LONG-TERM ANGIOGRAPHIC FOLLOW-UP RESULTS IN PATIENTS UNDERGOING PERCUTANEOUS TRANSLUMINAL CORONARY ANGIOPLASTY

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Long-term effects following percutaneous transluminal coronary angioplasty (PTCA) were examined using follow-up coronary angiography (CAG) in 49 lesions in cases in which the procedure was considered to be successful. Follow-up CAG was performed 2–5 times (average, 2.7 times) per patient during a period of 1 year to 3 years and 7 months (average, 1 year and 10 months). The luminal diameter of the PTCA sites was expressed as the percentage of the value immediately after the procedure. Narrowing by 10% or more was observed in 17 lesions 3–8 months after PTCA but in only 4 lesions on the final CAG. The luminal diameter of the PTCA site was significantly greater (p < 0.05) 2 years after PTCA in comparison to the findings after 1 year. These results suggest excellent long-term effects at the PTCA site.

With recognition of the effectiveness of percutaneous transluminal coronary angioplasty (PTCA), the procedure is rapidly being accepted for the treatment of coronary diseases. However, restenosis developing about 3 months after PTCA has emerged as the greatest problem associated with the procedure. Various investigations have been conducted concerning this topic. But whether the target sites that exhibited no restenosis after the treatment actually remain open for a long period has yet to be clarified. We examined the long-term effects at PTCA sites by two or more follow-up evaluations using coronary angiography (CAG).

MATERIALS AND METHODS

Of 51 patients successfully treated by PTCA between October 1984 and May 1987, 26 who fulfilled the following criteria were included in this study.

1) Patients treated by elective PTCA.
2) Patients in whom no severe restenosis that required coronary artery bypass grafting (CABG) or repeat PTCA was demonstrated by the initial follow-up CAG performed after 3–6 months (but asymptomatic patients with restenosis were included in this study).

The following patients among those successfully treated by PTCA were excluded from the analysis.

1) Seven patients with acute myocardial infarction or unstable angina pectoris treated by emergent PTCA.

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Fig. 1. A patient who underwent PTCA for complete occlusion of the left anterior descending artery.
A: before PTCA
B: immediately after PTCA
C: 7 months after PTCA
D: 1 year and 3 months after PTCA
E: 2 years after PTCA
Stenosis progressed to 70% 7 months after (C) as compared with immediately after PTCA (B), but improved thereafter and became comparable after 2 years (E) to the condition immediately after PTCA.

Fig. 2. A patient who underwent PTCA in the right coronary artery.
A: before PTCA
B: immediately after PTCA
C: 7 months after PTCA
D: 2 years and 2 months after PTCA
The target site of PTCA remained adequately widened 2 years and 2 months after procedure.

The 26 subjects consisted of 20 males and 6 females. The number of lesions was 49; 20 lesions were in the left anterior descending artery (LAD), 14 in the left circumflex artery (LCX), and 15 in the right coronary artery (RCA). The follow-up period was 1 year to 3 years and 7 months with an average of 1 year and 10 months. CAG was performed 2–5 times during the follow-up period with an average of 2.7 times per patient. Follow-up CAG was carried out 5 times in 3 patients due to recurrence of symptoms, but no significant stenosis was observed. All 23 other patients remained asymptomatic, and CAG was obtained 2–3 times for follow-up evaluation with consent of the patients.

The luminal diameter of the target lesions immediately after PTCA was determined by actual measurement using a guiding catheter or angiographic catheter as a reference. The luminal diameter was expressed as the mean of the determinations from two projections (RAO, LAO). Follow-up CAG was obtained in as close to the same projections of PTCA as possible, and the luminal diameter of the PTCA site was determined by the same method. The luminal diameter of the target lesion in the follow-up CAG was expressed as the percentage of the value immediately after PTCA, and was categorized as no change when it was 90–110% of the level immediately after PTCA, regression when it was 110% or greater, and progression when it was 90% or less.

RESULTS

Case presentation

Case 1 had old non-transmural anterior myocardial infarction with good collateral to LAD from RCA, and his left ventriculogram showed mild hypokinesis at anterior wall. PTCA was performed in segment 6 of LAD (Fig. 1, A), and the complete occlusion was almost completely eliminated, achieving a nearly normal state (Fig. 1, B). In the follow-up CAG obtained 7 months later, stenosis progressed to 70% (Fig. 1, C), but regressed to 83% after 1 year and 3 months (Fig. 1, D) and 95% after 2 years (Fig. 1, E), almost returning to the level immediately after PTCA.

Case 2 presented with effort angina due to 99% stenosis of segment 1 of RCA (Fig. 2, A). This stenosis was nearly completely eliminated and normal luminal diameter was obtained after PTCA (Fig. 2, B). The luminal diameter of the

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Fig. 4. Changes in the luminal diameter of 49 sites in follow-up CAG. Stenosis progressed in some lesions 3–8 months after PTCA but in few lesions thereafter.

3 ~ 8 Months After the PTCA

| Regression 9 | No change 23 | Progression 17 |
| Regression 5 | No change 3  | Regression 10 |
| Progression 1 | No change 12 | No change 6   |
| Regression 9 |                | Progression 1 |

Fig. 5. Frequency of progression and regression of stenosis in 49 lesions.
Regression: Increase in the luminal diameter to 110% or above 3–8 months after PTCA as compared with immediately after PTCA, and at final CAG as compared with 3–8 months after PTCA.
No change: The luminal diameter remaining 90–110% of the value at previous evaluation.
Progression: Decrease in the luminal diameter to 90% or less.
Progression was observed in 17 lesions 3–8 months after PTCA, but in only 4 lesions at final CAG.

site was 97% after 7 months, and 90% after 2 years and 2 months, indicating good effectiveness (Figs. 2, C and D).

Case 3 also had old anterior myocardial infarction accompanying post-infarctional angina due to 90% stenosis of LAD. The stenosis observed in segment 6 was alleviated to 25% by PTCA. The vessel showed adequate patency with a luminal diameter of 81% after 6 months and 99% after 3 years and 7 months of the level immediately after PTCA (Figs. 3, A, B, C, and D).

Changes in the luminal diameter of the PTCA site

Changes in the luminal diameter in follow-up CAG of the 49 lesions are shown in Fig. 4. The luminal diameters of the PTCA sites in the follow-up CAG were expressed as percentages of those immediately after PTCA and plotted in Fig. 4. The diameter of the PTCA site decreased in some lesions until 3–8 months after PTCA, but tended to increase thereafter. Figure 5 compares the luminal diameters of the 49 lesions immediately after PTCA, 3–8 months after PTCA, and at the final follow-up CAG. The luminal diameter 3–8 months after PTCA was unchanged as compared with the value immediately after the procedure in 23 lesions (47%), increased (regression) in 9 (18%), and decreased (progression) in 17 (35%). However, regression was observed in the final CAG in 10 of the 17 lesions that showed progression of stenosis, and 9 of the 23 lesions that showed no changes after 3–8 months. Thus, progression of stenosis was noted in only 4 of the 49 lesions in the final CAG. These results indicated that stenosis of the target lesion often progresses 3–8 months after PTCA, but rarely progresses further and more often regresses thereafter. This tendency is illustrated in Fig. 6, in which Fig. 4 is modified to show the changes in the luminal diameter in the mean and standard deviation at 5 time intervals: in 4-month periods within 1 year after PTCA, 1–2 years after PTCA, and after more than 2 years. The luminal diameter of the PTCA site tended to decrease during the first year after the procedure (although the change was not significant), but tended to increase after more than 1 year, and become significantly greater (p < 0.05) after more than 2 years in comparison to after 1 year.

DISCUSSION

The recent improvements in the apparatus and technique of PTCA have contributed to its rapid clinical acceptance. However, increased application of the procedure has also highlighted problems with it, which have required further evaluation. The greatest of these problems is restenosis of the PTCA site, and a number of reports have appeared concerning this topic. PTCA as well as CABG is a mean of revascularization, and despite the utmost importance of long-term dilatation of the vessels after the treatment, few studies have followed up long-term results of the procedure. Evaluation by repeated CAG has been made only by Hirzel et al and Rosing et al, but none has been reported by Japanese investigators.

In the present study, the final CAG showed progression only in 4/49 lesions (8.2%). We defined a decrease in the luminal diameter by 10% or more as progression. Hwang et al evaluated patients showing progression in stenosis after PTCA and defined equal or more than 20% decrease in the luminal diameter as marked progression. However, the subjects evaluated by Hwang et al included patients who had restenosis. Therefore, ± 10% changes were considered to be progression and regression in our study in which patients with severe restenosis had been excluded.

According to the results of the follow-up studies in 11 lesions by Hirzel et al after a mean post-PTCA period of 5.1 years, a 10% increase in the luminal diameter was observed at follow-up as compared with immediately after the treatment. Rosing et al also reported that stenosis was reduced 3 years after PTCA as
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follow-up CAG is generally performed 3–6 months post-PTCA. Our present results suggest that patients showing no restenosis in follow-up CAG 3–6 months after PTCA are mostly free of subsequent progression of stenosis so that further CAG is unnecessary without special indications such as relapse of symptoms. We tried to clarify the obscurity of the long-term results based on serial follow-up CAG including 3 months later. Finally, follow-up by less invasive examinations such as interviews concerning symptoms and stress electrocardiography is considered to suffice after one repeat CAG 3 months post-PTCA.

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