New Technologies in CAPD

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Introduction

Since the inception of Continuous Ambulatory Peritoneal Dialysis (CAPD) in 1977 [1] the number of End Stage Renal Disease (ESRD) patients treated with this modality has shown a steady increase. Currently in the USA alone approximately 16,000 patients or roughly 15 % of the total ESRD population undergo CAPD.

Refinements in peritoneal access and prevention/treatment of peritonitis coupled with improvements in the understanding of the structure and function of the peritoneum [2] have resulted in patient survival comparable to that of chronic hemodialysis [3].

The experience with some of the newest technology applied to peritoneal access and peritonitis prevention follow.

Peritoneal Access

Peritoneal dialysis requires the implantation of a durable access device which perforates the abdominal wall. This has proven to result into complications, i.e. infection of the periaccess tissue, dialysate leakage, access migration, obstruction and hernia formation to mention just a few. These complications are a major cause of treatment failure and an obstacle to the greater acceptance of peritoneal dialysis as a treatment option.

Devices

Many different devices and implantation methods have been proposed to overcome these problems [4]. Over the last 20 years or so most devices have been made of silicone rubber. Most recently other polymers with better physical properties have been developed. In the peritoneal dialysis field a transition toward polyurethane devices has begun, a phenomenon that has also occurred in other fields such as the enteric feeding tube and vascular access. The newer polyurethane devices for peritoneal dialysis (table I) have excellent biocompatibility and physical properties such as thinner walls, scratch resistance and thermoplasticity resulting in better performance. Long term experience with this material is being accumulated. In short term studies the Dermaport®, a Tecoflex® polyurethane device of a distinctive design has resulted in the development of a stable device/skin interphase that reduced the need for exit site care and the incidence of exit site infections [5]. Currently a study is being carried out with a modification of the original design addressing the problems seen in a previous series [6]. Similarly an ongoing evaluating the performance of a Tecoflex® polyurethane of my design is being carried out.

Access Placement

Catheter implantation: Gaining acceptance as an alternative to open surgical implantation or blind percutaneous access placement is the peritoneoscopic implantation of peritoneal dialysis access devices (Y-Tec®, Medigroup, Aurora, IL) which employs a 2.2 mm peritoneoscope and a cannula assembly enveloped in a polypropylene quill catheter guide that serves as the tract for the catheter during the implantation. With minimal disruption of the abdominal wall and in particular the parietal peritoneum (only a small puncture wound is made) both the visual inspection of the peritoneal cavity and the catheter insertion are accomplished with this technique.

The procedure is done using local anesthesia and standard preoperative antibiotic prophylaxis (Cefazolin) and sedation (Meperidine and Midazolam). The ideal implantation site is the paramedial space 2 to 3 cm below the umbilicus. The important steps of the implantation procedure are:

a) The visualization of freely moving intestinal loops and a space free from omental interference or adhesions. Air insuflation not routinely necessary.

b) The inclusion of the distal cuff within the body of the rectus muscle for good support and tissue ingrowth.

c) The use of a purse string suture of strong absorbable material on the anterior rectus fascia to prevent accidental dislodgement and/or post operative dialysate leakage.

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Table I. Relative Advantages and Disadvantages of Polymers Used for Peritoneal Dialysis Access Devices *

Silicone	Polyurethan
(−) Thicker walls smaller lumen.	(+) Thinner walls higher flow capacity.
(−) Low resistance to tear propagation.	(+) High resistance to tear propagation.
(−) Flex life limited.	(+) Soften following implantation due to water absorption.
(−) Thermoset Has memory.	(+) Thermoplastic Can be given any shape, molds to shape given during implantation.
(−) Difficult to bond to other materials.	(+) Easier to bond to a variety of other materials.
(+) Sterilizable by all methods.	(−) Eto or gamma sterilization only.
(+) Non thrombogenic.	
(+) Very low extractables.	

* (+) Relative advantage.
(−) Relative disadvantage.

Table II. Incidence of Complications According to Catheter Placement Method

	Conventional (Surgical) N = 118	Peritoneoscopic * (Y-Tec) N = 94	P =
Leakage/Outflow Obstruction	11	1	.001
Tunnel infection **	24	1	.001

* All catheters placed peritoneoscopically had an inferolateral exit site.
** All tunnel infections led to catheter removal.

d) The intraoperative testing of the device function (in and outflow).

e) The orientation of the tunnel/exit site in a caudal position.

When compared with surgically implanted catheters at the same institution there is a significantly better survival of catheters implanted by the Y-Tec method (81 % vs 52 % at 1 year, p = < .001). Similarly the incidence of complications leading to catheter loss especially tunnel infection (table II) is significantly lower, perhaps because the tunneling has been made in such a way as to avoid the belt line and always in an inferior position relative to the catheter entry into the abdomen.

The advantages of this catheter placement method are: Better immediate function and functional survival, immediate availability obviating the need for «brake in» methods, lower incidence of cathetr leakage and tunnel infection, good patient acceptance and lower cost.

Prevention of Peritonitis

General measures to prevent infection complications include adequate nutrition, proper patient training and follow-up and the use of the appropriate system to suit individual needs. Touch

Table III. Incidence of Peritonitis According to System Type Used

System	# Patients	# Patient months	Episodes of peritonitis	Peritonitis * incidence
Manual				
Baxter 1®	49	1131	200	2.12
Abbott 1®	47	477	112	2.8
Abbott 3®	84	1227	217	2.12
Safelock®	43	319	11	0.41 **
Bagless (Y Sets)				
Biocap®	20	163	14	1.03
Ultraset®	4	28	1	0.43
Free Style®	5	37	7	2.27
Freedom Set®	38	399	19	0.57
Devices				
Baxter UVXD®	26	250	55	2.6
Abbott SCD®	63	864	84	1.16
Abbott OPTUM®	10	87	9	1.24

* Episodes of peritonitis per patient/year.
** P = < 0.01.

contamination continues to be the paramount cause of peritonitis in CAPD [9] thus strategies to decrease the likelihood of contamination at the connecting points have been moved in four general directions alone or in combination:

1) The elimination of unprotected spike connections.
2) The use of recessed Luer Lock connectors.
3) The use of devices that use:

a) U-V light irradiation of the connecting site.
b) Sterile welding of tubing.
c) Heat sterilization by autoclaving the connecting site.

4) Y sets with or without «on line» disinfectant.

Table III summarizes an 9 year experience at our institution with a total of 396 patients and 5068 patient months. In contrast to the manual systems that employ a spike connection (Baxter 1, Abbott 1 and 3) the use of the Fresenius recessed luer lock system (safe lock ®) has yielded a significantly lower incidence of peritonitis $p = < 0.01$. Similarly the use of bagless systems has generally a lower incidence of peritonitis despite the increase in the number and complexity of steps involved in the exchange process. The use of devices has been of no significance in the reduction of peritonitis, although the experience with the Optum® device has been limited. Furthermore devices add cost to the treatment and require maintenance. To summarize recessed luer lock connectors have made manual CAPD safer. Bagless systems with Y connectors have great patient acceptance but patient selection may be important. Devices are somewhat effective in decreasing touch contamination but they require maintenance and add to the time involved on each exchange. Their major contribution may be making it possible for patients with physical disabilities to undergo CAPD. Rapid methods for complete sterilization of the connections are in order.

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