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A simple and versatile driving appliance for upper-limb amputees

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Abstract

A simple fixed-hook driving appliance is described, suitable for upper-limb amputees, and its function compared with that of the commonly available ball-and-cup device. The hook is reliable, safe and inexpensive. An attachment is also described which fits on to gear levers, allowing the use of the driving appliance to change gears manually.

Introduction

The ideal driving appliance for upper-limb amputees should be simple, inexpensive, reliable and capable of being used in unmodified cars. The standard ball-and-cup device (motoring appliance AE44, manufactured by Hugh Steeper (Roehampton) Ltd.) partly fulfils these criteria, but is not completely safe, and requires the attachment of the ball device to the steering wheel of every vehicle used. An alternative device is described here, particulary suitable for right-hand amputees driving right-hand-drive vehicles.

Design

The appliance (Fig. 1) is a fixed V-shaped stainless-steel hook on a short stem. The two forks of the 'V' are covered with tubing rubber or a similar material with a high coefficient of friction. The hook is fitted to a standard adaptor, domed with holes (Steeper catalogue No. 16J) which allows free circumrotation of the hook in the prosthesis.

This design is particularly applicable to below-elbow amputees, but it is unlikely that any modification would be required for above-elbow prostheses.

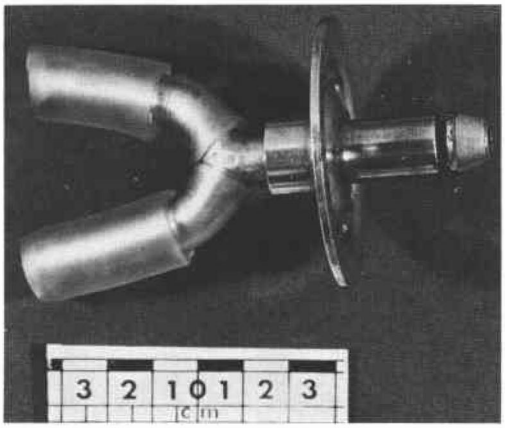

Fig. 1 The fixed-hook driving appliance. The forks of the 'V' are covered by rubber tubing.

Operation

This is most conveniently considered by comparing the hook with the standard ball-and-cup device.

The hook is able to grip the wheel at any point along its circumference, whereas with the ball and cup device grip is only possible at the point on the wheel to which the ball is attached. The hook offers two advantages in this respect. Firstly, turning the wheel can be executed by small arcs of movement using each arm alternately, which is the exact movement recommended to two-handed drivers. Secondly, because wide swinging movements of the prosthesis are therefore unnecessary, the prosthesis can be maintained in a position of optimum comfort and safety whatever the position of the wheel.

In the ball-and-cup device, the angle subtended by the prosthesis on the axis of rotation of the wheel, α, (Fig. 2, left) is critical.

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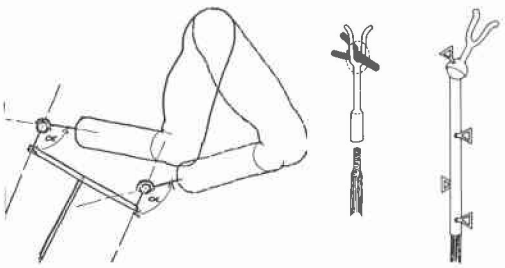

Fig. 2 Left, the use of the ball-and-cup driving appliance. The angle α changes depending upon the position of the wheel. Right, gear lever attachments for use with the driving hook. The simple attachment is shown on the left, the adjustable appliance on the right (see text).

Upon it depends the ability of the cup to cover the ball and thus effectively to control the wheel. Furthermore, since the ball remains fixed on the wheel, the angle α changes depending on the position of the wheel. In practice, the driver must be positioned so as to maintain the angle α as close as possible to 90° whatever the position of the wheel. Such optimum positioning can sometimes be difficult, for example in a sports car with low seats and a nearly vertical steering wheel. Here either the appliance or the vehicle must be modified if control of the wheel is to be adequate.

By contrast, with the hook, the angle α is unimportant, the V shape allowing a firm grip of most steering wheels whatever this angle. Whatever the vehicle, the driver's only consideration in positioning himself is his comfort.

With the hook, force can be applied in a plane approximately perpendicular to the axis of rotation of the wheel; force applied in this way not only grips the wheel but is effective in turning it. Little muscular effort is required in maintaining this grip, controlled shoulder extension with the elbow fixed in a position of comfortable flexion allowing the hook to wedge against the steering wheel. By contrast, in the ball-and-cup device, the force with which the cup grips the ball must be exerted in the axis of rotation of the wheel, and thus cannot contribute towards turning the wheel; in addition, this force requires continual active elbow extension (in below-elbow amputees). The continual attention necessary to keep the cup covering the ball detracts from that paid to the road.

The same problems arise with both appliances in operating controls on the steering column. In practice, it is usually possible to stabilize the wheel with the prosthesis and use the other hand to cross over to reach the necessary controls. Alternatively, the controls may be modified or repositioned to make them more easily accessible.

Use of the hook also obviates two other problems sometimes reported with the ball-and-cup appliance, namely a tendency for the ball to work loose (potentially very dangerous) and cracking or other damage to the steering wheel due to fixation of the ball.

Manual Gear Changes

Here it is necessary to fix an attachment to the gear lever. In principle, as shown in Figure 2 right, the stem of the driving hook fits snugly into the fork of the gearstick attachment, the latter positioned to allow traction in all directions in the horizontal (or other appropriate) plane.

In its simplest form, the gearstick attachment is screwed directly on to the gearstick in place of the gear knob, the attachment being bent permanently to the required shape appropriate to the motorist and his particular vehicle. A more versatile device has a hollow metal tube which slips over the upper part of the gear lever, to which it is attached with screws; such attachment also allows the height of the device to be adjusted. The final adjustment of the angle of the fork utilizes a ball-and-socket joint. A joint allowing movement on one plane only would add to the stability of fixation of the forks, but make the attachment slightly less versatile in its use in different vehicles, the chief advantage of the more complex of the two gearstick attachments.

The principles above can be applied equally well to devices suitable for vehicles with automatic gearboxes and those with column gear levers.

One advantage of the ball-and-cup appliance is that the cup can control a manual gearchange without any modification of the gear lever, although occasionally adjustment is necessary to make the gear lever optimally accessible, usually by permanent bending or replacement of the gear lever. However, this advantage is more than countered by the evident superiority of the fixed-hook appliance in controlling steering.

Discussion

The simple fixed hook appliance described has been used for the past 14 years by the author, a congenital below-elbow right-hand amputee, to drive a wide variety of vehicles, including high-performance cars (Fig. 3) and heavy four-wheel-drive vehicles. It has shown itself to be easy to use, very safe, and completely reliable. Its manufacture is simple and inexpensive. It allows the mechanism of driving for amputees to approximate closely to that used by two-handed drivers. The hook appliance itself is compact enough to be kept in the glove compartment of a car. In overcoming some of the problems encountered with the ball-and-cup appliance, this hook deserves to be considered as a safer and more versatile alternative.

Fig. 3 The driving hook in use.

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