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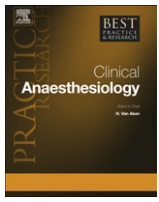

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# Ultrasound use in non-cardiac surgery

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Ultrasound is used in anaesthesia for diagnostic and interventional reasons. This article gives the anaesthesiolgoist an overview about the relevant indications for ultrasound in non-cardiac surgical patients. Other chapters will focus in more detail on different aspects of ultrasound use in non-cardiac anaesthesia.
Echocardiography is a monitoring tool for cardiac structures and function. In the anaesthetized patient the transoesophageal approach is preferred due to the unrestricted ultrasound view to the heart. Its use for non-cardiac surgery is discussed.
The use of transcutaneous ultrasound in anaesthesia is mainly interventional: The puncture rate for vascular access e.g. central venous catheterization is higher and the procedure can be performed safer under continuous sonographic guidance.
Nerve blockade under direct visualisation of target and accompanying structures has amplified the regional anaesthetic methods. The major nerve blocks are described and discussed.


## Introduction

Modern anaesthesia bears a huge number of indications for ultrasound. In contrast to all competitive radiologic techniques its benefits are the maximum of mobility and the absence of potentially dangerous radiation. While other specialities routinely are using ultrasound as a diagnostic tool and guidance of therapeutic procedures, in non-cardiac anaesthesia ultrasound was introduced in the last decade. This review will give a short overview of the most interesting applications of ultrasound in the anaesthesia arena.

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Using sonography intraoperatively the anaesthesiologist focuses on functional changes. Major indications are cardiac wall motion abnormalities, detection of embolic or thrombotic structures, changes in flow patterns or ventricular filling and function.

By using ultrasound preoperatively the diagnostic result may lead to substantial changes in the anaesthetic management. Typical examples for relevant findings are a patent foramen ovale for neurosurgical anaesthesia or vascular or neural anatomic variations influencing the approach to vascular access or peripheral nerve blocks. Ultrasound guided vascular access and regional anaesthesia are constantly gaining importance in anaesthetic practise. The visualisation of the target and the accompanying structures can improve the success rate and safety of each puncture attempt. This article highlights the relevant indications for the use of ultrasound as a monitor tool and for ultrasound guided vascular access and regional anaesthesia.

*History of ultrasound in medicine*

Ultrasound in medicine has a short history. The first technical application of ultrasound waves was described in 1912. Behm used the reflection of the sound waves for the identification of hidden targets and barriers in the sea. In 1950 Howrey and Bliss were the first who developed a compound ultrasound scanner, but it took time to 1967 when the Gynecologist I. Donalds developed the first handheld ultrasound probe. The scans provided a two dimensional (2D) picture of the addressed structures. 1954 Edler and Hertz used ultrasound for cardiologic diagnostic procedures. Their ultrasonic reflectoscope was able to depict cardiac wall motion and the valve leaflets. This technique provided an M-mode picture. Combined with the electrocardiogram important cardiac morphologic and diagnostic information were found. The cardiologic application of ultrasound was of major interest for anesthesiologists. Transthoracic (TTE) imaging of the heart is of limited value in ventilated patients due to difficult ultrasound windows. 1985 the first esophageal ultrasoundprobes were clinically usable positioning the transducer directly behind the heart. In the cardiac operating rooms transoesophageal echocardiography (TOE) was introduced around 1990. Main indications for its use were surgical procedures involving the mitral valve, aortic dissections and complex cardiac surgery. The online monitoring of cardiac function, intraoperative determination of cardiac output, detection of hypovolemia or the intraoperative detection of air embolism as substantial determinants of TOE diagnostics were described already in the 1980's.[1–5]

The first anaesthesiology publication describing 2D ultrasound for central venous access is from 1987.[6] The superiority of ultrasound guided cannulation of the internal jugular vein to landmark guided puncture is demonstrated in several studies.[7] In 2002 the National Institute of Clinical Excellence (NICE) in Great Britain gave a strong recommendation to use ultrasound for central venous access.[8]

In regional anaesthesia the application of ultrasound became a topic of major interest in the last five years. The first use of sonography for regional anaesthesia dates to 1989 when Ting described the spread of local anaesthetic (LA) in brachial plexus block.[9] The identification of neural structures improved with the development of ultrasound technology. High frequency probes reduce the lateral and axial resolution and lead to better visualisation of details. To date the advantages of ultrasound guided nerve blocks are based on the identification of the targets and the visualization of the LA during injection.

## Echocardiography: TOE/TTE

To provide a maximum of safety even in patients with relevant risk factors cardiovascular monitoring is of utmost interest in anaesthesia. The measurement of central venous, pulmonary arterial and arterial blood pressure gives only restricted information about cardiac function. Addition of thermo- or dye dilution methods is necessary to gain information about vascular flow pattern.

TOE is a minimally invasive diagnostic tool that is easily and quickly inserted, has a low complication rate and provides real-time 2D images of the heart and the great vessels. It also allows estimation of volumes, ventricular function, and cardiac filling pressures. The obtained information can be used to diagnose, treat and follow critical cardiac events during the intraoperative period. TOEs benefits and usefulness are well established for cardiac surgery. The only Class 1 indication in non-cardiac anaesthesia is the evaluation of acute, persistent and life-threatening haemodynamic disturbances not