Delta Press Indicator: A New Device For Adjustment And Monitoring Hemodynamic Pressure Transducer Position

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Citation

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Abstract

Proper placement of blood pressure transducers to patient's heart level is essential for invasive pressure measurement. This is particularly important during the measurement of low-pressure parameters such as central venous pressure, pulmonary artery pressure or intracranial pressure.

The Delta Press Indicator is a new device for set-up and continuous control of blood pressure transducer position. A transducer holding device has integrated a reference pressure sensor connected to a water filled reference tube, which is attached to the patient's heart level. The hydrostatic pressure difference between the patient's heart level and the blood pressure transducer zero level is computed from the hydrostatic pressure of the water column in the reference tube and indicated by a numerical display. It allows to adjust the transducer holding device in a simple and rapid manner to the patient's heart level.

Further changes of the patient or the transducer position are shown by the numerical display and are indicated by a visual and acoustical alarm system.

INTRODUCTION

Setting pressure transducers to patient's zero reference level is an important step in invasive pressure measurement. Usually, blood pressure transducers are aligned with a chosen reference point in supine patients, the midaxillary line for the right atrium ([1]). Difficulties with placement and displacement of external blood pressure transducer systems in the operation room, intensive care unit or in the cardiac laboratory can cause measuring errors from overlaying hydrostatic pressure components ([2]). This is particularly important during the measurement of low-pressure parameters such as central venous pressure, pulmonary artery pressure and intracranial pressure.

Different techniques and devices have been reported for compensating any overlaying hydrostatic pressure components (2,[3],[4],[5],[6],[7]).

A "Self-levelling venous pressure transducer" has been reported by Blackburn 1968 using a differential pressure transducer which has two measuring limbs (3). The reference limb is an open-ended water-filled tube which is attached to the patient's heart reference point. The other side of the transducer diaphragm is connected to the intravenous catheter in the usual way. Changes in the position of the patient affect both the venous and the reference catheter equally, so the measured pressure is always related to the reference catheter and the transducer need not be moved. Recently, the so-called "Compensator"-Transducer (SCHNEIDER/NAMIC - Glens Falls/NY) has been presented working with a similar concept (5).

Another group of hydrostatic pressure compensating devices incorporates a reference pressure sensor measuring the hydrostatic pressure difference between heart level and blood pressure transducer using a water-filled reference tube attached to the patient's heart reference point (2,6,7). The hydrostatic pressure difference is automatically subtracted from the electrical blood pressure signal in an electronic subtraction circuit. The electronically compensated blood pressure signal is transfered to the vital sign monitor.

Although these devices may facilitate hemodynamic pressure monitoring, direct modulation of the blood pressure transducer signal by an electronic compensation circuit or by a differential pressure transducer carries some risks. Electrical interference with the blood pressure transducer signal or monitoring system, zeroing problems respectively misunderstandings or unrecognized displaced reference line may lead to errors in blood pressure measurement. Furthermore, any pressure changes measured in the reference line due to tube vibrations or patient movements from coughing, breathing or raising the arm are directly transmitted to the monitor screen, which may lead to a virtual display of blood pressure data.

Therefore, I designed a transducer holding device with integrated hydrostatic pressure difference display system, only indicating, but not compensating the hydrostatic pressure difference.

INSTRUMENTATION / PRINCIPLE

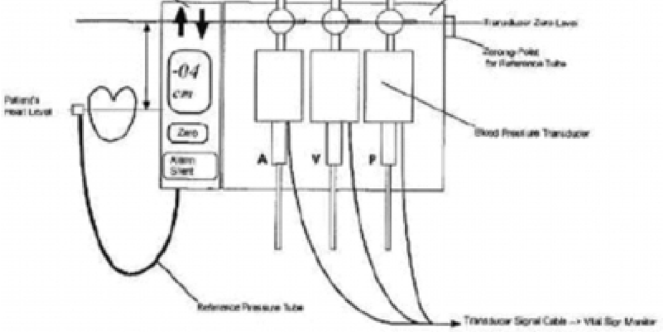
A transducer holding device incorporates a reference pressure sensor connected to a water-filled polyvinyl tube (100 cm long and 1 mm internal diameter). The distal end of the reference tube is opened to atmospheric pressure and is attached with a distal tube connector to the patient’s lateral thoracic wall at the heart level .

The hydrostatic pressure difference between the distal tube tip and the blood pressure transducer zero level is measured by a reference pressure sensor. The pressure difference is computed and indicated by a numerical display. Positive pressure values mean “transducer position to high” and vice versa negative pressure values indicate “transducer position to deep”. Flashing arrows indicate the direction of vertically moving the holding device until the pressure difference is zero.

Pressure differences of more than 2 cm are additionally indicated by a visual and an acoustical alarm system, which can be turned off for 5 minutes.

Figure 1

Figure 1: Delta Press Indicator



USE OF THE DEVICE

1) Preparing the reference system

The reference system is filled with water or physiologic saline solution up to the distal end of the reference tube.

2) Zeroing of the reference system

The distal tip of the reference tube is attached to the transducer holding device at the zeroing point (Fig. 1). Then, the reference system is zeroed by pressing the “zero” switch for > 3 seconds.

3) Adjusting the transducer holder bank

An ECG electrode is attached to the patient’s heart level reference at the lateral thoracic wall. The distal reference tube connector is attached to the ECG electrode like an ECG cable. The hydrostatic pressure difference between the blood pressure transducer zero level and patient’s heart level is indicated on the display. The transducer bank is vertically adjusted until the pressure difference is “zero”, indicated by the display.

4) Zeroing of the blood pressure transducer system

Finally the blood pressure transducers are zeroed as usual by opening the stop cocks to atmospheric pressure and activation of the monitor zeroing process for each blood pressure transducer.

5) Monitoring the transducer position

The pressure difference between the patient’s heart level and the transducer zero level is continuously monitored and any changes are indicated by the display and hydrostatic pressure differences more than 2 centimeters are indicated by an alarm system.

DISCUSSION

Delta Press Indicator (DPI) allows rapid, simple and reliable positioning of blood pressure transducers to the patients heart level only by vertically moving the pressure transducer holder until the display indicates “zero”.

In contrast to the above mentioned compensating devices, with the DPI the hydrostatic pressure difference is only indicated by a display and the electrical blood transducer signal remains unchanged. Thus, there are no electrical interferences between the reference system and the blood pressure measuring system. Furthermore, the zeroing process remains simple and independent from the other system and hydrostatic pressure changes from a displaced or a moving reference tube are not directly transmitted to the vital sign monitor. There are no black box situations” with the DPI, because visual control of the blood transducer position rapidly allows to exclude any levelling errors, whenever measured blood pressure data are questionable.

Changes of the blood pressure transducer position or of the patient position are not uncommon and levelling must regularly be repeated. Often, hydrostatic pressure differences remain unrecognized until to next routine transducer position control or until the blood pressure transducer level is re-adjusted because of unbelievable pressure data.

After initial transducer set-up, the DPI indicates immediately further hydrostatic pressure differences over 2 centimeters by the numerical display and an additional alarm system. The Delta Press Indicator allows continuously monitoring the blood pressure transducer position in a simple manner and rapid re-adjustment of the holding device.

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