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Use of the Nexfin™ device to detect acute arterial pressure variations during anaesthesia induction

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Editor's key points

- Continuous measurement of beat-to-beat arterial pressure (AP) during the dynamic phases of anaesthesia facilitates recognition and treatment of acute variations.
- The non-invasive AP monitor Nexfin™ was compared with invasive AP (IAP) measurements during induction of anaesthesia.
- Nexfin™ reliably and quickly detected acute changes in AP, but its accuracy was insufficient to replace IAP monitoring.

Background. Standard non-invasive arterial pressure (AP) measurements are discontinuous. By providing non-invasive beat-to-beat AP measurements, Nexfin™ might limit duration of intraoperative hypotension and hypertension. We assessed the ability of Nexfin™ to detect AP variations by comparing its trending ability with invasive AP monitoring.

Methods. Thirty-one subjects undergoing elective surgery under general anaesthesia were included. During induction, simultaneous pairs of AP measurements were collected every 5 s from the Nexfin™ finger sensor and a homolateral radial artery catheter. Magnitude and time lags of AP variations from baseline to nadir and peak were calculated for both methods. Concordance analysis was performed by the Bland–Altman method (for comparison of repeated measures when appropriate).

Results. Nexfin™ detected 100% of AP changes with the median delays of 0 s (−13 to 7) and 0 s (−5 to 12) for nadir and peak, respectively. Bias [limits of agreement (LOA)] of systolic AP (SAP) variations was −0.5 mm Hg (−31.2 to 30.2) and −9.4 mm Hg (−31.3 to 12.6) from baseline to nadir and from baseline to peak, respectively. For 3479 analysed paired measurements, bias was −3.8 and −8.8 mm Hg for SAP and diastolic AP, with LOA of (−36.0 to 28.5) and (−29.8 to 12.3), respectively.

Conclusions. Nexfin™ detects AP variations accurately and can be a useful warning device during anaesthesia. However, it is not interchangeable with invasive monitoring, given the large LOA between the two measurements.

Clinical trial registration. NCT01658631.

Keywords: anaesthesiology; arterial pressure monitors; monitoring, intraoperative

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During general anaesthesia, invasive arterial pressure (IAP) monitoring remains a standard of care in high-risk patients or in the case of high-risk surgery. In other cases, that is, most of the anaesthetic cases, arterial pressure (AP) is measured every 3–5 min, using an oscillometric AP device as recommended by the ASA[1] and the Association for Advancement of Medical Instrumentation (AAMI).[2]

Devices allowing continuous beat-to-beat non-invasive measurement of AP (NIAP) could be particularly useful in a large proportion of patients who experience unpredictable anaesthesia-induced haemodynamic disturbance. Such devices based on the volume-clamp method were developed many years ago[3] and used particularly for physiological studies.[4 5] More recently, several have been introduced for routine use during anaesthesia and intensive care. Among them, the Nexfin™ (BMEYE B.V., Amsterdam, The Netherlands), using photoplethysmographic technology, provides non-invasive beat-to-beat AP readings via a single finger-cuff and is easy to use.

While the induction period of anaesthesia is associated with higher risk of unstable AP than the maintenance period, validation studies of Nexfin™ in children[6 7] and adults[8–11] were performed during the whole period of anaesthesia, that is, induction and maintenance. Consequently, concordance between the reference method and Nexfin™ was biased because the maintenance period (with less acute variations of AP) represented much more data than the induction period.

Thus, the aim of the present study was to specifically compare NIAP values measured with Nexfin™ and IAP values obtained by an arterial line during general anaesthesia induction.

Methods

Subjects

After institutional approval of the Ethics Committee (CPP Ile de France XI, reference 10051) and written informed consent, all consecutive adult patients managed exclusively by E.W. or

V.D.-N., undergoing major surgery at Foch Hospital (Suresnes, France) under general anaesthesia and requiring continuous IAP monitoring because of their comorbidities or high haemorrhagic risk, were prospectively included from November 2011 to June 2012. Exclusion criteria were as follows: (i) age under 18, (ii) body weight <40 or >180 kg, and BMI >35 kg m^{-2}, (iii) history of Raynaud syndrome and related diseases, cardiac arrhythmia, or vascular surgery of upper extremities, (iv) propensity to hand ischaemia in the presence of radial arterial obstruction as evidenced by a positive Allen test (defined clinically as a lack of return of colour within 7 s after the release of ulnar artery compression or by using a Doppler as a lack of palmar arcade flow detection, while the radial artery is compressed).

Nexfin HD technique

The Nexfin™ is a non-invasive beat-to-beat AP measurement device based on the so-called 'vascular unloading' principle. Finger cuff pressure is continuously adjusted through the systolic AP (SAP) and diastolic AP (DAP) cycle so that the blood volume flowing through the finger arteries is held constant. Thus, cuff pressure is used to indirectly measure finger AP and an algorithm converts the raw beat-to-beat finger AP into brachial AP.[12]

Study protocol

All subjects were orally premedicated with hydroxyzine (1 mg kg^{-1}) 1 h before the induction of anaesthesia. Upon admission in the operating theatre, standard monitoring was applied and a 20 G intra-arterial catheter (Leadercath 20G, Vygon, Ecouen, France) was inserted in the non-dominant arm radial artery under local anaesthesia. The catheter was then connected, using standard low compliant tubing, to a disposable pressure transducer (Edwards Lifesciences, Irvine, CA, USA) and placed at the heart level with the patient in the supine position. The transducer was first zeroed to ambient air pressure, and the line was subsequently flushed with a 300 mm Hg pressurized bag of normal saline to remove air bubbles. To test the adequacy of the pressure monitoring system, a rapid flush test was performed as described by Gardner[13] and Kleinman and colleagues.[14] With this test, an under-damped (extra oscillations) or over-damped (slowed upstroke and loss of

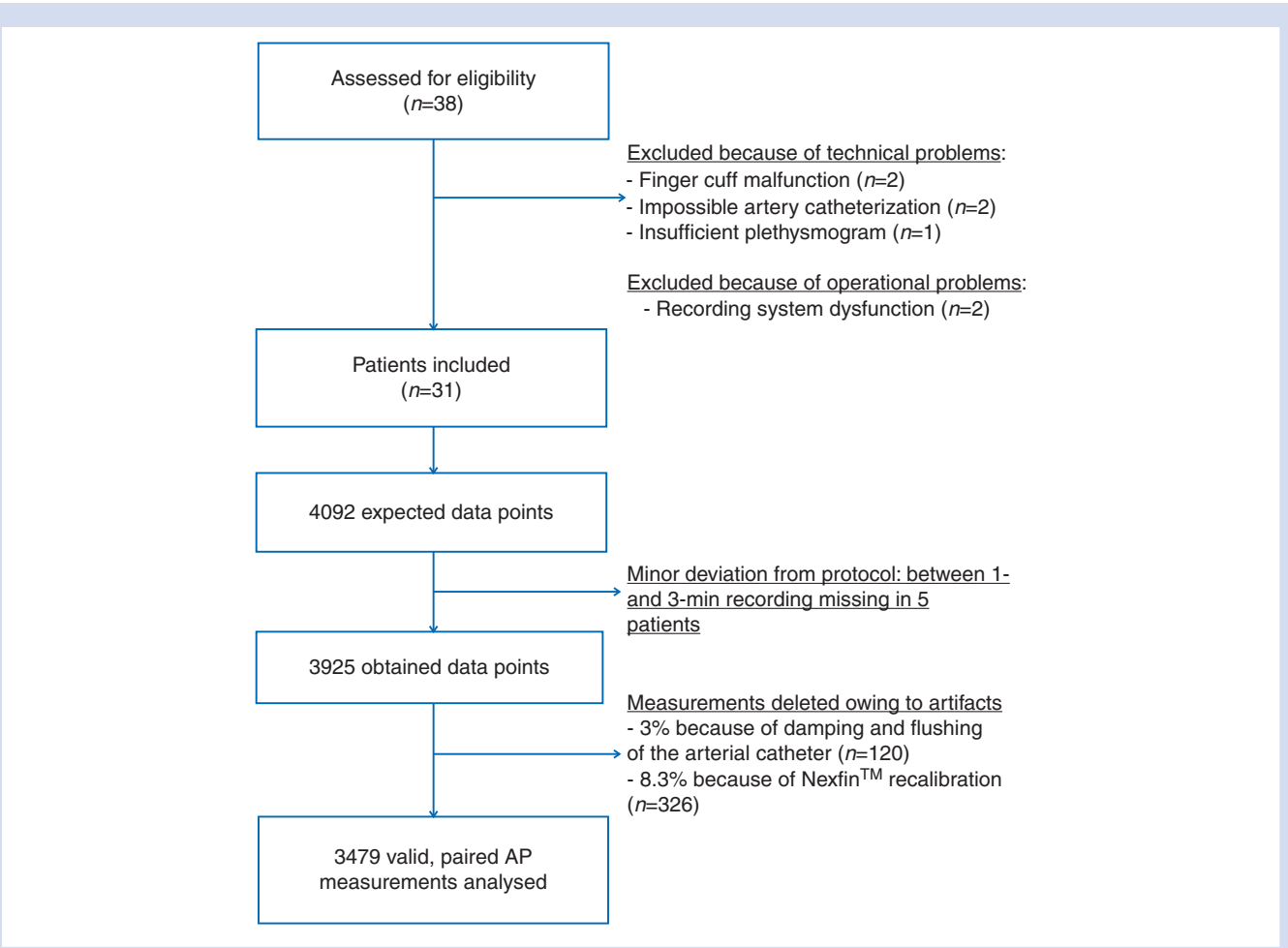

Fig 1 Flow chart. Each stored AP value represents an average of all AP values measured over the previous 5 s period.