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Original Article

Patency or recanalization of the arterial duct after surgical double ligation and transfixion

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Abstract *Objective:* The frequency of residual shunting or recanalization was investigated in patients in whom a persistently patent arterial duct had been doubly ligated and transfixed during surgical closure. *Methods:* We investigated in retrospective fashion for any residual shunting 325 patients who, between January 1990 and December 2004, had undergone surgical double ligation and transfixion of a persistently patent arterial duct. Shunting was discovered in 10 patients, of whom four male and six female. *Results:* Of those with residual shunting. 4 patients had initially exhibited only persistent patency of the duct, while the other 6 had associated mild cardiac lesions. The mean age at operation was 5.5 years, with a range from 0.5 to 17.9 years. Postoperatively, the mean period for detecting the residual shunt was 22.8 months, with a range from 2 days to 72 months. The frequency of residual shunting amongst our patients, therefore, was 3.1%. We detected the residual shunt by colour-flow Doppler mapping in all patients, although a continuous murmur was heard in only one patient on physical examination. *Conclusion:* Our findings suggest that clinical sensitivity of detecting residual shunting subsequent to surgical closure of the persistently patent arterial duct is low, and hence that colour-flow Doppler interrogation should be a part of follow up. Residual shunting, or recanalization, may occur even after double ligation and transfixion of the duct. Since the residual flow may emerge after months, or even years, follow-up is needed for longer periods.

Keywords: Patent ductus arteriosus; residual shunting; congenital heart disease

Persistent patency of the arterial duct is a common congenital cardiovascular lesion, accounting for up to one-tenth of patients with congenital cardiac disease. Closure of the duct may be required for symptomatic relief in patients with a large left-to-right shunt, otherwise the reason for recommending closure of small ducts is to prevent infective arteritis, which has an incidence of 0.45% per year.[1] It was in 1938 that Gross and Hubbard first reported successful surgical ligation of a patent arterial duct.[2] In the following decades, analysis of large series has shown that surgical ligation is a safe and effective procedure. Although complete closure of arterial duct is expected after surgical division of the duct, ligation has been reported to be associated with recurrences, either due to recanalization or to incomplete closure.[3] The reported frequency of such residual shunting varies from 6% to 23%.[4–6] In addition to double ligation, therefore, transfixion is also used to decrease the frequency of residual shunting. There is limited data, however, concerning the frequency of residual shunting or recanalization after double ligation combined with transfixion. We presented here an analysis of the results from our own centre with this technique.

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Material and methods

Between January 1990 and December 2004, we investigated retrospectively for residual shunting 325 patients from our centre who had undergone

double ligation and transfixion of a persistently patent arterial duct. Surgical closure had been achieved by double ligation using number 4 or 5 silk sutures. Additionally, the middle of the duct had been transfixed with a ligature of 5.0 or 6.0 polypropylene. All patients had been followed up after their operations with physical examination and colour Doppler echocardiography. Doppler colour flow interrogation was used to establish any residual shunting across the duct. A diagnosis of residual shunting, or recanalization, was made if colour-flow mapping revealed typical ductal flow into the pulmonary trunk. Pulsed and continuous-wave Doppler was used to corroborate the colour-flow mapping in all cases. We excluded from consideration patients undergoing transcatheter occlusion, and those with additional complex cardiac pathology.

Investigation of the cohort of 325 patients as described above revealed that 10 exhibited residual shunting, 4 being male and 6 female. All 10 patients had undergone surgery through a left lateral thoracotomy. Of the patients, 4 had initially exhibited only patency of the duct, while the other 6 had associated mild cardiac disorders (Table 1). Only one patient had pulmonary hypertension.

Results

The mean age at operation had been 5.5 years, with as range from 0.5 to 17.9 years. Subsequent to the operation, the residual shunting was detected at a mean of 22.8 months, with a range from 2 days to 72 months. On physical examination subsequent to detection of the residual shunting, a continuous murmur was audible in only one patient. Another patient had the systolic ejection murmur of aortic stenosis, and yet another had the typical systolic regurgitant murmur of ventricular septal defect (Table 1). No patient had any evidence of other cardiac lesions that might mimic residual ductal flow, nor did any have any brief transient retrograde flow at the inferior aspect of the pulmonary trunk, which may be a normal finding.

Although 6 patients had residual shunting identified in the first echocardiographic examination during follow-up, no residual shunting was demonstrated at this initial examination in four patients (#1, 4, 6, and 7 in Table 1). Colour-flow mapping revealed residual flow in these patients at subsequent follow-up.

Discussion

The reported frequency of residual shunting after simple surgical ligation of the arterial duct has varied from 6% to 23%.[4–6] The residual shunting is presumed to represent either incomplete closure or to recanalization. Such shunts occurring after alleged surgical closure may not be noted clinically. Sorensen et al.,[5] for example, reported that no clinical evidence of residual ductal flow, such as a continuous murmur, was identified in any patient. In 7 of their 31 patients, however, colour-flow mapping revealed typical ductal flow in the pulmonary trunk. In their 12 patients with residual shunting, Zucker et al.[6] found continuous and systolic murmurs in 3 and 2 patients, respectively. Schmaltz et al.[7] heard a systolic murmur in 2 out of 5 patients with residual shunting. On the other hand, in their 12 cases, Podnar et al.[8] stated that continuous murmurs were audible in 5, and systolic murmurs in 6. In our study, a continuous murmur was audible in only one patient, with two others having audible systolic murmurs because of their associated cardiovascular problems.

Colour-flow mapping, however, is a very sensitive method for the identification of ductal flow.[4,9,10] In our study, like the previous ones, residual shunting was detected by such colour-flow Doppler interrogation. Accordingly, we suggest that, in the follow-up of patients after surgical closure of the persistently patent

Table 1. Patients with residual ductal shunting after surgical double ligation and transfixion.

Patient no.	Sex	Age at operation (year)	Associated cardiac disorders	Murmur	Duration of detecting residual shunt
1	M	0.5	–	–	72 mo
2	F	0.92	–	–	2 mo
3	F	1.17	CoA (mild) + AR (mild)	C	2 mo
4	M	1.5	ASD	–	54 mo
5	M	4.5	AS + AR	–	3 mo
6	F	4.5	VSD (small) + ASD	S	30 mo
7	F	4.67	AS (mild) + CoA (mild)	S	48 mo
8	F	4.95	–	–	3 day
9	M	7.17	–	–	2 mo
10	F	17.9	PH	–	2 day

Abbreviations: AR: aortic regurgitation; AS: aortic stenosis; ASD: atrial septal defect; C: continuous murmur; CoA: coarctation of aorta; F: female; M: male; Mo: month; PH: pulmonary hypertension; S: systolic murmur; VSD: ventricular septal defect

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arterial duct, colour-flow Doppler echocardiographic examination should be performed to detect residual shunting, even if no murmurs are audible clinically.

Our study has revealed a rate of residual shunting of 3.1%, which is low when compared to previous studies. This difference can be attributed to the additional transfixion used as part of the surgical technique, most of the previous studies reporting the results of double ligation alone. In four of our patients, although initial studies revealed no abnormality, they were subsequently found to have residual shunting. We speculate that this is the consequence of recanalization, as opposed to incomplete closure in the other patients. The clinical sensitivity of detecting residual shunting subsequent to surgical closure of the arterial duct, therefore, is low, and colour-flow Doppler echocardiographic examination should be done as part of the follow up. Residual shunting or recanalization may occur even after double ligation and transfixion. Since the residual flow may emerge months or even years after the surgical procedure, follow-up should be considered for longer periods.

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