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Repeat Coronary Angioplasty

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The potential of repeat percutaneous transluminal coronary angioplasty as a mode of therapy for recurrence of stenosis after initially successful angioplasty was examined on the basis of data on all 514 patients with successful angioplasty at Emory University before April 1982. Recurrence was found in 171 (33%) of the 514 patients. Repeat angioplasty was attempted in 95 patients with a significantly higher primary success rate (97 versus 85%, $p < 0.001$) and a lower complication rate (8 versus 15%, $p < 0.10$) than those of initial angioplasty. Follow-up documentation was available in all 92 patients with successful repeat angioplasty. A second recurrence of stenosis was found in 26% (24 of 92). A third angioplasty was performed in seven patients; six procedures were successful and there have been no recurrences of stenosis.

Repeat coronary angioplasty provides a means to treat recurrence of stenosis. It proved to be very successful and safe and yielded good long-term results. It also increased the percent of patients with documented lasting success after angioplasty from 63 to 78%.

Several thousand patients throughout the world have been treated with percutaneous transluminal coronary angioplasty. Reports from various centers (1–5) indicate that 59 to 92% of the procedures succeed in significantly reducing the degree of stenosis and in ameliorating or eliminating symptoms. Recurrence of stenosis and symptoms is of major concern to all physicians performing coronary angioplasty. According to previous reports, recurrences occur in 13 to 47% (6–8), usually within the first 3 (6) to 9 (5) months. This retrospective study analyzes repeat coronary angioplasty as a means to manage patients with recurrence of stenosis after successful angioplasty.

Methods

Patients. From the inception of coronary angioplasty at Emory University in July 1980 to the end of March 1982, 608 patients underwent coronary angioplasty for the first time. Primary success (reduction of diameter stenosis by 20% or more and functional improvement) was achieved in 514 patients (85%). Follow-up data were available on 510 (>99%) of the 514 patients with primary success. Four patients were lost to follow-up study because they had moved and could not be located.

For follow-up, the most reliable information was used. The degree of reliability of follow-up data was defined in descending order as follows: angiographic data more reliable than exercise test results, exercise test results more reliable than data from questionnaire. The date of the most reliable information was used for determination of the follow-up time. If less reliable information suggesting recurrence was available at a later date, it was considered instead of earlier data indicating patency (unless refuted by repetition of a more reliable test).

Criteria for recurrence of stenosis. Recurrence occurred in 171 patients (33% of the 514 patients with primary success). The principal evidence for recurrence consisted of 1) a coronary angiogram showing a loss of 50% or more of initial diameter gain at the site of the dilated segment (156 patients, 30%), 2) in the absence of an angiogram, conversion from a negative to a positive stress test (9 patients, 2%) or 3), when neither follow-up test was performed, recurrence of chest pain formerly eliminated by angioplasty (6 patients, 1%). In more than 90% of the cases, restenosis was heralded by recurrent angina.

A second angioplasty was attempted in 95 patients (61% of the 156 patients with angiographically documented re-

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Table 1. Patient Characteristics at First Coronary Angioplasty

	All Patients (n = 608)	Patients With Second Angioplasty (n = 95)
Age (yr)	54 ± 9	53 ± 8
Men	76%*	86%*
History of chest pain (mo)	9 ± 20	6 ± 7
Positive ET (pre-angioplasty)	59%	59%
Smoker	28%	27%
Ex smoker	45%	39%
Nonsmoker	27%	34%
Pack-years	37 ± 22	38 ± 19

*$p < 0.05$. ET = exercise test; pack-years = packs of cigarettes smoked daily × years of smoking. Ex smoker = previous smoker. Figures in parentheses denote number of patients.

currence of stenosis) at a mean of 5 months (range 1 to 9) after the first angioplasty. All 95 had again a diameter reduction of 50% or more and had exhibited functional deterioration and relapse of symptoms after the initial improvement following the first angioplasty.

Clinical and angiographic features. The patient and lesion characteristics at first angioplasty of the 95 patients who underwent repeat angioplasty are listed and compared with those of all 608 patients in Tables 1 and 2. Eccentricity and length were defined as published previously (9). There were significantly more men among the patients with a second angioplasty (86% [82 of 95] versus 76% [462 of 608], $p < 0.05$). Lesions in the left anterior descending coronary artery were also significantly more frequent among patients with a second angioplasty (76% [72 of 95] versus 66% [404 of 608], $p < 0.01$). This trend was true also for all patients with recurrence of stenosis after the first angioplasty, that is, men and those with left anterior descending coronary angioplasty had the highest recurrence rate.

Statistics. For statistical analysis, the chi-square test and the Student's *t* test were employed. Probability values less than 0.05 were considered significant.

Results

Second angioplasty. The primary success rate of the second angioplasty was 97% (92 of 95), which was significantly higher than the 85% rate (514 of 608) of the first angioplasty ($p < 0.001$). The reasons for the 3 failures are listed and compared with those of the 94 failures of the first attempt in Table 3. Complications of both attempts are compared in Table 4. There was a tendency toward fewer complications and fewer emergency bypass operations at second angioplasty. Obstructive dissections (dissections causing a significant coronary pressure gradient and visible retardation of flow), most of which did require emergency bypass surgery, were significantly fewer at second angioplasty.

The technical descriptors of both first and second angioplasty, such as pressure used for dilation, change in degree of stenosis and change in pressure gradient across the ste-

Table 2. Coronary Artery Lesions

	All Patients (n = 608)	Patients With Second Angioplasty (n = 95)
Single angioplasty	94% (574)	95% (90)
LAD	66% (404)*	76% (72)*
RCA	24% (145)†	12% (11)†
LCx	6% (33)	5% (5)
BPG	3% (19)	2% (2)
LMS	<1% (4)	— (0)
Double angioplasty	6% (34)	5% (5)
LAD + LAD	3% (19)	4% (4)
LAD + RCA	1% (4)	1% (1)
RCA + RCA	1% (4)	— (0)
LAD + LMS	<1% (2)	— (0)
RCA + LCx	<1% (2)	1% (1)
LAD + LCx	<1% (1)	— (0)
LCx + LCx	<1% (1)	— (0)
LCx + BPG	<1% (1)	— (0)
Calcified stenosis	4%	6%
Eccentric stenosis	29%	25%
Length of stenosis (mm)	4.7 ± 3.0	4.9 ± 2.9

*$p < 0.05$; †$p < 0.01$. BPG = bypass graft to any coronary artery; LAD = left anterior descending coronary artery; LCx = left circumflex coronary artery; LMS = left main stem; RCA = right coronary artery. Figures in parentheses denote number of patients.

Table 3. Reasons for Angioplasty Failure

	First Angioplasty (n = 608)	Second Angioplasty (n = 95)
Lesion not reached	3% (18)	1% (1)
Lesion not passed	7% (46)*	— (0)*
Dilation <20%	5% (30)	2% (2)
Total	15% (94)†	3% (3)†

*$p < 0.01$; †$p < 0.001$. Figures in parentheses denote number of patients.

nosis are shown in Table 5. They were similar at initial and repeat angioplasty.

Follow-up. Follow-up data were also obtained on all of the 92 patients with successful repeat angioplasty. Table 6 shows the principal follow-up data determined as explained in the Methods section.

Continued success over a mean period of 8.5 months (range 3 to 28) could be documented in 68 (74%) of the 92 patients with successful repeat angioplasty. In 33 patients, the finding of continued success was based on a coronary angiogram obtained at a mean of 7.2 months (range 3 to 12) after the repeat procedure. In 13 patients, it was based on a lasting reversion of previously positive exercise tests over a mean of 8.9 months (range 3 to 19). In 22 patients, it was based on a questionnaire revealing absent (17 patients) or clearly improved (5 patients) symptoms at a mean of 10 months (range 4 to 28) after the repeat procedure.

A second recurrence was evident on angiography in 23 patients (25% of 92 patients with successful repeat angioplasty) at a mean interval of 7 months (range 2 to 26) after the repeat procedure, and on a positive stress electrocardiogram without chest pain after 4 months in 1 patient refusing control catheterization. The mean time interval between repeat angioplasty and the 24 second recurrences was 7 ± 6.2 months (mean ± SD), which was longer than that of the 171 first recurrences (5.2 ± 2.7 months). Eleven of the patients with a second recurrence were treated with bypass surgery. Seven underwent a third angioplasty. Five patients with return of symptoms but only a mild recurrence of stenosis by angiography and the patient who refused catheterization were treated medically.

Third angioplasty. In the seven patients who underwent a third angioplasty at an average of 8 months (range 4 to 12) after the second angioplasty, there was one failure in a patient who went on to have bypass surgery and no complications. Five of these patients were men with a lesion in the proximal left anterior descending coronary artery. Follow-up data of the six patients with a third angioplasty were obtained from angiograms in two patients showing continuing success, a normal exercise tolerance test in two patients and absence of angina in the remaining two patients.

Discussion

Indications for second angioplasty. Recurrence rate of stenosis after successful initial coronary angioplasty in the patients studied was 33%. Thus, every third patient had to be evaluated for repeat angioplasty or an alternative mode of therapy usually within less than a year. Repeat angioplasty was attempted in 56% (95 of 171) of these patients or in 61% (95 of 156) of the patients with angiographically documented restenosis. The decisions to attempt a second angioplasty were based on several grounds, namely, the patient's preference, the referring physician's choice and the soundness of the patient's candidacy according to criteria previously described (5).

Comparison of second and third angioplasty. Repeat coronary angioplasty proved to be more successful and safer than the initial procedure, both in our cohort and also in 191 patients with repeat coronary angioplasty reported from the National Heart, Lung, and Blood Institute Percutaneous Transluminal Coronary Angioplasty Registry (10). Two reasons may apply: 1) patients with repeat angioplasty are a subgroup of patients with initially successful angioplasty, and 2) they are further screened for problems encountered during the initial procedure.

Although morphologic and hemodynamic variables of the stenoses at first and second angioplasty were not different

Table 4. Complications of First and Second Angioplasty

	First Angioplasty (n = 608)	Second Angioplasty (n = 95)
Obstructive dissection	7% (43)*	1% (1)*
Emergency surgery	5% (31)†	1% (1)†
Occlusion of side branch	2% (14)	2% (2)
New Q wave	1% (7)	— (0)
Other complications	5% (31)	5% (5)
Death	— (0)	— (0)
Total patients with one or more complications	15% (88)	8% (8)†

*$p < 0.05$; †$p < 0.10$. Other complications = nonobstructive dissection, transient spasm, significant blood loss or arrhythmia. Figures in parentheses denote number of patients.

Table 5. Description and Results of Angioplasty

	First Angioplasty (n = 608)	Second Angioplasty (n = 95)
Pressure used for angioplasty (atm)	7.3 ± 2.0	7.2 ± 2.0
Occurrence of first effect (atm)	4.7 ± 2.0	5.0 ± 2.2
Diameter narrowing pre-angioplasty	73 ± 14%*	74 ± 13%*
Diameter narrowing post-angioplasty	30 ± 19%*	29 ± 12%*
Diameter increase	43 ± 20%	46 ± 15%
Pressure gradient pre-angioplasty (mm Hg)	48 ± 16	51 ± 13
Pressure gradient post-angioplasty (mm Hg)	13 ± 9	14 ± 9
Pressure increase (mm Hg)	35 ± 15	36 ± 14

*Caliper measurements are mean values of several projections. atm = atmospheres. Figures in parentheses denote number of patients.

(Tables 2 and 5), the histologic aspect of previously dilated arteries differs from that of stenoses that have not been dilated (11,12). Hence, a different immediate and delayed reaction to repeat angioplasty is conceivable. As for primary success of repeat angioplasty, a possible effect of the different histologic substrate is concealed by the overwhelmingly positive influence of the selection process just mentioned. Long-term recurrence of stenosis after repeat angioplasty is not appreciably different from that after the first angioplasty (26 versus 33%).

Third angioplasty. Six of the seven patients who underwent a third coronary angioplasty had a favorable outcome. Third recurrences of the same lesion have not yet been observed, with all patients having passed their longest previous remission interval. Additional treatment became necessary in one patient because of disease progression angiographically unrelated to the previous angioplasties. The meticulous selection and the small number of these patients do not allow conclusions about the usefulness of a third angioplasty.

Conclusions. Repeat coronary angioplasty yields better primary success and fewer complications than does initial angioplasty. Recurrence of stenosis seems to occur with the same frequency after the second or after the first angioplasty. If information on long-term prognosis of asymptomatic patients is desired, control angiograms seem most appropriate 8 months after initial and repeat angioplasty. Repeat coronary angioplasty provides a valuable, safe and cost-effective way of management for recurrence of stenosis after initially successful angioplasty. It increased the percent of patients with documented long-term success of angioplasty from 63 (one angioplasty) to 78% (one, two or three angioplasties), sparing these patients the alternative of coronary bypass surgery.

Table 6. Principal Follow-Up Information After Repeat Coronary Angioplasty

Source	Successful Repeat Angioplasty (n = 92)
Angiogram	61% (56)
Serial ET	15% (14)
Questionnaire	24% (22)
Total	100% (92)

ET = exercise test. Figures in parentheses denote number of patients.

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