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Working Group Report

Indications for intracoronary stent placement: the European view

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Aims In Europe, no written official guidelines on indications for coronary stent placement are available. We therefore assessed the opinions of European interventional cardiologists on these indications.

Methods and Results In April 1997, a questionnaire was sent to the members of the Working Group on Coronary Circulation of the European Society of Cardiology with interventional cardiology as the main activity. A total of 165 questionnaires were returned and analysed. For the treatment of acute or threatened vessel closure during PTCA, the threshold for stenting is set at the level of a type C dissection by 42% of the cardiologists, while 22% stent any form of dissection and 13% require an impaired TIMI flow. A suboptimal PTCA result necessitating stenting is defined as a residual stenosis of >50% by 35% or of 30 >30% by 55% of the respondents. When considering primary prevention of restenosis, only 2% unconditionally stent focal, new-onset lesions in native coronary arteries, 44% refrain from stenting in a case of a stent-like PTCA result ($\leq$30% residual stenosis) and 73% think that stent types other than the Palmaz-Schatz may be implanted for this indication. Restenotic lesions are unconditionally stented by 30% of the interventionists while 64% reserve this option only for suboptimal PTCA results. Amongst the other indications, stenting is considered to be the treatment of choice as follows: chronic total occlusion, 85%; saphenous vein graft lesions, 59%; aorto-coronary ostial lesions, 64%; and primary intervention for myocardial infarction: 59%.

Conclusion European interventional cardiologists have integrated current literature on stenting into their daily practice. The most cited indications (threatened vessel closure and suboptimal PTCA results) are not supported by randomized trials. The variations in the conclusions from randomized trials may be explained by the general expectation that stenting will improve PTCA results.
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Key words: Stent, coronary artery disease, restenosis, acute vessel closure.

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Introduction

Intracoronary stenting is generally considered the most important development in the field of percutaneous coronary revascularization since the introduction of balloon angioplasty in 1977. The immediate clinical and angiographic results are reasonably predictable with a high success rate. Clinical data have demonstrated reduced restenosis rates in selected cases and the usefulness of these devices for the correction of suboptimal balloon angioplasty results[1]. Most scientific information is based on observational studies while only a limited number of randomized trials substantiate the above statements. Nevertheless, this technique is widely applied with a continually growing proportion of interventional procedures ending with the placement of intracoronary stents. Furthermore, at present more than 30 different types of stents are in use or are in clinical evaluation without substantial comparative data. As with most new techniques, this creates a gap between current clinical practice and supporting scientific data. This statement holds especially true for Europe where, despite the restrictions imposed by the CE mark, stents

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Table 1 Estimated proportion of stenting during intervention according to country of residence

Country	Number of respondents	Proportion of stenting*
Austria	3	58 ± 8
Belgium	24	37 ± 12
France	29	62 ± 17
Germany	22	47 ± 20
Israel	2	65 ± 7
Italy	22	62 ± 17
The Netherlands	19	51 ± 13
Spain and Portugal	5	53 ± 10
Switzerland	10	52 ± 10
United Kingdom	20	52 ± 23
Eastern Europe	7	25 ± 7
Northern Europe	2	50 ± 10
Total	165	51 ± 18

*Average ± SD

are being used more extensively than in the United States. Specific recommendations concerning indications have been published by a working group on coronary stents for the American College of Cardiology, while similar recommendations in Europe have remained technical and focused on manufacturing aspects[2,3]. A questionnaire sent to the members of the Working Group on Coronary Circulation of the European Society of Cardiology evaluated the opinion of European interventional cardiologists on indications for coronary stent placement.

Methods

In April 1997, a questionnaire was sent from the Secretary of the European Society of Cardiology at the European Heart House (Nice, France) to the members of the Working Group on Coronary Circulation with interventional cardiology as its main activity. Approved by the chairman of the Working Group, it contained 14 questions with multiple choice, non-exclusive answers. The 165 returned questionnaires (83% of the questionnaires sent out) were analysed according to the country of residence of the cardiologist.

The complete questionnaire can be found in the Appendix to this report.

Simple descriptive statistics were applied for data analysis.

Results

Overall use of stents during interventional procedures

Table 1 shows the numbers of respondents per country and an estimate of the percentage of stent placement during percutaneous revascularization procedures. With the exception of Belgium and Eastern European countries, half or more of all interventional procedures end with stent placement.

Stenting for acute or threatened closure/suboptimal PTCA results

The overwhelming majority of respondents considers stenting the treatment of choice for acute or threatened vessel closure during PTCA. Only 13% require a dissection with a reduced TIMI flow, while 22% of respondents stent any form of dissection. The vast majority (42%) sets the threshold for stenting at the level of a type C dissection[4] (Fig. 1). When considering the type of stent to be used, no-one is of the opinion that only stents approved by the U.S. Food and Drug Administration should be used. For 33% of the cardiologists, any type of implant able to scaffold the vessel can be used, while 60% consider that most (but not all) available devices may be implanted for this indication.

A suboptimal angiographic result, defined as an important residual stenosis after PTCA, is considered an indication for stent placement by 55% of the respondents if the residual stenosis is >30% and by 35% and 10% of the interventionists for a >50% and >20% residual stenosis, respectively. When considering the type of stent to be used, opinion is to use: only Food and Drug Administration approved stents (2%), any type of stent (25%) and most available stents (66%).

Physiological guidance (by measuring flow velocity and intracoronary pressure parameters) during PTCA complicated by suboptimal results is considered equally useful to or even more useful than angiography by 45% of the cardiologists, while 58% do not agree with this statement[5].

Primary and secondary prevention of restenosis after PTCA

Unconditional stenting is only performed by 2% of the respondents for Benestent-STRESS like lesions (new onset, discrete ($\leq$15 mm) lesions in native coronary arteries with a reference diameter of $\geq$3 mm)[6]. If a stent-like PTCA result (residual stenosis of $\leq$30%) is achieved, 44% do not proceed with stenting. Moreover, 73% consider that stents other than the P-153 Palmaz–Schatz (which was compared with conventional PTCA in these trials) may be used for this indication. In accordance with the results from a meta-analysis of the above trials, 65% of the interventional cardiologists agree that stenting is not superior to PTCA for small (<2·6 mm) and large (>3·4 mm) coronary arteries[7]. In considering primary restenosis prevention, only 28% find physiological guidance helpful. Heparin-coating of stents (as was the case in the Benestent II trial) is considered to have the potential to improve the immediate and long-term clinical and angiographic outcomes

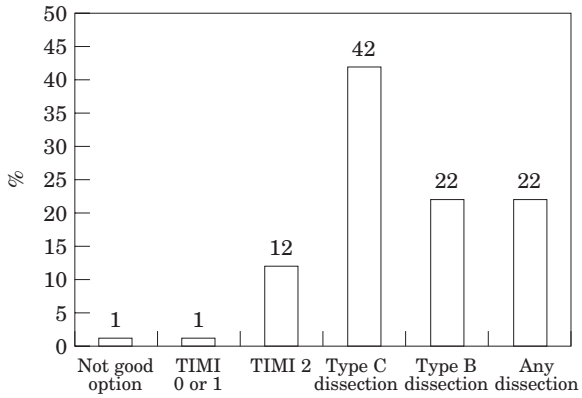

Figure 1 **Threshold for stent placement in case of abrupt or threatened vessel closure during percutaneous transluminal coronary angioplasty according to TIMI flow and dissection type.**

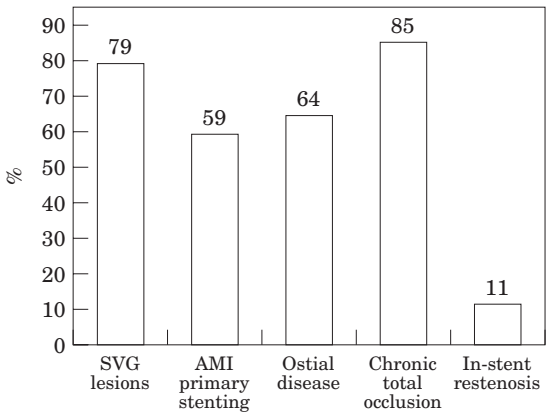

Figure 2 **Indication for stenting as the treatment of choice according to the following clinical and angiographic presentations (AMI=acute myocardial infarction, SVG=saphenous vein graft).**

(compared with non-coated stents) by only 39% of respondents[8]. The majority (44%) do not agree with this statement, while 16% do not express an opinion.

Unconditional stenting is preferred by 30% of cardiologists for the treatment of restenosis after PTCA, while 64% do not stent if a stent-like result is achieved.

Other indications

Figure 2 illustrates the percentage of intended stent placement for other indications. Chronic total occlusion and saphenous vein graft stenoses are considered as good indications for stent placement by about 80% or more of positive respondents.

When considering the treatment of long and diffuse disease only 21% will use long and/or multiple stents for vessel reconstruction; 14% refrain totally from stenting and 61% use stents only for suboptimal PTCA results.

Contraindications for stenting

The following contraindications (in order of importance) are cited: (1) reference vessel diameter <2 mm (55%), vessel diameter <2·5 mm (38%), extreme vessel tortuosity (38%), diffuse coronary artery disease (23%), thrombus-containing lesion (5%), bifurcation lesion (5%) and extreme calcification (3%).

Discussion

The results of the questionnaire on indications for coronary stent placement submitted to the interventional cardiologists of the Working Group Coronary Circulation of the European Society of Cardiology show that this technique is widely accepted and applied in about 50% of all coronary interventional procedures in Europe.

The practice of coronary stenting was first introduced in 1986 but remained in limited use until 1994–1995, mainly because of the unforeseeable problem of subacute stent thrombosis and bleeding related to anticoagulation therapy after implantation. In 1994, the Benestent I and STRESS I trials, comparing conventional PTCA and Palmaz–Schatz stent placement for discrete, de novo lesions in native coronary arteries, were published[6]. They establish an improved clinical outcome at 6 months following stenting which was related to less lesion site revascularization and lower restenosis rates. In 1995, the concept of optimal stent deployment and the use of ticlopidine (as additional antiplatelet therapy to aspirin, rather than to maintain anticoagulation) were introduced which led to a spectacular reduction in thrombotic complications after stent placement[9,10]. In addition, the dramatic angiographic improvement classically observed after stenting led to the widespread and growing use of stents in interventional cardiology practice.

Overall use of stents during interventional procedures

As a corollary, the questionnaire has revealed that, on average, stenting took place in 50% of coronary interventions in Europe in 1997. The lower numbers reported for eastern countries and Belgium may be explained by economic reasons and reimbursement facilities, respectively. Only recently, in 1998, have stents been recognized as a treatment option by Belgian health authorities. A further increase in use of stents may be expected in forthcoming years; this again illustrates the growing divergence between evidence-based medicine and daily practice.

Stenting for acute or threatened closure/suboptimal PTCA results

At present, there is evidence from several 'observational' studies, including large single-centre experiences and

multicentre registries with different types of stents, that this option emerges as the best solution in cases of acute or threatened vessel closure during PTCA[3]. Additional, although limited, data favour the 'corrective' use of stents for suboptimal PTCA results[11,12]. Because of heterogeneity in definitions, it may be more appropriate to group these forms of unsuccessful PTCA. It may be concluded that extensive dissection and/or large residual plaque burden are the ideal target for a scaffolding device such as a stent.

Data from the pre-stent era indicate that the risk for subsequent vessel closure tends to increase beyond the level of a type C dissection induced by the angioplasty catheter. Huber and colleagues reported a reclosure rate of 3% for a type B dissection, while this complication was reported in 31% of cases for a type C or more dissection[13]. The largest proportion of interventional cardiologists (42%) set their threshold for stenting at this level. More than 90% of respondents consider that several stent types can be used and point out that trackability and scaffolding properties are the main determinants in the choice of a particular device.

Substantive data from quantitative coronary angiography and intravascular ultrasound studies have, however, identified the amount of residual plaque burden following intervention as a powerful predictor for restenosis[14,15]. Subgroup analyses from Benestent I and II trials exhibited similar clinical outcomes in stented patients and patients treated by PTCA that result in a $\leq$30% residual stenosis[8,16]. Therefore, the term 'stent-like' PTCA result was proposed. The majority of interventional cardiologists (55%) consider stenting in cases with >30% residual stenosis and probably aim to improve the angiographic outcome at 6 months.

The usefulness of a physiology-guided percutaneous intervention was first demonstrated in the DEBATE 1 trial[17]. The combination of Doppler (a coronary flow velocity reserve post-PTCA of $\geq$2·5) and quantitative angiography (a residual stenosis of $\leq$35%) end-points identified a patient population with a low incidence of adverse clinical events at 1–6 months and a restenosis rate (16%) comparable with the results from 'contemporary' stent trials[18]. The present questionnaire reveals that 45% of the respondents believe that physiological guidance may help in deciding whether additional stenting is required in the case of a suboptimal PTCA result.

Primary and secondary prevention of restenosis after PTCA

Despite the conclusions of the Benestent I-STRESS I, II and III trials, only 2% of cardiologists unconditionally stent patients meeting the angiographic study criteria. The concept of provisional stenting seems widely accepted as 44% of respondents refrain from stenting in cases with a stent-like PTCA result. This viewpoint contrasts with 'American habits' which implies faithful application of the conclusions of randomized trials published in well-respected, peer reviewed journals.

Another 'European particularity' is the conviction (73% of positive respondents) that stents other than the P-153 Palmaz–Schatz stent may be implanted for this indication.

Controversy exists about the usefulness of heparin coating. Although the incidence of subacute stent thrombosis was extremely low in the Benestent II trial (0·2% compared with 3·5% in Benestent I using a non-coated stent), the trials may not be comparable concerning this particular complication because the Benestent I trial was conducted in an era of different stenting protocols. Otherwise, angiographic restenosis rates were similar (22% and 18% for Benestent I and II studies, respectively)[6,8]. These results indicate that the role of a heparin coating remains an open question.

Historically, the first stent ever was implanted for the treatment of restenosis in a proximal left anterior descending artery[1]. The only randomized trial for this indication (the REST study) was terminated last year and has yet to be published[6]. The results are similar to the conclusions of trials on primary restenosis prevention. For this reason, and perhaps because interventionists would like to anticipate the risk of a third lesion site intervention, a large proportion (30%) of cardiologists unconditionally stents restenotic lesions in native coronary arteries.

Other indications

There is evidence (although limited to only one randomized trial for each indication) that stenting is beneficial in the setting of chronic total occlusion of a native coronary artery and saphenous vein graft narrowing[19,20]. A large majority (over 80%) of respondents subscribe to the conclusions of these studies indicating stenting as the treatment of choice.

Recently, an initial single-centre randomized study favouring the use of stents for direct PTCA during acute myocardial infarction was published[21]. Follow-up data from the large multicentre PAMI-stent trial are still lacking. Nevertheless, 59% of respondents consider stenting as a first choice option for this indication.

Aorto-coronary ostial lesions, treated by conventional PTCA, are characterized by high recurrent rates[22]. On the basis of the results of the few observational trials published on this subject, and probably on positive personal clinical experiences, 64% of respondents were positive for stenting for this indication[23].

Despite the availability of customized stents (often available in lengths of up to 40 mm and more), only 21% of cardiologists agree with the concept of vessel reconstruction in cases of long and diffuse coronary artery disease. This may be explained by the risk for diffuse in-stent restenosis, a condition characterized by the absence of valuable therapeutic solutions.

Contraindications for stenting

The opinions expressed by the European cardiologists clearly indicate that the practice of interventional cardiology is evolving. A few years ago, a vessel reference diameter of <3 mm, thrombus-containing lesions and acute myocardial infarction were considered contraindications for stenting and represented exclusion criteria for all major randomized stent trials. At present, vessel reference diameter is still being considered as the major contraindication for stenting with a cut-off value of 2 mm for more than half of the respondents. The fact that a thrombus at a lesion site is no longer considered a contraindication may be explained by recent experiences showing no correlation between thrombus and subsequent stent thrombosis[24]. Acute myocardial infarction — the thrombus containing lesion by definition — is the subject of current clinical investigation in the PAMI-stent trial and is being considered an indication, rather than a contraindication, for stenting.

Study limitations

This questionnaire was sent to the interventional members of the Working Group Coronary on Circulation. With 165 respondents, of 83% addressed colleagues, the analysis can be considered representative of the opinion of the Working Group. Nevertheless, they represent only a small part of the whole European interventional community.

Moreover, practices may have changed since despite the fact that no major randomized trial has been published in this field since 1997.

Conclusions

Stenting is an established treatment applied in about half of all percutaneous coronary interventions in Europe. This poll demonstrates that the European interventional cardiologist has integrated knowledge of current literature into his daily practice. Although not supported by randomized trials but largely evident from a substantial number of observational studies, stenting for the correction of unsatisfactory PTCA results is certainly the most applied indication. The concept of 'provisional stenting' has found a large following for economic reasons and by intuition rather than based on evidence.

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Appendix

Questionnaire on indications for coronary stent placement

1. Acute or threatened vessel closure after PTCA, which implies the need for stent placement, is:
   - Stent placement is not an established treatment for this complication
   - A stent may be implanted as a bridge to urgent-CABG which should imperatively be performed
   - TIMI flow 0 or I with underlying dissection
   - TIMI flow II or less with underlying dissection
   - Normal TIMI flow with dissection type C or more
   - Normal TIMI flow with dissection type B or more
   - Normal TIMI flow with dissection type A or more (any form of dissection).
2. Stent placement for acute or threatened vessel closure requires:
   - Any stent as long as it covers the lesion can do the job
   - Most stents can do the job
   - Only FDA approved stents should be used
   - I do not agree with any of the above statements.
3. A suboptimal angiographic result after PTCA, which implies the need for stent placement is:
   - A residual stenosis of >50%
   - A residual stenosis of >30%
   - A residual stenosis of >20%.
4. Stent placement for a suboptimal angiographic result requires:
   - Any stent as long as it covers the lesion can do the job
   - Most stents can do the job
   - Only FDA approved stents should be used
   - I do not agree with any of the above statements.
5. Physiological measurements (velocity flow, pressure) after initial angioplasty may be even or more important than angiography for a final decision whether or not to stent in case of suboptimal results:
   - Yes
   - No.
6. Patients with a BENESTENT-like lesion should be stented by means of a P-153 Palmaz–Schatz stent:
   - Always
   - Always, except if a stent-like angioplasty result is achieved
   - Another than a Palmaz–Schatz stent may be used.
7. Primary prevention of restenosis after PTCA by stenting:
   - There is no benefit in very small or large vessels
   - Physiological measurements are even or more important than angiography
8. Stent placement for the treatment of restenosis after PTCA:
   - Always
   - Only if a suboptimal angiographic result is achieved
   - Is not the treatment of choice.
9. Vein graft disease:
   - Stenting is the treatment of choice
   - Stenting should only be performed in case of suboptimal results
   - Stenting is not the treatment of choice.
10. Stents should liberally be used in the following indications:
    - Direct PTCA and myocardial infarction
    - Ostial disease
    - Chronic total occlusion
    - Restenosis within a stent.
11. Use of long or multiple stents for long or diffuse disease:
    - Stenting is the treatment of choice
    - Stenting should only be performed in case of suboptimal results
    - Stenting is not the treatment of choice.
12. Compared to non-coated stents, heparin-coated stents improve the immediate and long-term angiographic and clinical outcomes in patients with BENESTENT-like lesions:
    - Yes
    - No.
13. Contraindications for stenting are:
    - thrombus at lesion site
    - Small vessels: <3 mm
      <2·5 mm
      <2 mm
    - Extreme vessel tortuosity
    - Bifurcation lesion
    - Diffuse disease
    - Others.
14. Finally, what is your actual proportion of stenting during coronary intervention?