Chapter 5

Implications of Intracoronary Ultrasound Imaging for Clinical Practice

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ABSTRACT

Intracoronary ultrasound (ICUS) provides detailed microscopic imaging of coronary anatomy within a living patient. These images allow visualization of lumen, outer vessel wall, and plaque and give reliable information regarding the constitution of the plaque and the extent of the atherosclerotic disease. However, although it provides supplementary information to coronary angiography which may be useful in diagnosis and treatment planning, its clinical application is limited due to the additional expense, procedure time, and the risk of complication that ICUS examination carries. In this chapter, we review the literature and summarize the clinical indications of ICUS imaging in diagnostic and therapeutic procedures.

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INTRODUCTION

Coronary angiography constitutes the predominant imaging modality for portraying coronary artery morphology and anatomy, and guiding interventions. Its ability to provide in two dimensions (2-D) a holistic visualization of vessels’ silhouette and geometry allows direct assessment of the extent and severity of coronary atherosclerosis and provides valuable information for treatment planning. As the complexity of interventions has increased it has become apparent that coronary angiography has significant limitations. First of all due to its limited resolution coronary angiography cannot accurately estimate the severity of moderate lesions. In addition, it provides only 2-D images of the luminal silhouette and not the real 3-D anatomy of the vessel; a fact which renders it unreliable for assessing luminal narrowing in the cases of overlapping or foreshortened segments. Finally, it is unable to delineate the complex anatomy of a lesion and gives no data regarding the plaque load and the constitution of the atheroma information that are valuable to plan treatment and estimate prognosis (Kotani et al. 2003, Hong et al. 2004).

To overcome these limitations intracoronary ultrasound (ICUS) was introduced as a supplementary image modality to coronary angiography. This provides the interventional cardiologist with transverse cross sections of the lumen, stent and vessel wall and allows accurate assessment of plaque burden and identification of the constitution of the plaque. These additional data allow a more accurate assessment of coronary lesions and may offer potential advantages over coronary angiography for deciding appropriate therapy. This chapter focus on the clinical indications of ICUS imaging and is organized as follows: the background section discusses the controversies over the use of ICUS; the main section presents the current indications for ICUS in diagnostic angiography and in percutaneous coronary interventions (PCI) while in the future trends section, we explore the potential role of systems, which will allow automated ICUS processing in clinical practice.

BACKGROUND

Although ICUS is regarded as the gold standard for assessing coronary dimensions and evaluating coronary pathology it has a limited clinical applicability. Recent data from British Cardiovascular Interventional Society indicates that ICUS imaging is only available in 60% of UK PCI’s centers, and used in less than 2.5% of PCI procedures. This paradox has been attributed to the fact that ICUS examination is expensive, can be time consuming, requires additional radiation exposure and carries a small risk of complication such as coronary dissection or abrupt vessel closure (Hausmann et al. 1995). In addition, many interventional cardiologists avoid using ICUS since they are not familiar with it, and are unaware of the potential advantages of its use.

On the other hand, new developments in coronary intervention (e.g. drug eluting stents (DES), improved guidewires) have enabled more complex lesions to be amenable to PCI; a fact which has created a greater need for more detailed visualization of coronary pathology. Thus, over the recent past there has been an increased interest in the role of ICUS in clinical practice and a trend towards more frequent use.

Main Focus - Clinical Indications of ICUS Imaging

Utility of ICUS in Diagnostic Procedures

The conventional method for the evaluation of a lesion and for the quantification of coronary artery disease progress is quantitative coronary angiography (QCA). To validate the performance of QCA a number of studies have compared ICUS