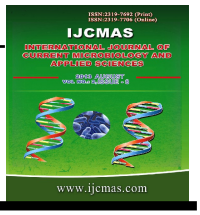
Int.J.Curr.Microbiol.App.Sci (2013) 2(8): 144-147

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 2 Number 8 (2013) pp. 144-147**
http://www.ijcmas.com



Review Article

Better understanding of peritoneal membrane anatomy and physiology - a success behind peritoneal dialysis

S.Lokesh*, and R.ArunKumar

Department of General Medicine, MGMC&RI, Puducherry, India
Corresponding author e-mail: *lokeshsdr@gmail.com

A B S T R A C T

The incidence of non communicable disease is on a rise, more so the Diabetes Mellitus and Hypertension. As a result of increased longevity the end organ dysfunctions are noticed often in Diabetic and hypertensive individuals. In addition there are various primary renal diseases which leads on to End Stage Renal Disease, once ESRD sets in Renal Replacement Therapy (RRT) become mandatory for survival. Peritoneal Dialysis is a form of RRT that has gained enormous popularity due to its simplicity and ease at which it could be performed at home by the patient himself. There has been several changes in the Peritoneal Dialysis technique, catheter insertion, catheter designs, dialysis prescription, management of complications and so on. All these emerged over decades as a result of a better understanding of peritoneal membrane and its functions. Some of the complications which were poorly defined before and were occurring at higher incidence (MIA syndrome, glucotoxicity) now has reduced and are rarely seen in the clinical practice. In this article we describe the anatomical and physiological processes which helped in emergence Peritoneal Dialysis, a novel Renal Replacement Therapy.

Keywords

Peritoneal Dialysis; Renal Replacement Therapy; End Stage Renal Disease.

Introduction

Peritoneal dialysis is a form of renal replacement therapy which was first performed on humans by Ganter in Germany, in the 1920s. Palmer developed the first permanent peritoneal catheter made of silicone rubber. Moncrief and Popovich in 1977 developed Continuous Ambulatory Petitoneal Dialysis (CAPD) as a form of renal replacement therapy in chronic kidney disease.

Peritoneal dialysis (PD) gained an enormous popularity due to its simplicity, low cost, and ease at which it could be performed at home by patient himself. The key factor for success of PD in recent years is because of better understanding of peritoneal surface anatomy and physiology, which has led to development of better technology, solutions and devices.

Peritoneal membrane anatomy

Peritoneal membrane is a serosal membrane with an area equivalent to body surface area i.e. 1 to 2 m^2. Visceral peritoneum constitutes 80% of overall peritoneal membrane and gets its vascular supply via mesenteric arteries and portal vein, remaining 20% is formed by parietal peritoneum which gets its vascular supply via arteries and veins of the abdominal wall.

The Peritoneal blood flow is thought to be about 50-100 ml/min, as compared to 1200 – 1400 ml / min of renal blood flow. Peritoneal cavity is lined by a single layer of mesothelial cells which produces a thin layer of peritoneal fluid. Under the mesothelium is a gel like interstitium containing connective tissues, capillaries and lymphatics. The effective peritoneal surface area is critical for dialysis and depends on the vascularity of the peritoneum as well as its surface area.

Anatomical barriers of peritoneal membrane clearance

There are six sites of anatomical resistance against which the retained by products present in the blood has to move to gain access in to the peritoneal cavity [Fig.1]. The byproducts that enter in to the peritoneal cavity are drained out at the end of peritoneal dialysis dwell. The vascular endothelium and the interstitium offer the maximum resistance and are the key determinants of effective peritoneal dialysis.

Peritoneal membrane physiology

The movement of solutes and solvents across the peritoneal membrane has been described by 2 physiological models, which include, The three-pore model, and the distribution model.

The "three-pore model"

The three-pore model of peritoneal transport was described by Rippe et al., (Figure 2). As per this model, there are three distint types of pores existing in peritoneal membrane.

The transcellular pore / ultrapores – the smallest pores which has a diameter of <0.5 nm, and they transport only water and not solutes.

The small pores – have a diameter of 4 – 6 nm, these are the predominant pores of peritoneal membrane and they transport small solutes (urea, creatinine).

The large pores – have a diameter of > 20 nm, they are less in number and transport large molecular weight substances like albumin, β_2 microglobulin.

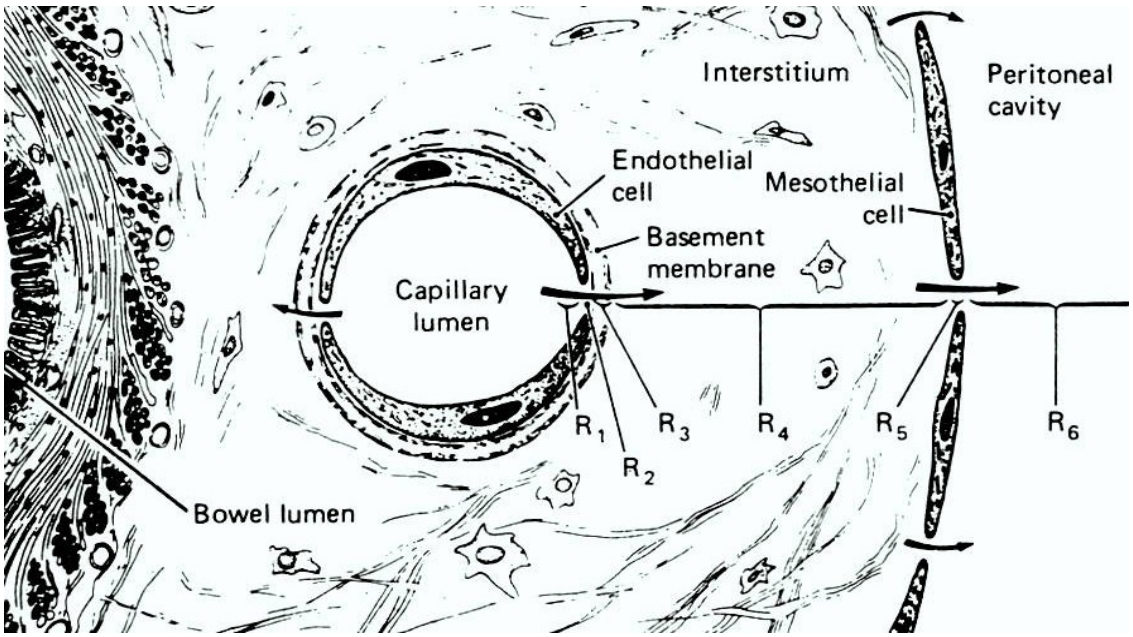
The "distribution model"

This model basically explains the role of capillaries in the peritoneal membrane, The rate and extent of solute transport which is basically determined by the proximity of capillaries to the peritoneal surface, and the difference in characteristic of peritoneal transport among different patients. It concludes that it is the vascularity of the peritoneal membrane that is more important than its surface area.

Physiology of ion transport

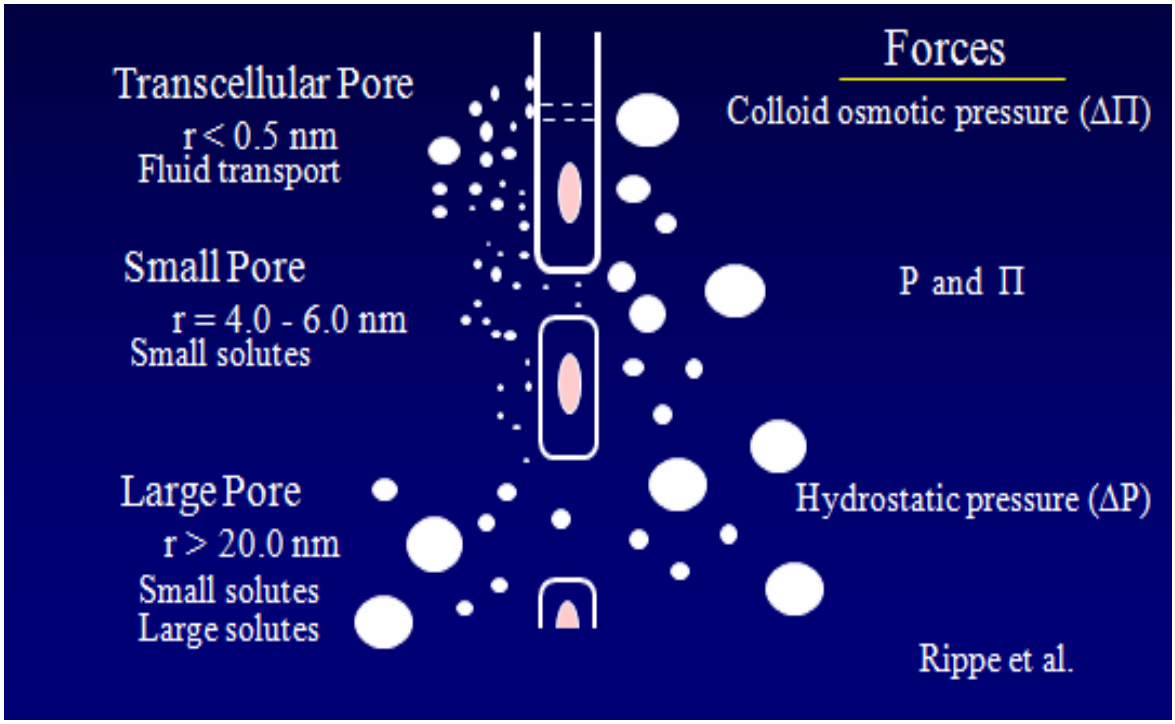
The solute and solvent transport occurs by 3 distinct processes, namely – Diffusion, Ultrafiltration, Fluid Absorption.

Figure.1 The Schematic representation of various anatomical layers of peritoneum**.**



R_1-Capillary fluid film, R_2-Vascular endothelium, R_3-Endothelium basement membrane, R_4-Interstitium, R_5-Mesothelium, R_6-Peritoneal fluid film

Figure.2 The Three-pore model of peritoneal transport



Diffusion

Diffusion is a passive phenomenon which is maximal at the beginning of the peritoneal dialysis dwell as the concentration gradient is maximal and the solute removal is fastest. The key determining factors of diffusion include, Concentration gradient for the solute concerned (*i.e.*, plasma to dialysate), Mass transfer area coefficient – which depends on, Effective peritoneal surface area, Diffusive characteristics of the peritoneal membrane for that solute

Ultrafiltration

This process occurs due to osmotic or oncotic forces, which in traditional PD is provided by glucose. The extent to which the osmotic agent is retained in the peritoneal cavity and continues to exert its osmotic or oncotic pressure is termed as reflection coefficient. A reflection coefficient of 1.0 signifies that the agent is retained and exert a sustained ultrafiltration throughout the peritoneal dialysis dwell. Glucose which remains the mainstay of PD, has a very low reflection coefficient of 0.02 due to its low molecular weight which makes it to diffuse in to peritoneal capillary bed from the peritoneal cavity.

Fluid absorption

During PD a constant amount of fluid from peritoneal cavity moves in to peritoneal circulation through lymphatics. The peritoneal fluid absorption occurs at a constant rate of 1- 2 ml/min or 250-500 ml during a 4 hour peritoneal dwell. Both water and solute moves in to the systemic circulation. Thus the overall solute removal depends on sum of diffusion and convection minus peritoneal fluid absorption.

Better understanding of peritoneal membrane anatomy and physiology has lead to development of Peritoneal Equilibration Test (PET), by which one can assess the characteristic of peritoneal transport and helps in prescribing an adequate peritoneal dialysis prescription in individual patients. The newer osmotic agent Icodextrin has emerged which has a sustained osmotic gradient throughout PD dwell and has a reflection coefficient of 1.0. Emergence of glucose free dialysis solution has reduced the incidence of glucotoxicity exerted over the peritoneal membrane by traditionally used glucose based dialysis fluid. Development of newer catheter designs help in smooth functioning of PD, with few adverse effects. The risk of MIA syndrome (Malnutrition, Inflammation and Atherosclerosis) has significantly reduced with the use of Icodextrin (non glucose) containing dialysis solution.

References

Brenner and Rector's , The Kidney, Text Book of Nephrology, edition 8, peritoneal dialysis, chapter 59.

Gokal, R., 2000. The Text Book of Peritoneal Dialysis, peritoneal dialysi.pp. 565.

Todd., T.John, Daugirdas, Peter Gerard Blake, Todd S. Ing. 2006. peritoneal dialysis and its physiology, Handbook of dialysis – Medical. pp. 321 – 339.

Lauralee Sherwood,2008. Human Physiology.

Willian Henrich., 2012. Principles and practice of Dialysis. 267.