TWO LOW COST INDIGENOUS OPEN LOOP INSULIN DELIVERY PUMPS FOR DEMONSTRATION

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Abstract

Two different simple, safe and efficient "Open loop" devices for the continuous subcutaneous insulin infusion (CSII) developed and tried in the Department of Diabetology, Government General Hospital, Madras will be demonstrated.

One of them is a simple syringe pump in which insulin is delivered by rotating a small head-knob the amount of insulin delivered depending upon the rotation of the knob through the arcs of a circle. This is thus a "mechanical" pump that can be operated by the patient himself.

The second is a battery powered syringe pump weighing 300 G. This facilities both a basal insulin delivery according to a pre-programmed rate round the clock with facilities for the delivery of pre-meal insulin boluses. It is comparable in safety and efficiency to any pump available in the international market.

Their significant cost benefit ratio, light weight and small size compared to the presently available open loop devices in the international market need emphasis.

Whereas the imported pumps costing about Rs. 10-l2,000/- are beyond the reach of a common man, the ‘mechanical delivery pump’ referred to above costing only Rs. 25/- and the ‘battery powered syringe pump’ costing Rs. 250/- are suitable for developing and under developed countries.

Introduction

Insulin secretion by the natural human pancreas is such as to maintain euglycaemia round the clock. Researchers have developed two systems of insulin delivery : (a) open loop insulin delivery system that does not include a glucose sensor and (b) closed loop insulin delivery system in which glucose controlled insulin infusion (GCII) is possible. The latter is virtually an Artificial pancreas. The various insulin pumps available in the international market are of open loop type and insulin delivery by these devices can be pre-programmed. Their chief drawback is their cost which is beyond the reach of a common man. Hence, we proceeded to develop low cost open loop insulin delivery systems from indigenous materials in our department. This paper relates to two such low cost open loop insulin delivery pumps.

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l. Insulin Delivery system Mark I ‘Mechanical Delivery pump’

The first model of open loop insulin delivery pump developed by the Department is shown in Fig. 1. It consists of a 5 cc all glass syringe to which fitted a screw-gauge like control. The control system consist of a head knob, the rotation of which through the arcs of a circle delivers insulin. Thus the rotation of head-knob through 90° delivers one unit of Insulin. This can therefore be operated manually by the patient himself. There are no dangers of accidental over dosage that occurs with a sophisticated imported pump. This is safe, simple and cheap, costing Rs.25/-

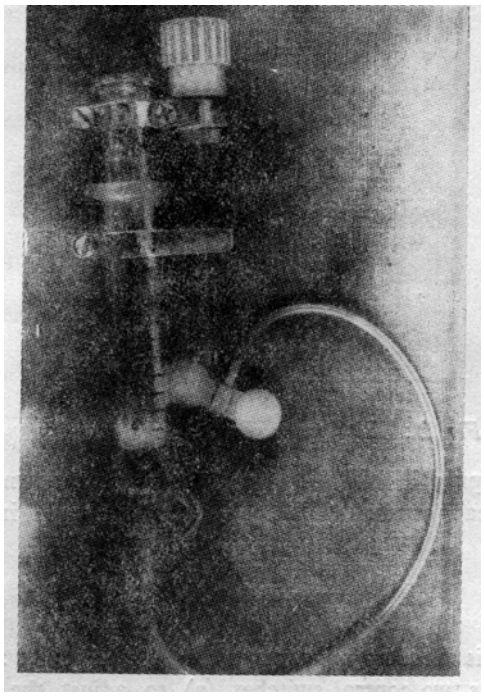

Fig. 1 : “Mechanical Pump”

2. Insulin delivery system Mark II Battery powered syringe pump.

The second model is a battery powered open loop delivery system (Fig. 2) that costs of two parts :

(1) The Delivery system and
(2) The control system.

1. *The Delivery system* : (12 cms x 6 cms, weight : 300 g)

The delivery system houses a standard insulin syringe held in place by a paperclip. Along side the syringe and parallel to it is a railing to which is attached a propeller rod that can be moved through its entire length either forward or backward by means of a motor.

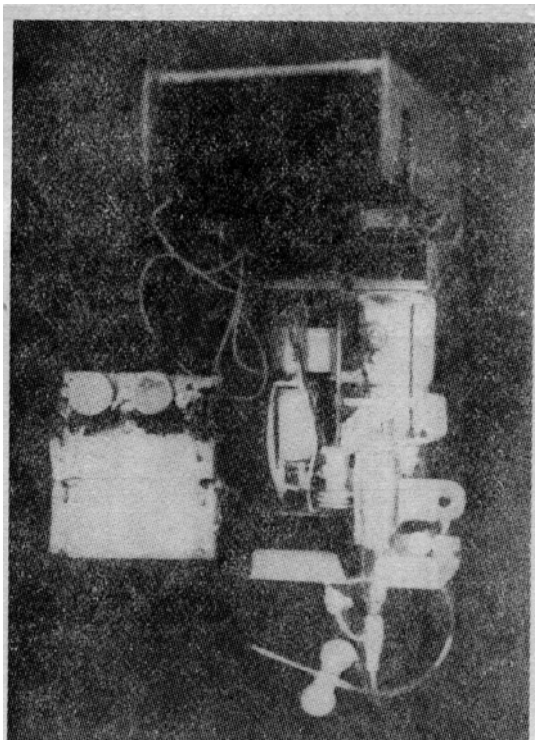

Fig. 2 : "Battery powered Insulin Pump"

The function of propeller rod is to push the plunger down the syringe. On the front of the device is a read out which reflects the amount of insulin that had been delivered.

2. *The control system*

The control system. is mounted on a control board of 5 cm X 5 cm that can be kept in the shirt packet. It has two control switches (a) to adjust the frequency of insulin delivery and (b) to adjust the amount of insulin delivered at a time. They can be so adjusted to deliver 2 to 4 units per hour. The power source consists of 4 dry cells of 1.5 volts each.

The insulin delivery system can be worn around the waist or any other convenient site by means of a belt. The terminal limb of the device is a scalp vein set with a needle of gauge 27.

The component parts of the pump costs about Rs. 250/-

Advantages of the two indigenous pumps

1. Continuous round the clock control of blood sugar is assured.
2. Low cost.
3. No need for multiple daily insulin injections.

4. All components are available even in the remotest part of the world.
5. Patient can be ambulant.
6. The patient's compliance to therapy is better as he is involved in the procedure.
7. The weight of the devices are comparable to that of the imported pumps.

Situations where the device is particularly useful

1. Control of brittle diabetics.
2. Control of Diabetic keto-acidosis.
3. Pregnancy diabetics during labour.
4. To control diabetes within a short time eg. when emergency surgery become necessary in a diabetic.
5. Diabetic neuropathy and over complications of diabetes.
6. To determine the total daily requirement of insulin.

Comparison between the imported and the indigenous pumps

Particulars	Imported Insulin pump	Mechanical Insulin pump	Battery powered Insulin pump
1. Cost	Rs. 10-12,000	Rs. 25/-	Rs. 250/-
2. Weight	Auto syringe 500G Mill-Hill 300G	--	300 G
3. Performance	Comparable	Comparable	Comparable
4. Availability	To be imported	Can be developed locally from indigenous components	Can be developed locally from indigenous components
5. Technical problems.	Yes. Needle slipage, disconnection or mal-functioning of charger or batteries. Accidental delivery of insulin leading to 'pump over run'.	No technical problems	No technical problems