Haemolysis following implantation of duct occlusion coils

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Abstract

Objectives—To describe the incidence and management of haemolysis after transcatheter coil occlusion of the arterial duct.

Design—Prospective clinical and echocardiographic follow up of patients who have undergone implantation of the Cook detachable duct occlusion coil.

Setting—Tertiary paediatric cardiac centre.

Patients—Five cases of haemolysis (two girls aged 6 and 11 months; three boys aged 6, 17, and 14 months) from a series of 137 duct coil implantations.

Main outcome measures—The occurrence of clinically significant haemolysis after implantation of duct occlusion coils and resolution of haematuria after completion of duct occlusion.

Results—Haemolysis was detected in five of 137 procedures following implantation of Cook detachable duct coils. Four patients became symptomatic 12 hours after the procedure but in one haemolysis was detected three months later. Resolution of ongoing haemolysis was achieved within 48 hours of detection with further coil implantations, but haematuria persisted for up to 10 days. In one patient the extensive destruction of erythrocytes resulted in acute renal failure requiring peritoneal dialysis.

Conclusions—Haemolysis is an important complication after duct coil implantation. It occurred in 3.6% of 137 procedures in this series and is most likely to occur in young patients with relatively large ducts. Further coil implantation to occlude the duct completely is not only successful but technically relatively straightforward and should be undertaken early if major complications such as severe anaemia and renal failure are to be avoided.

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Complications after duct coil implantation are rare and usually minor.¹⁻⁴ Early residual ductal shunting occurs in approximately 30% of patients. In this case the shunts are usually small and often resolve spontaneously, although repeat coil implantation may occasionally be required.² Haemolysis is known to occur in a small proportion of patients after implantation of the Rashkind duct occlusion device and there have been single case reports suggesting that haemolysis may also occur with

the Cook detachable coil.³⁻⁵⁻⁷ We report our experience with haemolysis occurring in five of 137 procedures using the Cook detachable duct coil.

Methods

In a prospective study of coil occlusion procedures, patients were followed by clinical examination and by echocardiography at intervals of one day, one month, three months, and one year after the procedure. Size of any residual left to right shunt was judged by both clinical signs and a crude assessment of jet size in the pulmonary artery. Major haemolysis was detected by simple naked eye inspection of urine colour within 24 hours after coil implantation. Independent *t* tests were used to compare age, weight, absolute duct diameter, and duct diameter indexed for body weight in patients with and without haemolysis.

Results

Haemolysis occurred in five children (two girls, three boys) with arterial ducts and otherwise normal hearts after coil implantation. The youngest was 6 months and the oldest 14 months. Four of the five children had substantial left to right shunts before intervention, with duct diameters ranging from 3 to 4 mm, and one child had a small shunt through a duct of 1.5 mm diameter. Three of the children with large shunts had either two or three coils implanted, and a single coil was used in the other two cases. Ten minutes after implantation, tiny residual shunts were detectable by ultrasound in all five cases but as the shunts appeared sufficiently small for spontaneous resolution to be likely and no continuous murmurs were audible no further coils were implanted. All the children appeared well after the procedures but one presented six months afterwards with pallor from chronic haemolytic anaemia and the other four children had black urine the morning after cardiac catheterisation; no spontaneous improvement occurred. Murmurs had reappeared in four of the five patients. Ultrasound showed more marked residual shunting—with easily detectable broad regurgitant flow approaching halfway between the pulmonary valve and the bifurcation—than had been observed immediately after the coils were implanted in four of the five cases. A single jet was visible in two children, two jets were seen in one, and three jets in the other two. In four cases there was no obvious change in coil position but in one the coil had changed orientation within the duct and this appeared to be the cause of the increase in residual shunting.

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Figure 1 Fluoroscopy in lateral projection in a child with a 1.5 mm diameter duct. (A) Aortography in lateral projection showing the duct, which is long and tubular, tapering to its minimum diameter at the pulmonary artery. (B) Immediately after implantation the coil is oriented in line with the long axis of the duct. Ultrasound at this stage showed only a trace of residual shunt without any audible murmur. (C) The following day there was an audible murmur and frank haematuria, and ultrasound revealed an easily detectable broad jet across the duct suggesting a substantial increase in the residual shunt. At repeat catheterisation the orientation of the coil had changed, although its position within the duct remained stable. Addition of a second coil resulted in complete duct occlusion and resolution of haemolysis.

Repeat cardiac catheterisation was undertaken six months after the initial procedure in the patient with chronic haemolysis, within 24 hours in two, and within 48 hours in the other two cases. Between one and three further coils were required to achieve complete duct occlusion and the haemolysis ceased in all cases, although it took up to 10 days for the urine to become free from haemoglobin. In one of the cases where repeat coil implantation was delayed until 48 hours after the initial procedure the child developed renal failure after the repeat cardiac catheterisation, and required three days of peritoneal dialysis. The renal function returned fully to normal 11 days after the duct was completely occluded.

All five patients with haemolysis were under 14 months of age (mean 8.8 months) and under 9 kg in weight, and four had large ducts with substantial shunts. Age (mean 8.8 months with haemolysis *v* 40.9 months without) and weight (mean 7.6 kg with haemolysis *v* 15 kg without) were both inversely associated with risk of haemolysis (*t* test assuming unequal variances $p < 0.001$ and $p < 0.001$, respectively). Duct size indexed for body mass was larger in the group with haemolysis ($p = 0.035$) but there was no significant difference in absolute duct diameter between the two groups (mean 2.9 mm with haemolysis *v* 2.1 mm without).

Discussion

Our early experience of this technique,^{1,2} and that of other groups,^{3,4} suggested that haemolysis would prove to be a rare complication in patients with residual shunting after coil implantation; in our initial reports of 76 procedures only one case of mild chronic haemolysis occurred.^{1,2} As our experience has increased we have attempted the procedure in larger ducts and smaller patients, and we have encountered haemolysis in five (3.6%) of 137 consecutive coil implantation procedures. It is clear that the risk of haemolysis is greatest with attempts to close relatively large ducts in younger children.

All our patients left the catheterisation laboratory with a very small residual shunt and none had an audible duct murmur. In these circum-

stances 74% of such shunts should resolve spontaneously within three months² and it has therefore been our policy to minimise the number of coils implanted. Others have suggested a more aggressive approach which involves a lower threshold for multiple coil implantation and is likely to result in a higher percentage of patients with immediate complete duct occlusion.⁴ There was a marked change in coil orientation in one patient who had a minute residual shunt immediately after coil implantation but later developed a larger shunt and haemolysis (fig 1). A possible explanation for the change in residual shunt without any evidence of change in coil position in the other four children would be ductal spasm occurring during catheter manipulation with later relaxation.

When haemolysis occurs, immediate measures such as correction of anaemia, careful fluid management to avoid dehydration and acidosis, along with alkaline diuresis may help to preserve renal function.⁸ Our experience suggests that early reintervention should be undertaken to occlude the duct fully, even if there is no immediate biochemical evidence of renal impairment, as haemoglobinuria may continue for some days after occlusion is achieved and late renal failure may occur. The risk of haemolysis increases with relative duct size as well as lower body weight and younger age.

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