINT

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THE emergency splinting of fractures is a frequent problem facing all doctors and first aid workers. In war, difficulties are increased by the evacuation of the patient through hostile terrain and uncertain lines of communication.

The use of the air or inflatable splint in the emergency treatment of simple and compound fractures of the lower limb below the knee is far superior to the conventional methods. Splintage commonly used consists of Kramer wire, which is usually not broad enough, wooden slabs which are cumbersome and frequently too short, and plaster of Paris slabs which, unfortunately, are often badly applied (I saw one such case of a fractured tibia and fibula where the slab was applied anteriorly, directly on to the skin, with resulting blistering and consequent hold-up in internal fixation of the limb).

To be useful in an emergency a splint must be safe, reliable, efficient and easy to apply and remove. It must be durable, portable, easily stored and cheap. The air splint fulfils these criteria and offers a means of continuous, undisturbed support from the scene of the injury to the casualty department in hospital, and thence for definitive treatment in plaster room or operating theatre.

The air splint is an inflatable plastic bag, which, when applied to the broken limb and blown up, supports and largely restores the normal contours of the limb. There are many different designs with minor variations, but in its simplest form it is a rectangular bag with a hole for the foot, a full length plastic fastener to allow easy application and removal, and a valve to control air in the splint (Fig. 1). Application of the splint is simple. It is opened out flat after undoing the fastener, wrapped around the affected limb and fastened in place. Air is blown in by mouth through the valve, which is then closed. The whole procedure takes thirty seconds. The limb is supported by a cushion of air, in the same way that a tyre is held by the air in the inner tube.

The rigidity of this system can be shown in two simple ways. First, a long sausage-shaped balloon is blown up fully; when one tries to approximate the two ends by bending it in the middle, there is a tendency for the balloon to resist the change in shape and to stay straight. Second, a plaster model of the lower limb is made weighing twenty pounds; it is sawn in two at a site corresponding to the middle of the lower limb, and introduced into an air splint with a two-inch gap between the two ends of the model; when the splint is blown up, the model can be picked up from its thigh end and held out with no shift or buckling between the two ends of the model (Fig. 2).

Features of the Splints

Speed and ease of application. No special training is necessary to splint a limb efficiently and speedily. The splint can be put on over clothing, without spoiling it, but the wrinkles caused by the clothing may damage the skin, if the splint is left on for more than an hour or two. Removal is simple, by letting the air out of the valve and undoing the fastener.

Safety. The skin of the limb is cradled by the smooth plastic lining, which is exerting an even pressure. No colour or temperature change is noted in the part beyond the

Fig. 1—The splint applied to the lower leg.

Fig. 2—No buckling of a 25 pound plaster of Paris model.

splint, even when it has been left on for periods up to six hours. In a hot climate, or in a sweaty individual, such a period could be followed by some skin maceration (It is hoped that work will be undertaken to solve this problem, probably by lining the splint with a sponge material which will absorb sweat and will allow the skin to breathe). In applying the splint over a compound fracture, it is advisable first to apply a bulky sterile absorbent dressing such as a first field dressing or shell dressing, since bleeding can continue within the splint.

Efficiency. Patients immediately acknowledge comfort and confidence in the broken limb when in an air splint, and can be persuaded to lift the injured limb off the ground within thirty seconds of application (Fig. 3).

Fig. 3—Fractured tibia and fibula; raising of leg thirty seconds after application of splint.

Translucency and Transradiancy. The clear plastic material enables the limb and its skin to be watched all the time. Since the limb is so well supported and can be moved by the patient himself, it makes the task of taking radiographs much easier for both patient and radiographer. The painless freedom of movement of the fractured limb also facilitates the task of evacuating the casualty from difficult situations.

Carriage and Storage. They are light and compact and, when rolled up, an adult's splint measures seven inches by five inches, weighs only six ounces and can be carried in a pocket. They can be stored for long periods without detriment to the plastic, provided they are rolled up. If folded they may crack along the folds. Gross changes in temperature may lead to hardening of the plastic and consequent cracking. Lightness and ease of storage would make them ideal splints for mass casualty evacuation.

Durability. They last for long periods and can be used again and again, but are prone

to puncture if carelessly used (One complaint which I saw in a personal communication was that the patient had burst the splint when walking on it, following its application on a broken leg). This is a disadvantage when removing a person from an area where there are sharp projections as from machinery or fallen masonry. However, if the limb and splint are wrapped in a blanket this should prevent any sharp edges from perforating the splint. First aid repairs to the splint can be carried out with an adhesive dressing or tape.

Design and Application

Certain practical points have arisen from experience in the use of the splint.

Shape. The simple rectangular form described is easy and cheap to manufacture. The type which entirely encloses the foot like a boot is slightly more difficult to apply and much more expensive, and leads to cramping of the toes as if wearing a pair of new tight shoes. The type of splint with no foot support, which covers that part of the leg from ankle to mid-thigh, as does a guarding plaster of Paris cylinder, gives no support to fracture of the tarsus or to Pott's fracture. A type made for the upper limb stops short at the wrist and hence gives no support for the hand. The upper limb splint also keeps the elbow in the fully extended position, while the flexed elbow position is preferred in the treatment of all upper limb fractures, save the supra-condylar type with anterior angulation of the distal fragment.

Fastener. This should run the full length of the front of the splint to allow it to open out flat. It should be in a form of a plastic slide. Metal zips interfere with the passage of X-rays and there is added danger of the zip catching and damaging the skin on closure. Splints closed by criss-crossing string over metal hooks have no advantage over those closed with a plastic slide and, indeed, indent the skin. Another good method of closure is by Velcro, which allows the splint to be rolled up into a compact bundle.

Valves. It is advantageous to have a valve on each side for easy access. These should be situated about the middle of the splint. When placed at the bottom, they are liable to be displaced by the foot of a restless patient and, if at the top, they are aesthetically misplaced for blowing up. The type of valve varies. Some are closed by a simple bung or spigot, others by pulling a stopper out from within the valve and twisting it with the teeth. Such valves are liable to become undone readily. The easiest and most efficient is the one which is closed by an outside twist valve.

Air Pressure. Blowing up by mouth is easy and there is no need for mechanical means of inflation, which indeed could present danger from over-inflation. The amount of air required in the case of a conscious patient is determined by the feeling of comfort and support derived. With an unconscious patient, the amount of air introduced is determined by experience. The tension of air in the splint should allow it to be dimpled by half an inch through firm manual pressure on the plastic (Fig. 4). The tension in a properly inflated splint should simulate that of the contracted thigh muscle when felt with the fingers through the overlying fat. When measured with a manometer, the pressure should be approximately 30 mm of mercury.

Sets of Splints. Many manufacturers are producing an "Emergency Kit" of air splints. These usually consist of six splints, three for the upper limb and three for the lower limb. There appears to be little advantage in using air splints for fractures of the upper limb, which can be aptly treated in a triangular bandage or by strapping the limb

Fig. 4—Assessment of air pressure.

across the chest, or even pinning the shirt sleeve to the front of the shirt. The lower limb set includes a foot and ankle splint, a below-knee splint and an above-knee splint. The above-knee splint which supports from the toes to mid-thigh will cope with all fractures for which the other two leg splints have been designed, as well as its own range of fractures. It follows, therefore, that of the six splints in an emergency set, the three for the upper limbs and two of the three for the lower limbs may be regarded as superfluous. This would imply that only one useful splint remains in the set. Now that splints can be bought for less than twenty shillings each, a great number of Counties have their ambulances equipped with air splints, while many casualty and accident departments are similarly stocked.

Summary

The air splint represents a safe, efficient and cheap means of splinting fractures of the lower limb in first aid treatment in the field. It is a progressive implement in the armamentarium of the regimental medical officer and his orderlies. Unfortunately, high costs in the past have delayed its general acceptance. However, surgeons and first aid workers all over the world are now adopting it as their choice in first aid treatment of fractures of the lower limb.