

THE BIONIC BLADDER

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ABSTRACT

To a paraplegic, paralysis not only means an inability to move the legs, but also loss of control of the bladder. Everyday life is plagued by the threat of urinary tract infection and encumbered by awkward urine collecting devices.

This paper discusses a recently developed system which, by means of electrodes implanted in the spine, returns the ability to empty the bladder at will.

1. INTRODUCTION

The Medical Council Neurological Prostheses Unit in London has been responsible for producing a radio activated stimulator for controlling the paraplegic bladder. Based on research by Profesor G.S. Brindley, this unit is now being manufactured on a small scale by Finetech Engineering, at a cost of about \$NZ3,500. In Christchurch we are fortunate to be involved in this project as the first centre outside the U.K. to use the system.

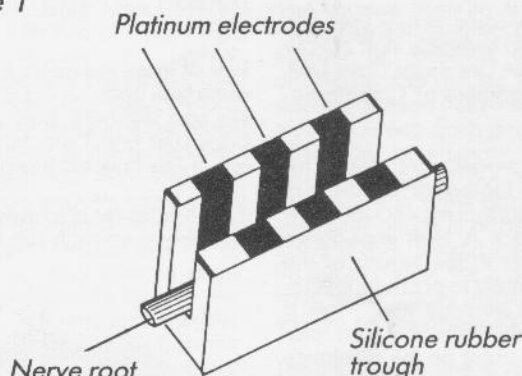
The controller works by stimulating both the bladder muscle and the outlet sphincter muscle simultaneously. This results in a bladder pressure rise, but a blocked outlet. Fortunately the bladder is made of slow acting smooth muscle whereas the sphincter is composed of fast acting striated muscle. When stimulation ceases the sphincter muscle relaxes instantly, but the bladder remains contracted for several seconds allowing urine to escape. Thus by applying bursts of stimulation, a pulsing flow of urine can be obtained. Conversely if continuous stimulation is applied the outlet will be held shut and leakage prevented.

The stimulator consists of two parts: An implanted electrode and receiver assembly, and a handheld transmitter and controller. (See Figure 1). In use it provides an effective means of emptying the bladder at will and achieving a low residual urine. Hence the risk of urinary tract infection is much reduced, and awkward collecting devices are unnecessary. A side benefit from the use of the stimulator enables some male patients with impaired sexual function to achieve erections.

The three criteria determining suitable candidates for the stimulator are that the nerves from the spinal cord to the bladder are intact, the patient can feel no pain below the chest and the patient has sufficient hand function to operate the equipment.

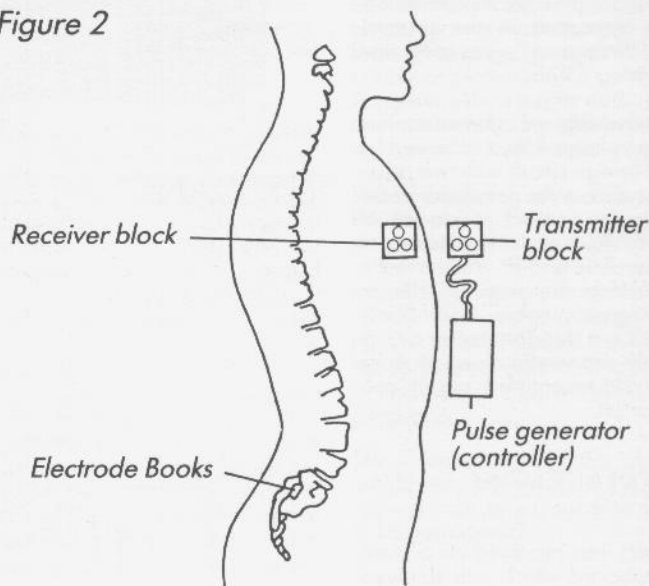
CONSTRUCTION OF THE ELECTRODES

Figure 1



LOCATION OF BLADDER CONTROL COMPONENTS

Figure 2



2. THE IMPLANT

The electrode assembly is made up of six components: the electrode "books", the receiver block, three sleeves for protecting the cable joints, and a grommet for sealing the spinal canal to prevent leakage of spinal fluid. The electrode books are fitted inside the sacral region of the spine, which is made up of the five lowest vertebrae. They are attached to three sets of nerve fibres known as the S2, S3 and S4 roots which control the bladder as well as other muscles in the lower part of the body. Three cables connect the receiver block, situated under the skin on the chest, to the electrode books.

Examined in detail the electrodes consist of silicon rubber "troughs" into which the nerves to be stimulated are laid. (See Figure 2). The principle is fairly similar to laying pieces of string between the pages of a book, and so for this reason the electrodes are called "books". Each of the troughs contains three U-shaped platinum electrodes, the middle one being the cathode and the two others being anodes. This method of construction is used to confine most of the stimulating field within the electrode, and so prevent stimulation of other unwanted nerves.