Accuracy of Multi-Slice Computed Tomography Angiography in The Diagnosis of In-Stent Restenosis in Proximal Left Anterior Descending Coronary Artery Stent Compared to Conventional Coronary Angiography

Thesis

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List of Abbreviations

Abb.	Full term
AUC	Area under the curve
BMS	Bare metal stents
CA	Coronal angiography
DES	Drug eluting stents
EBCT	Electron beam CT
HU	Hounsfield units
IH	Intimal hyperplasia
ISR	Instent restenosis
IVUS	Intravascular ultrasonography
MDCT	Multidetector row computed tomography
MSA	Minimal stent area
NPV	Negative predictive value
PCI	Percutaneous coronary intervention
PES	Paclitaxel eluting stent
PPV	positive predictive value
SES	Sirolimus eluting stent
SPECT	Single photon emission tomographic

Abstract

Our study included 50 stents placed in the proximal segment of the left anterior descending coronary artery regardless their diameters and strut thickness assessed by MSCT and CA to assess the accuracy of MSCT in the diagnosis of significant in stent restenosis.

Our results showed that MSCT is an accurate and reliable tool in diagnosis of in stent restenosis in stents more than 3mm in diameter with 100% sensitivity and specificity. However this accuracy drops markedly in the assessment of stents less than 3mm in diameter due to an artificial narrowing of the stent diameter caused by the blooming effect.

Although MSCT can't be reliable in diagnosis of ISR in stents less than 3mm in diameter, it still can be used as a tool to rule out the presence of ISR in these stents with a negative predictive value almost 100%.

Keywords: Minimal stent area - Minimal stent area - Minimal stent area Intravascular ultrasonography - Sirolimus eluting stent

Introduction

In the last years, coronary artery disease has been increasingly treated by coronary stent placement. Although stent implantation has been shown to greatly reduce restenosis after balloon angioplasty ***(Schoenhagen et al., 2004)*** in-stent restenosis can occur in 20-35% of patients for bare metal stents ***(Morice et al., 2006)*** and 5-10% for drug-eluting stents, as demonstrated by intravascular ultrasound.

Invasive coronary angiography is the gold standard technique for detection of in-stent restenosis. However, coronary angiography has limitations due to its invasiveness and association with potential risks of morbidity and mortality.

Given the high number of patients who receive coronary stents yearly, a non-invasive imaging technique for detection of in-stent restenosis will be clinically important and beneficial.

Since the introduction of multi-slice computed tomography (CT), CT angiography has emerged as a new tool in the diagnosis and monitoring of coronary heart disease. Additionally, noninvasive assessment of coronary stents is an attractive potential application of multi-slice CT technology ***(Schoepf et al., 2004).***

Multi-slice computed tomography (MSCT) is increasingly used for non-invasive imaging of coronary artery disease and has been reported to have a high diagnostic accuracy in the detection of coronary artery stenosis ***(Fine et al., 2006).***

However, imaging of coronary stents by MSCT is more difficult than native coronary artery. This is due to the presence of artifacts interfering with the interpretation of lumen patency.

Although several reports have shown that MSCT may be used to evaluate stent patency, more precise evaluation of the lumen within stent is markedly affected by the blooming artifacts that can cause an appearance of artificial enlargement of the metallic stent struts ***(Kruger et al., 2003).***

With increasing number of detector rows, promising results of MSCT in coronary artery disease have been reported with improved spatial and temporal resolution. However, it is unclear whether this also applies to the assessment of coronary stent implantation.

AIM OF THE WORK

To assess the accuracy of multi-slice Computed Tomography angiography in the diagnosis of in-stent restenosis in proximal Left anterior descending coronary artery stent compared to conventional coronary angiography.

Chapter 1

INSTENT RESTENOSIS

Percutaneous coronary intervention (PCI) has seen an enormous increase and tends to be the preferred method for myocardial revascularization ***(Mack et al., 2004).***

Nowadays, the routine use of balloon angioplasty is very limited due the recurrence of luminal narrowing due to recoil, the vessel wall remodeling or intimal hyperplasia induced by arterial wall injury and atherosclerosis progression. Because of the continuous evolution of stents and the introduction of newer drug eluting stents, interventional cardiologists have now a broad therapeutic spectrum. Thus the use of stents during PCI has achieved a significant decrease in complications and an improvement in all the patients' outcomes ***(Serruys et al., 1994).***

The basic idea was for the implanted stent to serve as a scaffold that would maintain the artery's patency permanently. But the major drawback about implanted stents is still the chance of in-stent restenosis ***(Kasaoka et al., 1998; Akiyama et al., 1998)***.

Although the introduction of drug-eluting stents (DES) has made a huge decrease in the percentage of in-stent restenosis compared to bar-metal stents, but it still remains the Achilles' heel of PCI.

Mechanism and factors contributing to in-stent restenosis

The rate of in-stent resteosis in BMS is very high reaching around 25% ***(Serruys et al., 1994; Fischman et al., 1994)***. Compared to a rate of less than 10% using DES ***(Moses et al., 2003; Stone et al., 2004).***

However, its prevalence will be greater in view of the fact that, in the real world, DES are being increasingly used in complex lesions such as those in the left main artery, bifurcations, small vessels, vein grafts, chronic total occlusions, acute coronary syndromes and diabetic patients.

In these patient populations, "off-label" use has led to an ISR rate exceeding 10% ***(Stone et al., 2005; Tanabe et al., 2004).***

Another fearful issue is that DES restenosis does not always present benignly, with myocardial infarction being the initial clinical manifestation in up to 10% of patients ***(Abizaid et al., 1998)***.

A number of predisposing factors have been associated with in-stent restenosis and can be divided into *vessel and lesion-related, procedure-related and patient-related.*

1- Vessel and lesion characteristics

The vessel nature is a main indicator of the probability of ISR such as the vessel size, tortuosity, calcification or totally occluded vessels.

Another indicator is the lesion characteristics and sites especially lesions located in the left anterior descending coronary artery (LAD).

2- Technical failures of the implantation

Improper implantation technique is still a risk factor for the occurrence of ISR such as small post-procedural minimum lumen diameter, underexpansion, overexpansion, stent fracture, non-uniform distribution of stent struts and malapposition.

3- Patient related factors

Patients having diabetes mellitus have a higher probability for ISR ***(Kip et al., 1996)***. Genetic factors, such as the PIA polymorphism of glycoprotein IIIa ***(Kastrati et al., 1999),*** the insertion/deletion polymorphism and the plasma activity of angiotensin I-converting enzyme ***(Ribichini et al., 1998)*** have been reported to be important patient-related risk factors of ISR.

Classification of ISR

An earlier classification of lesions into either diffuse (lesion length >10 mm) or focal (<10 mm) has proved inadequate to predict the rate of target vessel revascularization (TVR). Nowadays, the angiographic pattern of restenosis based on Mehran's classification for ISR seems to have important prognostic value and may be used for further clinical assessment ***(Mehran et al., 1999)***.

- ***Mehran classification (Figure 1)***

- **Class I:** Focal ISR group. Lesions are <10 mm in length and are positioned at the unscaffolded segment (ie, articulation or gap), the body of the stent, the proximal or distal margin (but not both), or a combination of these sites (multifocal ISR).

- **Class II:** "Diffuse intrastent" ISR. Lesions are.10 mm in length and are confined to the stent(s), without extending outside the margins of the stent(s)

- **Class III:** "Diffuse proliferative" ISR. Lesions are.10 mm in length and extend beyond the margin(s) of the stent(s).

- **Class IV:** ISR with "total occlusion." Lesions have a TIMI flow grade of 0.

Recurrent ISR was more frequent with increasing grades of classification, as with diabetes.

Target lesion revascularization (TLR) increased according to ISR class, ranging from 19% to 83% for classes I to IV, respectively (p<0.001).

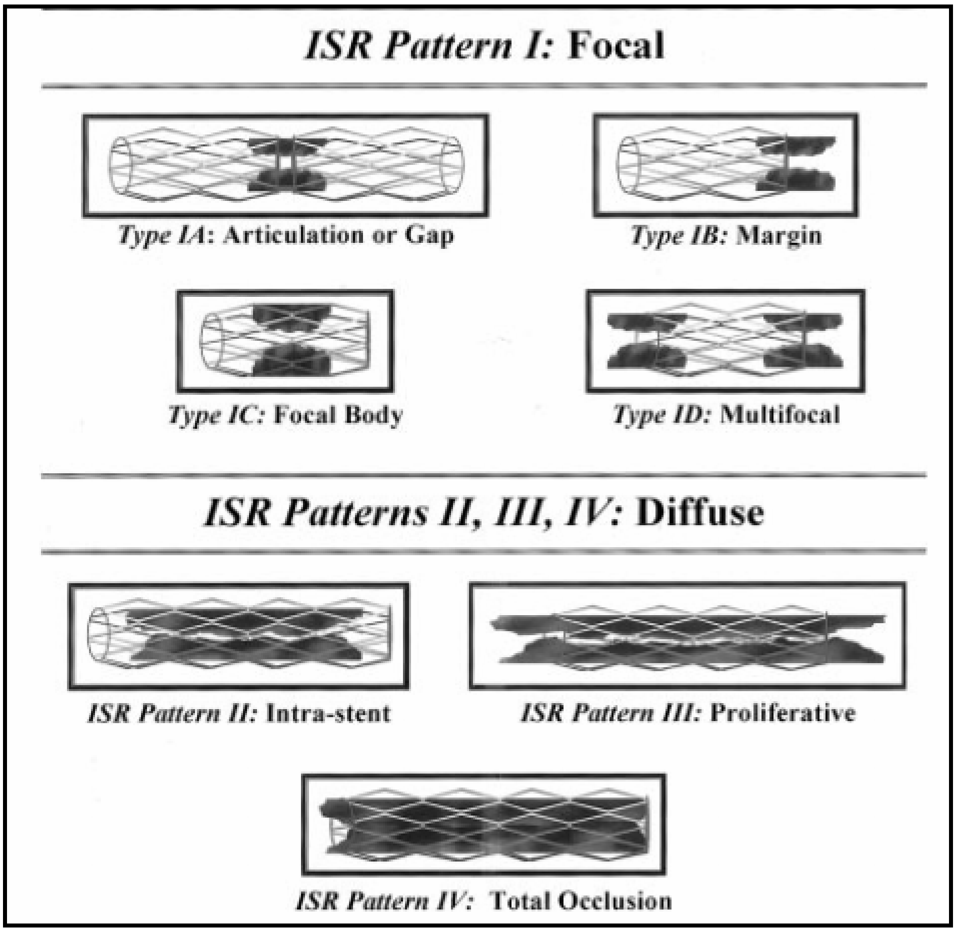

Fig. (1): Schematic image of 4 patterns of introduced classification of ISR in relation to previous dichotomous description of focal vs diffuse ISR. Pattern I contains 4 types (A-D). Patterns II through IV are defined according to geographic position of ISR in relation to previously implanted stent.