Editorial Comment

Coarctation and Balloons: Inflated or Realistic?*

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The use of catheters to dilate vascular obstructions began as early as 1964. In their classic article, Dotter and Judkins (1) described transluminal dilation of arteriosclerotic obstruction. It wasn’t until 10 years later that the use of balloon-tipped catheters in coronary artery dilations was reported by Gruentzig and Hopff (2) and later applied by Gruentzig and his colleagues (3). Since these reports, multiple uses of balloon catheters to dilate a variety of lesions of the circulatory system have been reported. In pediatrics, the first application of pulmonary balloon valvuloplasty led to widespread reports of success with this technique (4–7). Soon thereafter, other vascular obstructions such as peripheral pulmonary artery stenosis (8), pulmonary vein stenosis (9,10), aortic valve stenosis (11–13) and vena caval obstruction (14) were reported to be amenable to balloon dilation techniques. More recently, patients with coarctation of the aorta have been the subjects of balloon dilation procedures. Perhaps as many as 200 cumulative cases of balloon dilation have been reported (U-29), including discrete lesions as well as diffuse coarctation, native coarctation as well as restenosis coarctation and coarctation in infants as well as in older children.

Surgical correction of coarctation of the aorta has been successfully performed for >40 years (30). A variety of modifications of the classic end to end anastomosis has been described, all with advantages and disadvantages (31). Complications have included recurrence of stenosis, especially if the original operation was performed in infancy, and persistent hypertension, notable when surgical relief has been postponed (32–35). Of course, operative risk per se, postoperative paresis and paradoxic hypertension have all been associated with surgical correction of coarctation. These would be avoided by the use of the balloon dilation technique.

In the evaluation of a new technique, a number of considerations must be taken into account. First, the original procedure must have sufficient risk of mortality or morbidity, or both, to warrant a new procedure to replace it. Second, the new procedure must have significantly less risk than the first and preferably should be more “noninvasive.” Finally, both short-term and long-term follow-up of success as well as complications of the new procedure must be analyzed before conclusions can be drawn regarding its safety and efficacy. Analysis of long-term follow-up is particularly important because problems may not be evident initially or after only short-term scrutiny.

Literature review of coarctation angioplasty. Balloon dilation angioplasty of coarctation of the aorta was first reported in 1982 (15). Since then, almost 200 cases have been documented. In virtually all, short-term success in gradient reduction and increase in coarctation diameter has been reported. In the majority of cases, no serious morbidity occurred. Occasional loss of femoral pulses, probably secondary to large balloon catheters, has been described (18,27). Rarely, embolectomy has been required to be performed after balloon dilation (21,27). The rare mortality noted during the balloon dilation procedure has been related either to presence of associated ductus arteriosus or to perforation of the aorta after the procedure by an angiographic catheter reinserted without a guide wire in place (18). Short-term benefits, aside from coarctation gradient relief, have included relief of systemic hypertension and a lack of paradoxic hypertension with its concomitant increase in catecholamine and renin-angiotensin (28,35).

The long-term results, however, have been less uniformly positive. Whereas most follow-up studies (23,24) report continued patency and enlargement of the aortic diameter at the coarctation site, a few studies (17,26,36) note an increase in the transcoarctation gradient from the immediate post-balloon dilation decrease. These long-term results of balloon dilation also appear to differ when the age of the patient at the initial procedure is taken into account. Reports suggest that a better result (gradient reduction) was more likely to occur in long-term follow-up when the initial balloon dilation was performed after infancy (17).

A significant difference was noted as well in comparing native unoperated coarctation with restenosis coarctation. Despite initial reports by Castaneda-Zuniga and coworkers (37) that recurrent coarctation of an end to end surgical anastomosis could not be dilated effectively, recent studies (28,29,38) suggest that it is precisely this group that may have the greatest long-term benefit from balloon dilation and that a good result is more likely in restenosis coarctation than in native coarctation (17). Finally, and most important, the occurrence of complications in long term follow-up is
crucial. Here, a brief review of the established histologic effects of balloon dilation angioplasty is in order.

Postdilation aneurysm. Balloon dilation relieves the coarctation by tearing the intima and media (36, 39-41); early laboratory work in excised aortic coarctations confirmed the intimal and medial tears in these specimens. It is precisely the mechanism of the coarctation relief, therefore, that may be the cause of the most significant long-term problem: aneurysm formation. Review of “follow-up” studies, notably “long-term” follow-up studies, is at best confusing. The true incidence of late aneurysm formation escapes the reader and is clouded in definitions of how long is long (long-term follow-up studies range from 2 to 54 months). The multicenter survey results presented at the 1986 American College of Cardiology meetings noted that postangioplasty aneurysms were observed in 9% of 83 of the total group, but in 30% of the 30 patients who underwent routine postangioplasty angiography. To add to the confusion, methods of restudy vary. In two studies (42, 43) utilizing nuclear magnetic resonance (NMR) imaging, no aneurysms were found at follow-up; in one (43), six children were studied, but only 1 to 4 months after the initial procedure. In the other study (42), six children undergoing balloon dilation were studied by NMR imaging (only three were studied both before and after); no follow-up time is stated. In the study by Cooper et al. (36), three of seven patients demonstrated aneurysm formation after angiography; two of the three patients were studied by NMR imaging as well as the aneurysms visualized. (Histologic examination of these aneurysmal areas showed dilation with intimal and medial disruption: scar formation was sparse, resulting in a thin-walled media covered by adventitia.)

Duplicate reports. One of the main problems in determining the true incidence of complications of the procedure is in the reporting by some groups of similar series either in “short-term” and subsequently “long-term” follow-up studies or by reporting similar groups in different forums: note three reports by Rao (22 patients studied between October 1983 and February 1986 reported in the British Heart Journal (25); 6 patients studied between January 1985 and July 1985 reported in the Journal of Pediatrics (24) and 25 patients studied between January 1985 and May 1987 reported in the American Heart Journal (27). Also, the long-term study by Cooper et al. (36) of seven patients includes five of the seven patients originally reported in their short-term study (21). Many of the same patients were also included in another study reported by Boxer et al. (47) in long-term NMR imaging follow-up.

Significant morbidity with dissecting transverse aortic arch aneurysm occurred in one infant after balloon dilation angioplasty of coarctation (44).

Cystic medial necrosis. In a large pathologic study (45) of coarctation segments that had been subjected to balloon dilation in vivo and were subsequently excised at surgery, it was noted that all had cystic medial necrosis that in two thirds were graded as severe (≥3+). This suggests at the very least that cystic medial necrosis is a finding in coarctation and may represent the basis for aneurysm formation noted after balloon dilation. In another recent report (46), 4 of 11 children undergoing surgical treatment for coarctation after balloon angioplasty were noted to have an aneurysm. Pathologic examination showed no muscle and elastic lamella in the aneurysm section.

Finally, there appears to be a significant difference as well in the complications between native and restenosis coarctation. Kan et al. (28), recently reported that no aneurysms were found at 14 month follow-up of six children undergoing balloon angioplasty of restenosis coarctation. Soulen et al. (38) followed up eight patients treated by balloon angioplasty for coarctation restenosis for up to 54 months (mean 40) by NMR imaging; no aneurysms were found.

The present study. In this issue of the Journal, Suarez DeLezo et al. (47) report on 17 infants and 28 older patients (mean age 13 ± 8 years) who had undergone balloon angioplasty. In the older group 26 had a native coarctation and two had restenosis coarctation; only 16 of this group were then studied at follow-up, which took place 6 to 12 months later (mean ± SD, 10 ± 2). Typical results of immediate gradient reduction that persisted at follow-up were noted. Patients with discrete coarctation had better long-term reduction in gradient as compared with patients with other types of coarctation. Of interest in this report is the quantitative evaluation of the aorta: changes in configuration of the aorta with “realignment” over time provide insight into hemodynamic influences that may affect changes in the histologic features of the wall. The statement by Suarez DeLezo et al. (47) that reconfiguration change of the aorta could generate dilated zones of the arterial wall is an interesting albeit unproved theory. These changes did not appear immediately after angioplasty but increased at follow-up in 44% of the patients. However, only 1 of 16 developed an aneurysm; 3 patients in this group were noted to have “some abnormalities resembling an aneurysm . . .” before the procedure. . . . This is also noted by Rao et al. (27) in a retrospective study of predilation angiograms. This finding generated the comment that it is important to obtain quality aortograms before dilation to avoid “misinterpretation” of the postdilation findings. Other studies (21,23) using combined angiography and NMR imaging have not found this to be the case. Indeed, one must strongly question the advisability of proceeding with balloon dilation of an aorta already showing evidence of aneurysm formation.

Conclusions. The present study of Suarez DeLezo et al. (47) summarizes the current state of the art vis à vis balloon dilation angiography of coarctation of the aorta. It is clear that intimal and medial tears are created by “controlled” injury, however, “uncontrolled” damage may also occur,
leading to aneurysm formation. The incidence of the latter still varies widely in the literature citations. Follow-up periods labeled "long-term" are indeed still "short" or at best "intermediate" term; everything is of course relative. Balloon angioplasty is clearly a viable, relatively safe procedure for coarctation of the aorta: restenosis coarctation may be more optimal for this procedure in comparison with native coarctation. We agree with the authors that "larger series over longer periods of time are still needed to know the real incidence of aneurysm formation."

Inflation may not be detrimental only to the economy: early low interest mortgage payments (good short-term) with later balloon payment (poor long-term) is not necessary advantageous!

References

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