Meltec Multipoint Haemodialyser

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Summary

The 0.61 m² Meltec Multipoint dialyser has a performance 25% better than the standard Kiil at clinically important blood flows despite its smaller surface area. With low priming and uptake volumes, adequate ultrafiltration, and a negligible residual blood volume, it is compact and can be assembled by one person. It should replace the Kiil as the standard against which new dialysers are measured.

Introduction

The Meltec Multipoint is a new haemodialyser which has recently been marketed in Great Britain. A parallel-flow dialyser of similar construction to the Kiil but using a multiple point membrane support as originally suggested by Bluemle *et al.*,¹ it is made of Perspex (the British equivalent of Plexiglass). The points are produced by grooving the board longitudinally as in the Kiil dialyser, then grooving it at right angles, to leave pyramids of Perspex. It incorporates a pop-in rubber gasket of the type which is gaining popularity for the Kiil dialyser because of its freedom from bacterial contamination.² We describe the in-vitro and in-vivo evaluation of this dialyser.

Methods

The dialyser was studied on seven occasions on two patients. Blood flow was varied over the range 75-280 ml/min with a blood pump. Blood flow was measured by bubble-transit time over a 2-metre track (mean of three measurements). Dialysis fluid flow was taken as the average of two timed collections over one minute from the effluent of the Lucas proportioning system in use on the patient under test. Urea and creatinine were measured on 1-ml samples of heparinized blood placed directly into autoanalyser cups and allowed to sediment while protected from evaporation. Urea and creatinine dialysances were calculated from the formula: dialysance = blood flow rate (arterial concentration - venous concentration)/arterial concentration. Dialysance studies were carried out in the third and fourth hours of dialysis when the most stable conditions prevail.³

Residual blood volume was measured after an 800-ml saline wash-in to permit comparison with previous data on the Kiil. The fluid remaining in the dialyser and circuit was circulated through a 1-litre bottle of 0.04% ammonia solution for 10 minutes. Residual blood volume was calculated from the formula:

$$U \frac{(1,000 + \text{volume of circuit in ml})}{200 S}$$

where U is the haemoglobin concentration in the recirculated residual fluid and S is the haemoglobin concentration of a sample of arterial blood drawn at the end of dialysis and diluted 1:200 in 0.4% ammonia.

Priming volume, uptake volume with increasing transmembrane pressure, blood flow resistance, and ultrafiltration

were measured in vitro under standard conditions of "blood" flow (200 ml/min) and "dialysis fluid" flow (500 ml/min).

Results

Dialysance.—The mean curves for urea and creatinine dialysance against blood flow obtained by computer analysis of 40 observations are shown in Figs. 1 and 2 and Table I. They have been compared with those of the Watson Marlow Kiil, which is the

FIG. 1—Comparative urea dialysance of Meltec Multipoint and Watson Marlow Kiil dialysers at a dialysis fluid flow of 500 ml/min and temperature of 38°C. Mean curves with 95% confidence limits of the mean based on 40 observations for the Multipoint and 105 for the Kiil are shown.

FIG. 2—Comparative creatinine dialysance of Meltec Multipoint and Watson Marlow Kiil dialysers at a dialysis fluid flow of 500 ml/min and temperature of 38°C. Mean curves with 95% confidence limits of the mean based on 40 observations for the Multipoint and 98 for the Kiil are shown.

TABLE I—Comparison of Urea and Creatinine Dialysance (ml/min) of the Meltec Multipoint and Watson Marlow Kiil Dialysers in vivo. Mean and 95% Confidence Limits of Mean

			Blood Flow (ml/min)				
			100	150	200	250	300
Urea:							
Meltec	..	..	80 ± 1.3	101 ± 1.0	117 ± 2.0	128 ± 3.0	138 ± 4.0
Kiil	..	..	68 ± 1.3	84 ± 1.4	95 ± 2.4	103 ± 3.0	
Creatinine:							
Meltec	..	..	63 ± 1.5	79 ± 1.5	90 ± 2.5	99 ± 3.5	107 ± 5.2
Kiil	..	..	56 ± 1.2	66 ± 1.2	72 ± 2.0	76 ± 2.5	

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best Kiil dialyser that we have tested⁴ and the artificial kidney in widest use in this country. Cross-grained 12-micron cuprophane was used on both dialysers, assembled wet.

The Meltec Multipoint dialyser shows a 22-25% improvement in the urea and creatinine dialysance over the Kiil in spite of its smaller size (0.61 m² against 1.02 m² membrane area). Its urea and creatinine clearance are similar to those of the Ultraflow 100 coil (calculated from the data of Lowrie *et al.*⁵) with a marginal advantage to the Meltec at blood flows below 200 ml/min.

Priming Volume.—The Meltec Multipoint has a smaller priming volume than the Kiil—mean result 77 ml against 105 ml. The uptake volumes with increasing negative pressure are also lower than those for the Kiil, amounting to 20 ml for an increase in transmembrane pressure to 100 mm Hg and 10 ml for the next rise of 100 mm Hg. At a transmembrane pressure of 200 mm Hg (suitable for fairly rapid ultrafiltration) the total volume of the dialyser is only 107 ml (Fig. 3).

Blood Flow Resistance.—The Meltec Multipoint has a much lower resistance to blood flow than the Kiil as shown by the smaller pressure drop at the same blood flow (Fig. 4). Its superiority should therefore be enhanced when dialysis is performed without a blood pump.

FIG. 3—Variation in priming volume with net transmembrane pressure in Multipoint and Kiil dialysers at blood flow rate of 200 ml/min, dialysis fluid flow rate of 500 ml/min, and temperature of 38°C.

FIG. 4—Variation of pressure drop with flow rate in the blood compartment for the Meltec Multipoint dialyser at a dialysis fluid rate of 500 ml/min and temperature 38°C. Mean dialysis fluid pressure—13 mm Hg and blood at atmospheric outlet pressure.

Ultrafiltration.—The ultrafiltration rate is 5.6 ml/min or about 340 ml/hour at a transmembrane pressure of 200 mm Hg (Fig. 5). This will allow the removal of 2 to 3 litres of fluid during an eight-hour dialysis.

Residual Blood Volume.—The residual blood volume after an 800-ml wash-in was negligible (Table II). After 400 ml of saline the dialyser and circuit look virtually clear of blood.

FIG. 5—Ultrafiltration rate at varying transmembrane pressure for Multipoint and conventional Kiil at a dialysis fluid flow rate of 500 ml/min, blood flow rate 200 ml/min, temperature 38°C. Membrane, 12- μ cross-grained cuprophane.

TABLE II—Residual Blood Volume after an 800-ml Wash-in

	Mean (ml)	Range (ml)	Observations
Meltec	0.85	0.6–1.4	6
Kiil	2.1	0.4–3.8	9

Ease of Handling.—The smaller size of the dialyser makes it easier to handle than the Kiil and it can be built quite easily by one person. A longer experience involving more dialysers is required before the leak rate and durability of the Meltec Multipoint can be adequately assessed but we have found no defects in these respects to date.

Discussion

The Meltec Multipoint dialyser is assembled by hand in the hospital or home and sterilized with formalin. It therefore shares

TABLE III—Urea and Creatinine Clearance (ml/min) *in vivo*

	Blood Flow (ml/min)				
	100	150	200	250	300
Urea:					
Meltec 0.61 m ² ..	80	101	117	128	138
Meltec 0.75 m ² † ..	85	111	129	142	153
Ultraflow 100† ..	69	97	117	132	147
Creatinine:					
Meltec 0.61 m ² ..	63	79	90	99	107
Meltec 0.75 m ² † ..	69	88	102	114	124
Ultraflow 100† ..	64	83	94	104	114

*Experimental data from Table I.

†Predicted.

‡Data of Lowrie *et al.*⁵ converted to clearance at 500 ml/min dialysis fluid flow rate in a recirculation single pass system.⁶

FIG. 6—Predicted performance of a 0.75 m² Multipoint dialyser compared with actual performance of the 0.61 m² version and the Travenol Ultraflow 100 coil.⁶ Dialysis fluid flow rate of 500 ml/min and temperature of 38°C.

many of the advantages and disadvantages of the Kiil; it costs about the same. The Perspex construction is attractive as it reveals defects in building, accumulation of air in the dialysis fluid compartment, etc., and permits the pinpointing of membrane punctures. Its superiority over the Kiil is such that it should rapidly displace the latter, provided its leak rate remains low and it survives routine handling in busy dialysis units.

The choice of a membrane area of 0.61 m² was empirical and is not immutable. We have predicted the performance of a 0.75 m² Multipoint, which could be achieved by increasing the length by 10 to 12 cm (Table III and Fig. 6). Such a dialyser would still have a priming volume and blood flow resistance no worse than the Kiil and would have a urea clearance superior to that of the Ultraflo 100 by 23% at a blood flow of 100 ml/min and by 8% at a blood flow of 250 ml/min. A prototype of this larger size is under construction; it should prove useful to the larger patients who are underdialysed with the Kiil on a 30-hour-a-week schedule.

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Requests for reprints should be sent to N.A.H.

Addendum

Since this paper was prepared we have evaluated two production models of the 0.77 m² and a prototype 1 m² Multipoint dialyser and obtained the results shown in Table IV.

TABLE IV—Mean *in-vivo* Urea and Creatinine Dialysance (Mean and 95% Confidence Limits of Mean Shown)

	Blood Flow (ml/min)			
	100	150	200	250
Urea:				
Meltec 0.77 m ² ..	88 ± 1.3	112 ± 1.5	129 ± 2.5	142 ± 3.6
Meltec 1 m ² ..	89 ± 1.5	118 ± 1.5	141 ± 2.3	159 ± 3.6
Creatinine:				
Meltec 0.77 m ² ..	75 ± 1.5	91 ± 1.6	102 ± 2.5	110 ± 3.6
Meltec 1 m ² ..	75 ± 2.5	96 ± 2.2	111 ± 3.2	123 ± 5.5

The mean priming volume of the 0.77 m² unit was 85 ml increasing to 110 ml at a transmembrane pressure of 200 mm Hg corresponding values for the 1 m² unit were 82 ml and 142 ml. The ultrafiltration at a transmembrane pressure of 200 mm Hg was 8.6 ml/min (516 ml/hr) for the 0.77 m² unit, and 11.8 ml/min (708 ml/hr) for the 1 m² unit. The mean residual blood volumes after an 800 ml wash-in were 0.64 ml (0.3–1.6 ml) and 2.46 (0.6–4.10) based on nine and six observations respectively. These results show good agreement with the predictions based on the results for the 0.61 m².

References

- 1 Bluemle, L. W., Dickson, J. G., Mitchell, J., and Podolnick, M. J., *Transactions. American Society for Artificial Internal Organs*, 1960, 6, 38.
- 2 Tobin, B. M., Ralston, A. J., and Jones, D. M., *British Medical Journal*, 1970, 3, 226.
- 3 von Hartitzsch, B., Hoenich, N. A., Jolly, D., Frost, T. H., and Kerr, D. N. S., *British Medical Journal*, 1972, 1, 235.
- 4 Hoenich, N. A., Strong, A., Strong, H., Frost, T., and Kerr, D. N. S., *Proceedings of the European Dialysis and Transplant Association*, 1970, 7, 484.
- 5 Lowrie, E. G., Hampers, C. L., and Merrill, J. P., *Transactions. American Society for Artificial Internal Organs*, 1969, 15, 60.
- 6 Kerr, D. N. S., and Elliott, R. W., *Proceedings of the European Dialysis and Transplant Association*, 1966, 3, 316.

Any Questions?

We publish below a selection of questions and answers of general interest

I.U.D.: Risk of Bacteraemia

In view of the possibility of causing or aggravating pelvic infection when inserting an intrauterine contraceptive device, should this be done under antibiotic cover in patients with a history of rheumatic carditis?

Any operation or manipulation involving mucous membranes in a patient with rheumatic carditis carries a risk, however small, of causing bacteraemia and possibly subacute bacterial endocarditis. The seriousness of this complication hardly needs emphasis; even with modern methods of treatment it has something like a 20% mortality. It would therefore seem wise that even a trivial manipulation like the insertion of an intrauterine contraceptive device should be done under antibiotic cover. Alternatively it might be preferable to avoid the use of an intrauterine device and choose another method of contraception.

Axillary Abscesses and Antiperspirants

Two women with apocrine abscesses in the axillae have been using "antiperspirants." What are these substances, and could they contribute to the causation of the abscesses?

So-called "antiperspirants" have either some anticholinergic affect or act as feeble precipitating agents upon proteins. To the first group belong benzoyl scapolamine hydrobromide;¹ propantheline in a mixture of equal parts of ethanol and glycerol; and

5% of poldine methylsulphate in ethanol. The second group include many aluminium salts (chloride, chlorhydrate, sulphate, phenylsulphonate, and chlorhydroxide complex).² Neither group is likely to contribute significantly to the causation of apocrine sweat gland abscesses because of their feeble pharmacological effect and the large size of apocrine sweat ducts. The role of local factors in this condition is controversial but maceration leading to keratinous obstruction of the apocrine sweat duct could play a part.³

¹ MacMillan, F. S. K., Reller, H. H., and Synder, F. H., *Journal of Investigative Dermatology*, 1964, 43, 363.

² *Handbook of Cosmetic Science*, ed. H. W. Hibbott, Oxford, Pergamon Press, 1963.

³ Shelley, W. B., and Cahn, M. M., *Archives of Dermatology*, 1955, 72, 562.

Artificial Joints and Anti-inflammatory Drugs

Is the presence of an artificial joint in a patient a contra-indication to the use of indomethacin, phenylbutazone, or oxyphenbutazone?

I can think of no theoretical reason why anti-inflammatory drugs such as indomethacin, phenylbutazone, or oxyphenbutazone should be contraindicated in patients with artificial joints, nor have I met any in practice. The main dangers in people with artificial joints are mechanical breakdown, sepsis, and fibrosis.