What is the Clinical Role of the
<u>Upper Extremity Powered Prosthesis?</u>
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Object and Scope

The object of this brief paper is to try and promote discussion on the proper clinical role of the powered prosthesis and not to offer a solution to the problem. Any answer should probably take account of both short and long term aims. The application of power to splints is not considered.

The term powered prosthesis is taken to include any upper extremity prosthesis in which one or more movements are actuated by a source of power other than the patient's body.

The problem will be considered from two points of view namely that of a man who believes that all patients should derive benefit from the application of power at some point, and that of a man who considers that powered prostheses have at best, only a very limited application. To keep the statements short they will have to be somewhat dogmatic, though it is readily admitted that clear cut divisions seldom occur in practical prosthetics.

Powered Prostheses

Firstly the case for powered prostheses.

When an individual is without only one arm he can often manage with the other arm alone. When he is without both arms he needs some mechanical aids if he is to live a near normal life. But in any case the fitting of arms powered by the patients own musculature means that he has to learn new means of control and develop substitute means of feeding back information from the extremities. Surely such cases deserve the application of external power sources? In these days of micro-miniaturisation, even complicated control and feed back systems need not take up much space nor require much power to be supplied to them. The existence of electrical potentials in muscles provides an available source of signals which could actuate some of the same movements as were present in the missing limb, while electrical circuits to feed back information should be technically feasible. With a conventional prosthesis there is a limit to the number of controls which can easily be operated without undue thought on the part of the amputee whereas it should not be too difficult to build a programme into a control system which would give the amputee more simultaneous movements, greater freedom of operation and more natural movement.

It is true that to enable any artificial arm to do physical work will require some power reservoir larger than is required for the control and feedback systems, but even here modern techniques and materials provide means for storing energy in relatively small packages and the motors to be operated can be made small, light and easily concealed. This, therefore, should not be a serious barrier to the use of such arms, and should result in less fatigue to the amputee.

Conventional Prostheses

Secondly the case for the conventional type of prosthesis.

Given an arm amputee of normal physique he has ample power and movement in his body to operate artificial arms. It is a power source readily available, requiring no external connections and not subject to failure in akward circumstances. This power can be connected by simple means to the device to be operated and repairs to connections are easy.

The operating movements required can be learned without undue difficulty and a good amputee appears to be able to operate his arms almost wholly subconsciously. There is undoubtedly some feed back, though the exact mechanism is not clear. The interposition of a mechanical device might lessen this response. The added burden of carrying some form of power storage and the nuisance value of complex mechanisms are therefore unlikely to be acceptable to unilateral arm amputees or to bilateral amputees, particularly those with functional stumps, unless they offer appreciable advantages as well as having ease of control, adequate power, low bulk and weight, and complete reliability.

Many of you will have seen the skill with which Mr. Leavy uses his prostheses, and there are many other double amputees with conventional harness-controlled prostheses earning their living as craftsmen, and attending to their daily needs. Bilateral shoulder disarticulation cases can also earn their own living but admittedly need help in daily living. Why then do we want to go to the complications of external power sources?

Acceptability of Mechanical Aids

These, roughly, are the cases for the two types of prosthesis. In neither case have we really considered the acceptability of the prosthesis to the mind of the patient and this is a field which, as yet, is only incompletely explored. Some people adapt themselves to mechanical devices more easily than others. We have all probably seen workmen using hand operated drills when a power appliance is near at hand and housewives using a fork to beat up eggs when electrical beaters are at their elbows. Perhaps, in time, human nature will adapt itself more readily to a fully mechanical existence, but for the moment we cannot ignore the fact that muscle power is sometimes selected in preference to external power.

Clinical Role

Those of us who are working on the problem of powered prostheses, or co-operating in such work, are faced with the problem of trying to evaluate the probable clinical role of the upper extremity powered prosthesis and even a partial answer to the question would aid in directing work into the most fruitful channels.

As a basis for argument is it reasonable to suggest that the powered prosthesis is likely to be acceptable to the amputee in inverse proportion to the effectiveness of the conventional prosthesis and therefore, to say that powered prostheses should primarily be designed towards the needs of the most severely disabled, that is the bilateral high level amputee?

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