Br Heart J 1984; **51:** 237–40

Modified Blalock-Taussig operation using polytetrafluoroethylene (Impra) grafts

Sir,

The article P H Kay *et al* (1983; **49:** 359–63) deals with an important and controversial matter in neonatal and infant congenital cardiac surgery. The size of the pulmonary and subclavian arteries, and what size the polytetrafluoroethylene graft should be, are important considerations. A further problem is the development of pulmonary oedema after the shunt operation. A completely satisfactory small calibre (<5 mm) prosthetic graft is not yet available. At present polytetrafluoroethylene possibly offers the best results for this type of surgery. Long term graft patency (>90 days) is the major factor in the outcome of systemic to pulmonary shunt procedures. Kay and colleagues leave the impression that the internal diameter of the polytetrafluoroethylene graft plays no major role in this (p 363): "Indeed, there was no significant difference in shunt patency between the 4 mm and the 6 mm grafts at two years." Nevertheless, the authors state in Table 2 that, of the four children who died, one had a 6 mm shunt (state of shunt unknown), one had two 4 mm shunts (both occluded), one had a 4 mm shunt (patent), and one had two shunts, 4 mm and 6 mm in size (state of shunts unknown). Furthermore, from an analysis of Tables 2 and 3, the majority of complicated shunts were 4 mm (internal diameter)—for example, (Table 3) in the nine patients, five were 4 mm, three were 5 mm, and one was a 6 mm conduit. The two cases of late graft occlusion both occurred with 4 mm grafts. The number of patients shown in Figs. 2 and 3 also do not correspond to what they should for an actuarial curve.

In our experience, most problems are encountered with 4 mm conduits. This fact was also clearly pointed out by de Laval *et al.*[1] The 5 mm and 6 mm grafts had the best 1000 day patency rates (88–95%), whereas the 4 mm grafts had only a 66·6% patency at two years. McKay *et al.*[2] in their study on 87 modified Blalock-Taussig shunts also showed that the complication rate was highest in 4 mm polytetrafluoroethylene conduits. The internal diameters of the subclavian and pulmonary arteries are the most important factors regarding the haemodynamics and flow in the modified Blalock-Taussig shunts. Banding has never been shown to be necessary in the conventional Blalock-Taussig shunt. It is generally accepted that the reason for this is because flow is primarily regulated by the internal diameter of the subclavian artery. Shunt banding should theoretically, therefore, become necessary only in aorta to normal pulmonary artery shunts, where there is no volume inflow and outflow regulation through the shunt. Inflow and outflow is regulated by natural internal diameter of the subclavian and pulmonary arteries in the modified Blalock-Taussig shunts. We should, therefore, like to sound a word of caution in the selection of conduits for modified Blalock-Taussig operations and suggest that the internal diameter of these shunts should not be smaller than 5 mm. Banding is never indicated in modified Blalock-Taussig shunts.

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This letter was shown to the authors, P H Kay and colleagues, who reply as follows:

Sir,

Our study (1983; **49:** 359–63) represents the largest published experience of polytetrafluoroethylene grafts for the modified Blalock-Taussig shunt.

Poisseuille's law related the variables, pressure gradient (ΔP), conduit length (1), viscosity (η), and tube radius (r), to laminar flow in a tube. Obviously

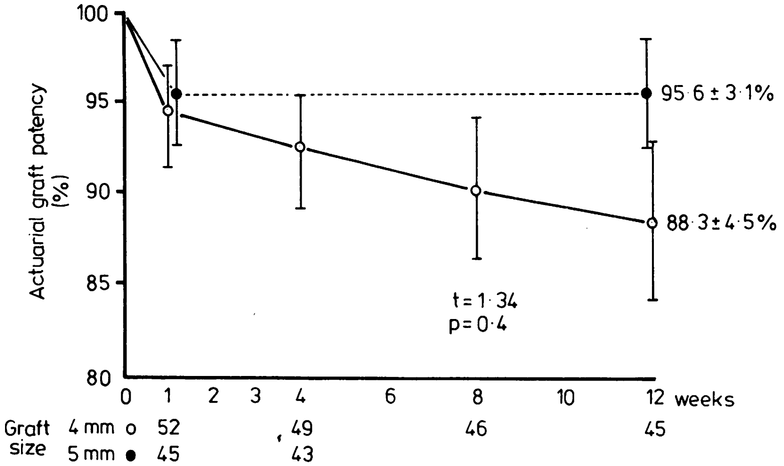

Figure *Patency of modified Blalock shunt in relation to graft size.*

this has its limitations physiologically but nevertheless shows the relation:

$$F = \frac{\pi r^4 \Delta P}{8 l \eta}$$

We agree with Dr Rossouw that the internal diameter of the shunt should be an important factor in determining shunt flow and patency and accept that more problems did occur with 4 mm shunts. Nevertheless, using the actuarial method described by Grunkemeier and Starr[1] the graft patency at 12 weeks was 95·6±3·1% for 6 mm grafts and 88·3±4·5% for 4 mm grafts (the Figure expands the data for the first 12 weeks of the original Fig. 3). Thereafter there was no occlusion with either 4 or 6 mm grafts. One 5 mm graft did occlude at five months. When Student's *t* test with two tails is applied $t = 1{\cdot}34$, $p = 0{\cdot}4$. It is always difficult to compare the results of retrospective series, but our improved results with 4 mm grafts compared with those of de Leval *et al.*[2] may be related to: (a) improved microvascular techniques, particularly after experience with 1 mm coronary artery anastomoses; (b) the use of Impra rather than Goretex grafts; (c) the use of platelet antagonists to reduce aggregation at the anastomoses[3]; and (d) active control of the haematocrit, reducing blood viscosity.

With control of these factors the limitations to flow are apparently the pressure gradient and thus the pulmonary resistance. The theoretical flow in the grafts assuming a 20 mm Hg pressure drop across a 3 cm long, 4 mm diameter graft is 138 ml/s. This is clearly not a limitation. If the pulmonary resistance is very high this may act as a limitation itself. The position of the graft on the subclavian artery may be important since a 5 mm subclavian graft near the aorta will carry 2·5 ml/s but further away a 3 mm graft will carry only 3·25 ml/s. Thus the subclavian must remain the limiting factor (unless the graft is put very near to the aorta), but the position of the graft may be important. Even so, excessive flow and the necessity for restricting the shunt have been reported with a classical Blalock shunt.[4]

Our results do show an increased patency for 6 mm grafts, but this does not reach statistical significance. For this reason we retain our conclusion that the largest possible graft that can be tailored to the anatomy should be used.

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