# New Tissue Doppler Imaging Techniques For Evaluation of Myocardial Function

An essay submitted in fulfillment for master degree in anesthesiology


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# ***Abstract***

Although not limited by tethering, since measurements are in reference to myocardium and not to an immobile transducer, it is still subject to the Doppler angle limitation. Speckle tracking derives myocardial velocity in two dimensions from tracking of acoustic markers, produced by the interaction of ultrasound with tissue. Speckle tracking is not based on Doppler and measurements are independent from insonation angle and tethering.  In addition, it is automated and provides regional as well as global measurements. Both Doppler strain and speckle tracking are not found wide-spread acceptance in everyday clinical practice. Currently, if the limitations are taken into consideration DTI can be a helpful diagnostic modality, offering quick, real time insights into clinical diagnostic challenge.

**Key word:**

Myocardial Function-2D Strain-TDI- The transesophageal echo
anesthesiology- examination-DTI

# Contents

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **A** | Late mitral inflow |
| **A'** | Peak late diastolic mitral annular velocity |
| **ACC** | American College of Cardiology |
| **AFI** | Automated Function Imaging |
| **AHA** | American Heart Association |
| **AI** | Aortic insufficiency |
| **Am** | Late diastolic myocardial velocity |
| **ASA** | American Society of Anesthesiologists |
| **ASD** | Atrial septal defect |
| **ASE** | American Society of Echocardiography |
| **AV** | Aortic valve |
| **2C** | Two chamber |
| **4C** | Four chamber |
| **CABG** | Coronary artery bypass graft |
| **CDMI** | Color Doppler myocardial imaging |
| **CI** | cardiac index |
| **CFD** | Color flow Doppler |
| **CWD** | Continuous-wave Doppler |
| **2D** | Two-Dimension |
| **3D** | Three dimension |
| **DTI** | Doppler tissue imaging |
| **E** | Early mitral inflow |
| **E'** | Peak early diastolic mitral annular velocity |
| **EAE** | European Association of Echocardiography |
| **EF** | Ejection Fraction |
| **Em** | Early diastolic myocardial |
| **ESC** | European Society of Cardiology |
| **IABP** | Intra Aortic Ballon Pump |
| ***IC*** | Isovolumic contraction |
| ***IR*** | *Isovolumic relaxation* |
| **IVC** | Inferior vena cava |
| **LA** | Left atrium |
| ***LAD*** | *Left anterior descending* |
| **LAP** | Left atrial pressure |

| | |
|---|---|
| **LAX** | Long axis |
| ***LIMA*** | *Left internal mammary artery* |
| **LV** | Left ventricle |
| **LVEF** | Left ventricular ejection fraction |
| ***LVOT*** | Left ventricular out flow tract |
| ***ME*** | Mid esophageal |
| **MI** | Myocardial infarction |
| **MR** | Mitral regurge |
| **MRI** | Magnetic resonance imaging |
| **PCWP** | Pulmonary capillary wedge pressure |
| **PDA** | Patent dactus arteriosus |
| ***PSS*** | *Postsystolic shortening* |
| **PSS** | Postsystolic strain |
| **PV** | Pulmonary valve |
| **PWD** | Pulsed- wave Doppler |
| **PW-TD** | Pulsed-wave tissue Doppler imaging |
| ***RA*** | *Right atrium* |
| ***ROI*** | *Region of interest* |
| **RV** | Right ventricle |
| **RWMA** | Regional wall motion abnormalities |
| **S'** | Peak mitral annular systolic velocity |
| **SAX** | Short axis |
| **SCA** | Society of Cardiovascular Anesthesiologists |
| **Sm** | Systolic myocardial velocity |
| **STE** | Speckle-tracking echocardiography |
| **SR** | Strain rate |
| **STI** | Speckle-Tracking Imaging |
| **SVC** | Superior vena cava |
| ***TCV*** | *Tricuspid valve* |
| **TDI** | Doppler tissue imaging |
| **TEE** | Transesophageal echocardiography |
| **TG** | Transgastric |
| **TMF** | Transmitral flow |
| **TTE** | Transthoracic echocardiography |
| **VSD** | Ventricular septal defect |
| **VTI** | Velocity Tissue Imaging |
| ***VTI*** | Velocity time integral |

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## Introduction

There has been a substantial increase in the use of transesophageal echocardiography (TEE) in the last10 years. Much of this has been due to the increase in perioperative echocardiography in patients undergoing cardiac and major non-cardiac surgery, and intensive care. Knowledge and skills in echocardiography are now part of the fundamental training of not only cardiologists but also cardiac anesthesiologists and intensivists, and indeed are commonly acquired by all specialists who care for patients undergoing cardiac surgery[1].

The evidence supporting the indications for perioperative TEE has evolved over time. The lack of randomized controlled trials and meta-analyses has previously justified a cautious approach. The latest North American guidelines and European Guidelines have stated a number of recommendations regarding the perioperative echocardiography including the indications and contraindications. Most strikingly, they recommend that ‟ for adult patients without contraindications; TEE should be used in all open heart and thoracic aortic surgical procedures, and should be considered in CABG surgeries as well.″ [2, 3]

Accurate analysis of myocardial function is one of the most challenging aspects of modern echocardiography. The conventional techniques, including two-dimensional (2D) imaging, spectral and color-flow Doppler, are valuable and have stood the test of time, but these techniques have clear limitations. However, modern developments in Doppler imaging and myocardial velocity imaging represent a major advance in our ability to understand and to quantify myocardial function. Coupled with advances in 3D technology, these techniques represent significant progress, and promise much for the future [4].

Placing special emphasis on myocardial quantification, a number of technologies have been introduced, to overcome these limitations. These include pulsed-wave tissue Doppler imaging (PW-TDI), color Doppler myocardial imaging (CDMI), and speckle-tracking echocardiography (STE). All of these technologies are available in both transthoracic (TTE) and transesophageal echocardiography (TEE) [4].

TEE has become a well-established imaging modality. It has enabled the more accurate diagnosis of complex lesions in cardiology, and its use in the perioperative setting has had a marked impact on the development of cardiac anesthesia and surgery[1].

## Aim of Work:

The aim of this work is to introduce these recent developments, including PW-TDI, CDMI, and STE in evaluation of myocardial function by transesophageal echocardiography, outline their physical background, and discussing their main areas of application and their limitations.

# *Indications, Contraindications and Complications of Intraoperative Transesophageal Echocardiography*

**Indications of intraoperative transesophageal echocardiography**

The indications for TEE stated by European Society of Cardiology in (2001) were to identify sources of embolism, and to evaluate infective endocarditis, aortic aneurysm and aortic dissection, mitral regurgitation, and prosthetic valves. However, they also noted that the indications for TEE were constantly increasing ,and that frequently TEE was undertaken in circumstances where transthoracic echo had failed to provide sufficient information in an individual patient[5].

In contrast, perioperative TEE is undertaken as a stand-alone procedure, although there is a high likelihood that many patients will have received a preoperative transthoracic (TTE) examination at some point .The first report on the indications for perioperative TEE was published in 1996 by the American Society of Anesthesiologists (ASA) and the Society of Cardiovascular Anesthesiologists (SCA)[6]. In these guidelines, they addressed the indications for TEE based on the level of evidence supporting their use, and also the proficiency of those carrying out the examination.

In 1997 the American College of Cardiology (ACC) and the American Heart Association (AHA) published guidelines for the clinical application of Echocardiography [7]. These guidelines referred to the overall