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Assessment of coronary angiograms prior to and after treatment with abciximab, and the outcome of angioplasty in refractory unstable angina patients

Angiographic results from the CAPTURE trial

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Background The CAPTURE study (*c*7E3 *A*nti *P*latelet *T*herapy in *U*nstable *Re*fractory angina) was designed to assess outcome in patients with refractory angina undergoing angioplasty, receiving either abciximab or placebo.

Methods One thousand two hundred and sixty-five patients with refractory unstable angina, defined as recurrent myocardial ischaemia despite medical treatment including heparin and nitrates were enrolled. After angiography, patients received an infusion of abciximab or placebo over 18–24 h preceding angioplasty, continuing until 1 h after the procedure. In 1197 patients undergoing angioplasty the angiographic committee centrally reviewed the baseline as well as the procedural angiograms. Coronary flow and lesion characteristics were assessed in the baseline angiogram as well as before intervention. Angiographic outcome, reason for failure as well as complications were assessed after angioplasty.

Results At 30 days follow-up, patients receiving abciximab (n=595) compared with placebo (n=602) had a 30% reduction in the composite primary end-point death, myocardial infarction or urgent (re)intervention: 10·8% vs 15·4% (P=0·017). Baseline demographics were identical in the angiogram available group compared with the total study group. At 30 days, the non-angiogram available patients showed a higher incidence of events compared to those in whom the angiogram was reviewed: 19·4 vs 13·1% (P=ns). Lesion characteristics and coronary flow were not different at baseline between the placebo and abciximab groups. A primary end-point was reached in 9·6% of both placebo and abciximab patients with type A or B_1 lesions, in 17·0% vs 12·0% with type B_2 lesions, and in 19·1% vs 11·5% with type $>B_2$ or C lesions. Sixty-one percent of placebo and abciximab patients had TIMI 3 flow at baseline angiography. Pre-angioplasty TIMI 3 flow was observed in 69% and 72% respectively. The thrombus was resolved between the angiograms in 22% and 43% respectively, in the placebo and abciximab groups (P=0·033). Angiographic success of the procedure was achieved in 88% and 94% in the placebo and abciximab patients, respectively (P<0·001). Stents were implanted in the ischaemia-related artery in 56 and 60 patients, respectively. However, failure of the stent procedure was more frequent in the placebo group than in the abciximab group, nine vs no patients (P=0·003).

Conclusion More frequent thrombus resolution was observed and a higher angiographic success rate was achieved in patients treated with abciximab before and during angioplasty compared with placebo. Patients with complex lesions as the underlying pathology reached fewer end-points if treated with abciximab before and during angioplasty.

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Introduction

Platelet aggregation and thrombus formation are the initial response to any interruption in the integrity of the endothelium, and contribute to the symptomatology in patients with unstable angina before as well as during PTCA. In many patients presenting with unstable angina, the syndrome can be stabilized with bedrest, nitrates, beta-blockers, heparin and aspirin[1]. In a minority of patients, however, symptoms continue, despite intensive medical treatment. Usually these refractory patients are referred for urgent angiography and revascularization[2]. As these urgent procedures carry a higher risk for complications than similar procedures in stabilized unstable angina patients, one has to weigh the risk of progression of the unstable syndrome to infarction or death[3,4] against the risk of the intervention.

As platelet aggregation plays a pivotal role in patients with unstable angina, the use of a recently developed antibody directed against the GP IIb IIIa platelet receptor (abciximab, c7E3, ReoPro) might prevent progression of the syndrome and make an intervention less hazardous. A pilot study treating refractory unstable angina patients with abciximab before and during angioplasty suggested beneficial effects[5]. Also the EPIC trial, treating high risk PTCA patients with a bolus and infusion of abciximab, during and after angioplasty, showed a 35% reduction in cardiac events at 30 days[6].

The CAPTURE study (*c*7E3 Fab *A*nti *P*latelet *T*herapy in *U*nstable *RE*fractory angina) was designed to evaluate the effects of treatment with abciximab in patients with refractory unstable angina. The main results at 30 days and 6 months have been published[7]. In order to assess the relationship between angiographic characteristics, treatment and outcome the baseline angiograms as well as those obtained at the time of angioplasty were centrally reviewed. Reviewers were blinded to treatment allocation. The underlying AHA/ACC lesion classification[8], as well as TIMI flow[9] at baseline and before and after angioplasty were analysed.

Patient selection and methods

Patients were recruited from 69 centres in 12 countries, between May 1993 and December 1995. Patients were eligible for CAPTURE if they had refractory unstable angina defined as: chest pain at rest with concomitant electrocardiographic (ECG) abnormalities compatible with myocardial ischaemia, and one or more episodes of typical chest pain, ECG abnormalities, or both, compatible with myocardial ischaemia during therapy with intravenous heparin and glyceryl trinitrate, started at least 2 h previously[7].

The latest episode of ischaemia should have occurred within 48 h before enrolment, corresponding to Braunwald class III 'acute' unstable angina[10]. All patients had undergone angiography and had significant coronary artery disease with a culprit lesion suitable for angioplasty. Patients were enrolled within 24 h of angiography, and angioplasty was scheduled 18–24 h after the start of study medication. If necessary because of recurrent ischaemia, angioplasty could be performed earlier, at the discretion of the investigator. In case of multivessel disease, the ischaemia-related artery was identified on the basis of the localization of reversible ST-T segment changes, combined with lesional aspects and left ventricular wall motion abnormalities.

Reasons for exclusion from the study were: recent myocardial infarction, unless creatine kinase values had returned to below twice the upper limit of normal; features of persisting ischaemia that would require immediate intervention; a greater than 50% occlusion of the left main coronary artery or a culprit lesion located in a bypass graft and bleeding risk factors as described in detail[7].

After enrolment, patients received aspirin at a minimum daily dose of 50 mg. In patients not previously on aspirin, the first dose was at least 250 mg. Heparin was administered from before randomization until at least 1 h after the PTCA procedure, and adjusted to achieve an activated partial thromboplastin time between 2·0 and 2·5 times normal. The protocol recommended that the initial heparin dose before PTCA should not exceed 100 units . kg^{-1} or 10 000 units, whichever was lower. Subsequent heparin boluses were given during PTCA after clotting time had been checked. The recommended anticoagulation target was an activated clotting time of 300 s or an activated partial thromboplastin time of 70 s.

All patients received intravenous or oral glyceryl trinitrate. Beta-blockers, calcium-channel blockers, and other cardiovascular drugs were allowed. In addition, patients were randomly assigned abciximab (0·25 mg . kg^{-1} bolus followed by a continuous infusion of 10 μg . min^{-1}) or matching placebo. The randomized treatment was started within 2 h of allocation and given 18–24 h before angioplasty and for 1 h after completion of the procedure.

Arterial sheaths were kept in place after the diagnostic angiogram, and exchanged before angioplasty. Balloon angioplasty was performed using standard techniques. The use of stents was not encouraged, unless required to maintain immediate patency of the dilated segment.

The primary end-point in the trial was the occurrence, within 30 days of randomization, of death (from any cause), myocardial infarction, or an urgent intervention for treatment of recurrent ischaemia (angioplasty, coronary artery bypass surgery, intracoronary stent placement, intra-aortic balloon pump).

Angiography

Both baseline and procedural angiograms were centrally reviewed at Cardialysis, Rotterdam by an angiographic committee, consisting of six experienced interventional cardiologists (the first six authors in this study) who were blinded to study drug assignment. All investigators were requested to send their angiograms to Cardialysis.

From the angiograms at baseline and before angioplasty the ischaemia-related artery, severity of all lesions present, collateral flow to the ischaemia-related artery, TIMI flow in the ischaemia-related artery, as well as all AHA/ACC lesion characteristics were scored individually from multiple projections[8]. These lesion characteristics included: length (<10 mm; 10–20 mm; >20 mm), eccentricity or concentricity, ostial or non-ostial location, smoothness or irregularity, angulated or non-angulated, easy or difficult accessibility, presence or absence of thrombus, no, moderate or heavy calcification, and involvement or non-involvement of a side branch at the lesion site. Thrombolysis in Myocardial Infarction (TIMI) flow was scored visually as TIMI 0 if no contrast penetrated distal to the entire ischaemia-related artery for the duration of the filming sequence, TIMI 1 if contrast penetrated the site of the lesion without complete filling of the distal ischaemia-related artery for the duration of the cinerun, TIMI 2 if contrast medium completely filled the ischaemia-related artery, but rate of inflow or clearing of contrast was slower than in comparable areas, TIMI 3 if both inflow and clearance of contrast were at the same speed in the ischaemia-related artery compared with other vessels[9].

Thrombus was scored as present if a spherical, ovoid or irregular intraluminal filling defect, surrounded on three sides by contrast medium could be visualized just distal to or within the lesion[11]. A lesion was classified as angulated if the artery at the site of the lesion exhibited an angle of $\geq 45°$. Lesion length was estimated by taking the length of the inflated balloon as a reference and defined as that segment of the artery with a narrowing of $\geq 50\%$ of the reference diameter. A side branch was scored as being present at the lesion site, when the inflated balloon covered the ostium of a side branch with a minimal estimated diameter of 1·5 mm. A lesion was scored as ostial if the inception of the lesion started within 10 mm of the origin of the left anterior descending, left circumflex or right coronary artery.

Eccentricity was scored if the remaining connection between the proximal and distal part of the ischaemia-related artery at the site of the lesion was situated in the outer third of the artery. The stenotic site was judged to be irregular if its luminal edge was irregular or had a sawtooth component. Accessibility was scored as easy if the lesion was distal to maximal one bend of $\leq 45°$, as moderately tortuous if the stenosis was distal to two bends of $\geq 45°$, and as excessively tortuous if the lesion was distal to three or more bends of $\geq 45°$. Calcification was scored if moderate or heavy radio densities were noted with fluoroscopy or cinearteriography at the site of the target lesion. If one of the characteristics only could be verified in one angiographic projection, this was considered enough evidence for the existence of the pertinent item. The definitions of TIMI flow, lesion severity and AHA/ACC characteristics were discussed with the members of the Angiographic Committee before angiograms were reviewed. The actual viewing was performed by one cardiologist and an angiographic technician from Cardialysis and agreement was reached after deliberation. In case of disagreement the final judgement was made by a second cardiologist.

After angioplasty, the procedure was scored as angiographically successful if the TIMI flow in the ischaemia-related artery was 3 (normal), and the remaining stenosis occupied less than half the diameter of the vessel, compared with the adjacent segment. The procedural results after the use of stent(s) were noted separately, as were side branch occlusions if the side branch was at least 1·5 mm in diameter. Dissections after the procedure were categorized according to modified National Heart Lung and Blood Institute criteria as A–F[12].

Dilatation of other significant stenoses outside the ischaemia-related artery during the same procedure was discouraged, but if deemed necessary by the investigator the result of dilatation of the additional lesions was also evaluated.

Statistical analysis

Categorical variables were summarized by count and/or percentages. Continuous variables were summarized by means and standard deviations. Fishers's exact test was used to assess differences in categorical variables with respect to treatment.

Multivariable logistic modelling was used to examine relationships between primary end-point and individual lesion characteristics, age, gender and treatment. Variable selection was done in a stepwise fashion. The selected variables were tested for interactions with all other variables. For the modelling the continuous variable age was dichotomized. Odds ratios with their 95% confidence intervals were calculated from the logistic model. When an odds ratio needed to be calculated from more than one regression coefficient, the relevant variance and covariance components from the variance–covariance matrix were used for calculation of the 95% confidence intervals for the subgroup odds ratios.

Results

Of 1265 patients enrolled in the CAPTURE trial, 1233 underwent angioplasty after treatment with abciximab or placebo. Of these 1233 patients, two angiograms were available for central review in 1197 (97·1%). Missing angiograms could either not be retrieved in the participating hospital, or were lost during transportation. Patients without angio review had more previous angina and previous infarction than those with review of the angiograms (Table 1). A primary composite end-point (death, myocardial infarction and urgent reintervention) was reached in 13·1% of the angio available patients, 19·4% in the angio not-available group (P=ns) and 13·3% of all studied patients. The incidence in reaching a primary composite end-point at 30 days of the angio available patients treated with placebo or abciximab

Table 1 Baseline and demographic data from the CAPTURE study population undergoing angioplasty and the angio available and angio not-available group. Primary composite end-point at 30 days

	Total population	Angio available	Angio not-available
Number of patients	1233	1197	36
Males (%)	73	73	73
Age (mean, (SD))	61 (10)	61 (10)	60 (11)
Weight (kg, (SD))	76 (12)	76 (12)	79 (10·0)
Height (cm, (SD))	170 (9)	170 (9)	171 (6)
Previous angina (%)	50	50	58*
Previous infarct (%)	39	39	50*
Primary composite endpoint at 30 days (%)	13·3	13·1	19·4

*$P<0·05$ Angio available vs not available.

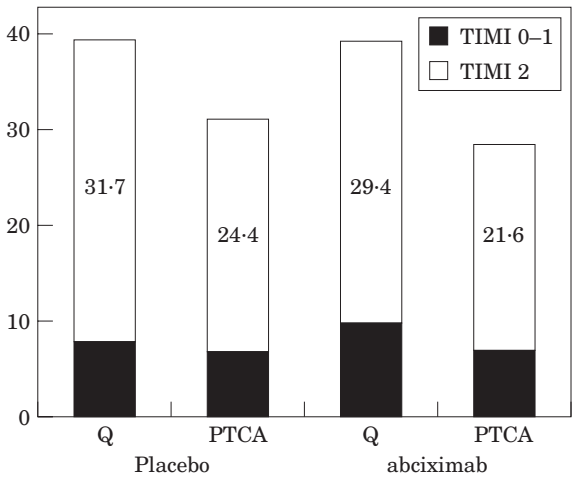

Figure 1 **TIMI flow grade in the ischaemia-related artery in abciximab treated and placebo patients at the time of diagnostic angiography before treatment (Q) and 18–24 h later during treatment (PTCA). Neither differences between groups, nor the changes are statistically significant.**

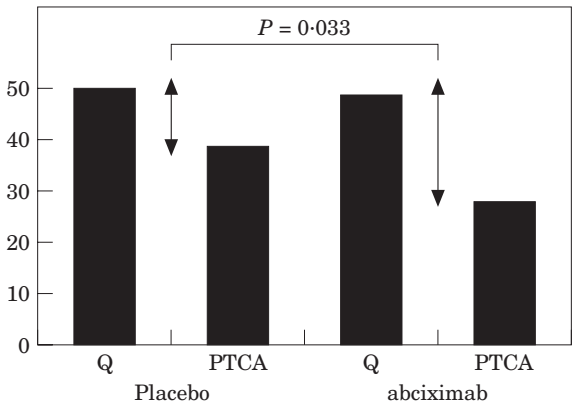

Figure 2 **Presence of any thrombus observed at the first (Q) and second angiogram (PTCA). There is a significant difference in thrombus resolution between patients treated with placebo or abciximab.**

was, respectively, 15·5% and 10·8% ($P=0·017$). Single-vessel disease was found in 54% of patients, two-vessel disease in 33% and three-vessel disease in 13%

TIMI flow could be assessed in 1168 pairs of baseline and pre-PTCA angiograms. No significant differences were present at baseline (Fig. 1). After infusion, the TIMI flow rate of the ischaemia-related artery was improved by at least one class in 88 abciximab patients vs 81 placebo group patients (P=ns). Worsening of TIMI flow by at least one class was seen in 27 placebo and 16 abciximab treated patients (P=ns).

TIMI flow 0 or 1 diminished in the abciximab group from 9·6% to 6·7% and in the placebo group from 7·7% to 6·7%, a non-significant difference between the two groups. If the final TIMI flow in the culprit artery after angioplasty was less than 3 the combined incidence of mortality and myocardial infarction at 30 days was 11·5% and 4·1% in placebo and abciximab treated patients, respectively. After achievement of TIMI 3 flow, the combined incidence was 8·1% and 4·9%, respectively.

Lesion type according to the AHA/ACC criteria assessed in the first angiogram was not different between the two groups (Table 2). Missing data are due to total occluded vessels. In the placebo group, more complications occurred and end-points were reached in patients with more complicated lesions (Table 2). Treatment with abciximab did not affect end-points in patients with type A or B_1 lesions, but reduced events in patients with complex lesions.

By univariate analysis, end-points (death, myocardial infarction or urgent reinterventions) were more frequent in patients with long lesions, angulated or bifurcated lesions (Table 3). By multivariable analysis only bifuracted lesions were associated with an increased end-point risk, particularly in younger patients with refractory unstable ischaemia.

The angioplasty procedure was angiographically successful in 88·0% of placebo patients and 94·1% of abciximab patients ($P<0·001$). Of all patients with a failed procedure 33·3% of placebo treated patients reached a primary end-point while this occurred in only 11·4% of abciximab treated patients with a failed procedure ($P=0·019$). If the procedure was successful the respective numbers were 13·0 and 10·7%. Stents were implanted in 56 placebo and 60 abciximab patients. All implants in the abciximab patients were successful, but implantation in nine placebo patients failed to achieve a less than 50% diameter stenosis with a TIMI 3 coronary flow ($P=0·003$).

After the procedure more abciximab patients had a type A–C dissection of the dilated vessel than placebo treated patients (31·5% vs 25·1% $P=0·014$). Higher grade dissections were equal in both groups (2·2% in abciximab vs 2·0% in placebo patients). Occlusion of a side branch of $\geq 1·5$ mm diameter, originating from the dilatation site, occurred in 2·8% of placebo patients and 1·0% of abciximab patients ($P=0·03$). No vessel

Table 2 Lesion type according to AHA/ACC criteria as scored in the baseline angiogram, and primary composite end-point

	Placebo 584	End-point	abciximab 569	End-point	*P* value
Lesion type					
A	48 (8·2%)	21 (9·6%)	50 (8·8%)	22 (9·6%)	ns
B_1	170 (29·1%)		179 (31·5%)		
B_2	188 (32·2%)	32 (17·0%)	166 (29·2%)	20 (12·0%)	ns
$>B_2$	166 (28·4%)	34 (19·1%)	167 (29·3%)	20 (11·5%)	
C	12 (2·1%)		7 (1·2%)		0·055

Table 3 Individual IRS lesion characteristics and outcome in patients treated with abciximab or placebo

Lesion characteristic	n	abciximab Primary end-point	n	Placebo Primary end-point
Length				
<10 mm	418	46 (11·0%)	442	57 (12 9%)
>=10 mm, <20 mm	143	16 (11·2%)	128	26 (20·3%)
>=20 mm	0	0 (0·0%)	12	3 (25·0%)
Eccentricity				
concentric	97	7 (7·2%)	93	15 (16·1%)
eccentric	470	54 (11·5%)	486	71 (14·6%)
Angulation				
<45°	528	57 (10·8%)	532	74 (13·9%)
>45°	40	4 (10·0%)	44	11 (25·0%)*
Contour				
smooth	451	46 (10·2%)	457	69 (15·1%)
irregular	115	16 (13·9%)	123	17 (13·8%)
Calcification				
yes	86	11 (12·8%)	89	15 (16·9%)
no	481	50 (10·4%)	486	69 (14·2%)
Bifurcation				
yes	129	13 (10·1%)	153	36 (23·5%)*
no	437	49 (11·2%)	427	50 (11·7%)
Thrombus				
yes	41	5 (12·2%)	40	9 (22·5%)
no	551	54 (10·6%)	558	76 (14·4%)
Ostial				
yes	23	1 (4·3%)	25	4 (16·0%)
no	545	61 (11·2%)	558	82 (14·7%)
Accessibility				
readily accessible	554	62 (11·2%)	564	84 (14·9%)
moderate tortuosity	0	0 (0%)	14	2 (14·3%)

*$P<0·05$·

perforation was visible on any angiogram. A single additional non ischaemia-related artery lesion was dilated in 113 patients. Two or more additional lesions were treated in another 17 patients. The results of these dilatations were similar to those of the ischaemia-related artery dilatations, with success rates in the abciximab treated patients of 92·5% and in the placebo treated patients of 83·7%.

Discussion

This analysis of the angiograms in the CAPTURE study has demonstrated that pre-treatment with abciximab prior to PTCA does reduce the amount of thrombus, and improves the angiographic result of the procedure both for balloon angioplasty and stent implantation. These observations help to explain the marked reduction in death, myocardial infarction and urgent revascularization observed in CAPTURE[7] as well as in other trials with glycoprotein IIb/IIIa receptor blockers[6,13–15].

Review of the angiograms of patients participating in the CAPTURE study was nearly complete. Of 97·1% of all patients undergoing PTCA both angiograms were reviewed. Patients whose angiograms were missing had a higher incidence of composite end-points. This explains the 0·5% lower occurrence of a primary end-point

in both groups, when comparing the patients with available angiograms with the total CAPTURE population[7].

More thrombi at the site of the lesion were resolved in the patients treated with abciximab, underscoring the platelet disaggregatory effects of abciximab[16]. This finding is in agreement with the qualitative angiographic data from the CAPTURE pilot trial where three out of six vessels being occluded or showing thrombi at the first angiogram, contained no intracoronary filling defects after treatment with abciximab, while this occurred in only one out of five patients pre-treated with placebo[5]. Similar results were obtained in a study with tirofiban (PRISM PLUS) in which angiograms were centrally analysed in 1168 patients after they had been treated with this IIbIIIa receptor blocker or placebo during 65 ± 17 h. In these patients, medium or large thrombi were reported in 20% of placebo patients and in 14% of patients after receiving tirofiban[17]. Recently, the baseline angiographic lesion morphology of patients enrolled in EPIC and EPILOG has been compared with 30-day outcome[18]. Although the absolute risk reduction was somewhat higher in more complex lesions, this difference was not statistically significant. The investigators scored a higher number of more complex lesions, compared with our core laboratory data. This is even more remarkable because EPIC and EPILOG randomized 42% stable angina pectoris patients, while in CAPTURE all patients exhibited symptoms of refractory unstable angina.

The angiographic success rate of the procedure was higher if patients were pre-treated with abciximab (94·1 vs 88·0%; $P = <0{\cdot}001$). Most of the failures of angioplasty were due to the inability to dilate the culprit lesion successfully. This is also true if a stent was implanted. Stent implantation resulted in a 100% angiographically successful procedure in abciximab treated patients, while success after stent implantation was only achieved in 86% of placebo-treated patients ($P = 0{\cdot}003$). Abciximab thus improves the angiographic outcome both with and without stent implantation. Again, these data have recently been confirmed in other trials comparing patients receiving stents with or without abciximab[19,20]. Apparently, heparin and aspirin are unable to control for ongoing thrombus formation at the dilatation site, while abciximab is able to control this process, thus resulting in a successful procedure. The limited success rate of angioplasty in both groups has to be viewed in the context of a low percentage of stent implantation in the CAPTURE trial (9·4%). Nevertheless at 30 days the incidence of myocardial infarction and morality and the difference in the occurrence of these events in placebo-treated or abciximab-treated patients was identical in the CAPTURE and the EPISTENT trial[20]. The difference in the occurrence of a combined primary end-point between these two studies was exclusively due to a difference in urgent revascularization, in placebo-treated as well as abciximab-treated patients.

Angiography might not be the most sensitive diagnostic tool to detect thrombi in coronary arteries[12], but it is tempting to ascribe the better angiographic outcome after abciximab to less thrombus formation at the site of the dilatation. In keeping with this finding is our observation of significantly fewer occurrences of side branch occlusion after dilatation, if patients are pre-treated with abciximab. Although this finding was rare in both groups, the absolute difference of 1·8% of side branch occlusion between both groups, might have contributed to the absolute difference of 3·6% in the number of infarctions between both groups, since most of these infarctions occurred in conjunction with the angioplasty procedure[7].

Even the higher incidence of visible vessel wall dissections in the abciximab treated patients could be caused by less thrombus formation at the dilatation site. Thrombi may fill up cracks and fissures of the intimal and medial layers of the vessel, obscuring the existence of a dissection. It is remarkable that in this trial patients pre-treated with abciximab and a failed angioplasty procedure did not exhibit a higher incidence of a primary end-point at 30 days (11·4%) than the total group of patients treated with abciximab (10·8%). Yet 33% of patients in the placebo group with a failed angioplasty procedure reached a primary end-point vs 13% of placebo patients with a successful angioplasty procedure. This raises the question whether treatment with abciximab for a longer period before angioplasty could further reduce the number of events, and even reduce the total number of revascularization procedures. This issue is addressed in the ongoing Gusto IV acute coronary syndromes trial.

TIMI 3 flow in the ischaemia-related artery at baseline angiography was observed in 61% and 60·6% of treated and placebo group patients, respectively. After infusion of study drug and before angiography the proportion of patients with TIMI 3 flow was, respectively, 71·7% and 68·9% (P=ns). Improvement in TIMI flow by at least one grade was observed in equal numbers in both patient groups. In the earlier mentioned PRISM PLUS study a significant difference in TIMI-3 flow in a subset of patients who underwent angiography (n=1168) was discovered in favour of patients who had been pre-treated with tirofiban (82% vs 74%). This discrepancy in results could be ascribed to selection because only 83% of all patients who underwent angiography have been incorporated in the angio substudy in PRISM PLUS[17]. Also the longer duration of infusion of tirofiban plus heparin, or heparin alone (65 ± 17 h) compared with the duration of heparin ($\pm$ abciximab infusion in the CAPTURE study could be responsible for the differences observed. Flow variations have been detected in an angioplasty model as described by Anderson *et al.*[21] and were abolished after administration of abciximab.

Grading lesions according to the system devised by the AHA/ACC task force, has led to the recognition of lesions more susceptible to angioplasty complications. Ellis *et al.*[22] noted a 2%, 8%, 10% and 18% of procedural complications consisting of death, myocardial infarction or emergency bypass operation in patients

with type A; B_1; B_2; or $>B_2$ or C lesions, respectively. In the group of patients treated with placebo or abciximab the number of primary end-points for A or B_1 lesions was 9·6% vs 9·6%; for B_2 lesions 17·0% vs 12·0% and for $>B_2$ or C lesions 19·1% vs 11·5%. When looking at individual lesion characteristics, only a lesion at the site of a bifurcation led to a significantly higher incidence of complications when patients were not pre-treated with abciximab. The risk of a bifurcated lesion is modified by age, in a sense that younger patients with such lesions have the highest odds ratio for reaching a primary end-point. Although abciximab seems to be more effective in patients with refractory unstable angina and more complex lesions, this difference has to be viewed against the background of a very restrictive stent implantation policy at that time, departing from contemporary clinical practice.

In summary, our findings are consistent with the antithrombotic potential of a combination of heparin, aspirin and abciximab in patients with refractory unstable angina, and help to explain the benefit of such a treatment, as observed in different studies[6,7,13]. Treatment with abciximab reduced thrombus before PTCA, and enhanced the PTCA success rate, both without and with stent implantation. Thus, such treatment should be recommended in patients with unstable angina, and specifically in patients with more complex lesions as determined by angiography. Future studies should address the potential of treating patients with unstable angina not scheduled for coronary intervention with abciximab as well as the possibility of prolonged treatment with oral glycoprotein IIbIIIa receptor blockers in such patients.

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