Release of Atherosclerotic Debris
After Transluminal Angioplasty

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SUMMARY To determine if there is release of endothelial cells or plaque contents after percutaneous transluminal angioplasty, effluent from atherosclerotic segments of the aorta and iliac arteries of rabbits were collected before and after angioplasty. No endothelial cells or cholesterol plates were identified in the pre-angioplasty effluents. Only a few single endothelial cells and cholesterol crystals were found in effluents after angioplasty. We conclude that embolization of endothelial fragments and cholesterol plates occurs during angioplasty, but only to a minor degree, and is probably not clinically important.

PERCUTANEOUS coronary transluminal angioplasty (PTCA) is useful in treating angina pectoris in selected patients with coronary atherosclerotic lesions. Improvement in the angiographic appearance of an atherosclerotic vessel after PTCA and improved thallium exercise scintigraphy1-14 have documented the clinical efficacy of this technique. Pathologic studies in an animal model have demonstrated that PTCA produces endothelial desquamation or splitting of the fibrous cap of the atherosclerotic plaque.8-13 These animal studies are corroborated by postmortem studies of human coronary and peripheral vessels that have undergone transluminal angioplasty.8-18

The demonstration of endothelial desquamation and intimal splitting implies that there is peripheral mobilization of fragments of endothelial cells or endothelial patches, and that the contents of the atherosclerotic plaque may be released at the time of PTCA. This study was done to determine whether there is release of cells and debris into the circulation during transluminal angioplasty using an animal model.

Methods and Materials

An animal model of atherosclerosis was produced. Aortic atherosclerosis was initiated in five male New Zealand white rabbits by feeding them a 2% cholesterol diet (ICN Co.). After 1 week on this diet, the aortic and iliac endothelium were injured using a procedure described previously.6 The rabbits were maintained on a 2% cholesterol diet following aortic debridement.

Six to 12 weeks later, the rabbits were reanesthetized with i.v. 2% pentobarbital. A laparotomy was performed and the abdominal aorta distal to the renal arteries and the right and left iliac arteries were mobilized. After ligation of the aorta just distal to the renal arteries and ligation of the left iliac artery, the right iliac artery was transected approximately 1.5-2 cm from the aortic bifurcation. A "bird's eye" (Goodale-Lubin) catheter was introduced into the aorta distal to the tie below the renal arteries and passed antegrade approximately 1 cm. Through a separate incision in the aorta distal to the tie, a Grünzig transluminal angioplasty catheter (balloon 3.0 mm in diameter, 2.0 cm long) (Schneider Co.) was introduced and advanced past the tip of the angiographic catheter. A Renografin (meglumine diatrizoate) cineangiogram of the isolated aortic/iliac segments was performed to find an area of atherosclerotic stenosis suitable for dilation. The Renografin was removed by flushing with 10 ml of normal saline. Another 10 ml of normal saline was then injected through the angiographic catheter and the effluent from the transected right iliac artery was collected. The transluminal angioplasty catheter (balloon 3.0 mm in diameter) was then...
positioned at the site of stenosis in the aorta and inflated twice to 5 atmospheres pressure with a 50% normal saline/renografin mixture. Inflation was recorded by cinefluoroscopy to document positioning. The balloon was deflated and the angioplasty catheter was pulled back to the tip of the angiographic catheter. Immediately, 10 ml of normal saline was injected through the angiographic catheter and the postangioplasty effluent was collected from the right iliac artery. The effluents collected before and after angioplasty from the right iliac artery were immediately cooled in ice, centrifuged for 30 minutes at 10,000 rpm, and resuspended in 0.5 ml of 10% neutral buffered formalin. Slides were prepared by a smear technique, stained with toluidin blue, and examined microscopically for embolic material.

Results

Preangioplasty Effluent

Forty-five slides of effluent from the five rabbits were scanned for endothelial cells and cholesterol crystals. No endothelial cells or cholesterol plates were identified in the preangioplasty effluents.

Postangioplasty Effluent

Forty-five slides were scanned for evidence of embolic debris. Single endothelial cells were occasionally seen and rare cholesterol crystals were demonstrated (figs. 1 and 2) in effluents from only two of the five rabbits. Despite careful collection of effluent from the right iliac artery, no evidence of embolic material other than rare endothelial cells and cholesterol plates was found.

The stenotic luminal diameters before dilation in the five rabbits were 0.9, 1.1, 1.5, 1.6 and 1.8 mm. These areas were dilated with a 3.0-mm-diameter dilating balloon catheter. Because the iliac artery had been transected and the aorta tied, pressure measurements were not performed. Valid angiographic documentation of the size of the dilated segment after angioplasty was impossible because of handling of the aortoiliac segment and rapid runoff through the transected iliac artery.

Discussion

This study shows that release of endothelial fragments and cholesterol plates occurs during transluminal angioplasty, but only to a very minor degree. Of 90 slides scanned for embolic debris from five rabbits in this study, rare endothelial cells and cholesterol plates were found in only four slides.

That only small amounts of debris were released into the circulation after angioplasty is not surprising in light of previously reported clinical data. Peripheral embolization was noted in only 3% of patients who underwent transluminal angioplasty of subtotal obstructions of the leg vessels. More patients developed evidence of embolization if a totally occluded vessel was recanalized during angioplasty. PTCA has not been complicated by clinical evidence of embolization.

Less than 5% of patients who undergo PTCA develop evidence of ischemia without demonstrated occlusive changes on repeat coronary angiography. One might speculate that these patients may have had distal coronary embolization of endothelial fragments and cholesterol plates, which produce subendocardial ischemia or infarction. Grünzig reported an increase in the CPK in some of

\[ \text{FIGURE 1. A cholesterol cleft identified in one of four slides of effluent collected from a right iliac artery of a rabbit that had undergone transluminal angioplasty of the aorta. Magnification} \times 100. \]

\[ \text{FIGURE 2. A single endothelial cell identified in a slide of effluent collected from an aorta of rabbit that had undergone transluminal angioplasty. Very little other debris is noted on the slide. Magnification} \times 100. \]
his PTCA patients who had no evidence of ECG abnormalities. Small areas of infarction might cause slight elevations of CPK after PTCA without ECG changes; these could be due to microemboli. These would not be clinically important in terms of cardiac function.

Our previous reports have shown that transluminal angioplasty produces endothelial desquamation with exposure of subendothelial microfibrils and subsequent platelet adhesion in the area of angioplasty. Platelet thrombi occur in areas of coronary stenosis produced in an animal model and have been associated with electrocardiographic evidence of probable subendocardial ischemia. Platelet deposition occurs after PTCA; thus, small platelet microemboli may also contribute to the chest pain present in some patients after angioplasty.

Experimental pathologic studies have suffered from difficulties with an animal model; this study is no exception. Rabbit “atherosclerotic” plaques are filled with foam cells and are high in cholesterol deposits. One might argue that extrapolation of the results of this study to the effects of angioplasty in man might not be valid. However, vascular wall changes induced mechanically by angioplasty have been so uniform in studies using normal dogs rabbits and in man that this argument is not valid. Splitting of the atherosclerotic plaque and endothelial desquamation are almost certainly the mechanisms involved in successful angioplasty. Therefore, the demonstration of embolic material after angioplasty is not surprising.

This study demonstrates that release of endothelial fragments and atherosclerotic debris occurs after transluminal angioplasty. The amount of embolization, however, is minor and is unimportant clinically. This conclusion is supported by the results of the clinical experience with PTCA. Microembolization of endothelial fragments, cholesterol plates, or even platelet thrombi may account for some of the episodes of ongoing pain of coronary insufficiency and minor CPK abnormalities after successful PTCA.

References
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