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Femoral arterial and central venous catheters in the trauma resuscitation room

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ABSTRACT

Background: Arterial and central venous femoral catheters (fAC-CVC) use during the initial management of severe trauma patients is not a standard technique in most trauma centers. Arguments in favor of their use are: continuous monitoring of blood pressure, safe drug administration, easy blood sampling and potentially large bore venous access. The lack of evidence makes the practice heterogeneous. The aim of the present study was to describe the use and complications of fAC-CVC in the trauma bay in two centers where they are routinely used.
Methods: This was a retrospective analysis of routine fAC-CVC use from two French trauma centers. All patients admitted directly to the trauma resuscitation room were included. Demographic, clinical and biological data were collected from the scene to discharge to describe the use of catheters during initial trauma management including infectious, mechanical and thrombotic complications.
Results: 243 pairs of femoral catheters were inserted among 692 patients admitted in both trauma centers. Femoral AC-CVC use was more frequent in critically ill patients with higher ISS 26 [17; 41] vs 13 [8; 24], $p < 0.001$ (median [quartile 1–3]), severe traumatic brain injury (AIS head 1[0–4] vs 0[0–3], $p < 0.001$), lower systolic blood pressure, 92 (37) vs 113 (28) mmHg, $p < 0.001$ mean (standard deviation), lower haemoglobin on arrival, 10.9 (3) vs 13.3 (2.1) g/dL ($p < 0.001$), and higher blood lactate concentration, 4.0 (3.9) vs 2.1 (1.8) mmol/L ($p < 0.001$). In patients with fAC-CVC use time in the trauma room was longer, 46 [40;60] vs 30 [20;40] minutes ($p < 0.05$). In total 52 colonizations and 3 bloodstream infections were noted in 1000 catheter days. An incidence of 12% of mechanical complications and of 42% deep venous thromboses were observed. Of the latter none was associated with confirmed pulmonary embolism.
Conclusion: Femoral AC-CVC appeared to be deployed more often in critically ill patients, presenting with shock and/or traumatic brain injury in particular. The observed rate of complications in this sample seems to be low compared to reported rates.

Introduction

The use of arterial catheter and central venous catheter (AC-CVC) in the trauma bay for the management of major trauma patients is not widespread, although some reports suggest their usefulness [1,2]. They allow continuous and reliable monitoring of blood pressure, safe drug and vasopressor administration, easy blood sampling and large bore venous access for high volume resuscitation [3–5]. Nevertheless, the absence of evidence and data on the subject does not allow formulating a concise recommendation on their role in the management of major trauma patients. The ATLS course proposes the introduction of a central venous catheter for “unstable patients”, but does not precise the conditions, the timing or the anatomic site, and no recommendation exists on the

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invasive arterial pressure catheter [6]. As a consequence, practices are heterogeneous with regard to their use and the morbidity associated with AC-CVC use in the trauma bay has not been assessed. Compared to the sub-clavicular or jugular site, cannulation at the femoral site offers the technical ease of use and relative safety in a resuscitation situation while other operators can still access the patient to perform concurrent interventions. For this reason, femoral AC-CVC use has been adopted into routine use in many resuscitation protocols in particular in trauma centers.

Given the lack of data and evidence on this practice in general, the aim of the present study was to describe the routine use and complications of femoral AC-CVC (fAC-CVC) cannulation during initial resuscitation in two trauma centers where fAC-CVC are part of the resuscitation protocol.

Material and methods

This retrospective study was carried out in two French university hospitals, Hôpital Beaujon and Hôpital Bicêtre, between January 1st and December 31st, 2011. Both participating centers are designated regional trauma centers within the Paris region with a population of around 12 million inhabitants. The trauma system and pre-hospital management has been described in detail in Hamada et al., 2014 [7]. The institutional review board (Comité d'Ethique et d'Evaluation de la Recherche Biomédicale, no. 11–115) approved the study and waived the need for informed consent.

Trauma management

All patients directly admitted to the trauma resuscitation room of the participating hospitals were included in the study. Secondary admissions and patients who arrived in cardiac arrest were not included.

The diagnostic and therapeutic strategy in the trauma bay was left to the discretion of the senior experienced trauma leader in charge of the patient. All patients were supposed to be managed according to the current European guidelines and international standards of care for major trauma patients:

- Management by a designated trauma team, standard operating procedures, damage control principles if indicated, specified transfusion protocol.
- Focused and extended ultrasound examination including pleura, abdomen, pelvis, pericardium, and identification of vessels for central line placement [8]. In cases of suspected traumatic brain injury, a transcranial Doppler to determine the diastolic blood velocity in the mean cerebral artery $<20\ cms^{-1}$ and a pulsatility index >1.4 were interpreted as a high probability of increased intracranial pressure and induced immediate therapeutic measures [9].
- Fluid challenge and vasopressor support to maintain a systolic blood pressure (SBP) between 80 and 100 mmHg [10]. For patients presenting with severe traumatic brain injury (TBI, Glasgow Coma Scale ≤ 8), a SBP above 120 mmHg was targeted [10].
- During active hemorrhage, haemostatic resuscitation was based on administration of red blood cells (RBC), fresh frozen plasma (FFP) in a ratio of 1:1 to 2:1 and platelet transfusion associated with fibrinogen concentrate and systematic use of tranexamic acid.
- Secondary survey according to ATLS guidelines followed by whole body computed tomography scan (CT scan) [6].
- Thromboembolic prophylaxis started 6 h after correction of coagulation disorders and/or after the end of surgery. In case of TBI, anticoagulation started after a renewed cerebral CT scan (usually between 48 and 72 h).

The decision to make use of fAC-CVC was based on clinical gestalt [11] of the attending physician and could be taken prior to the arrival of the patient, based on information available from the trauma pre-alert. The lines for the arterial and central catheter were prepared in a sterile manner by a trained trauma nurse before the arrival of the patient. The site of insertion was femoral in all reported cases with a simultaneous insertion of the arterial and venous cannula, as a "package" [12]. The arterial catheters used in both centers were 5Fr, 11 cm PVC catheters and venous catheters were adapted to the clinical situation. According to Poiseuille's law, short length and large bore are efficient for rapid resuscitation and high flow rates (choice of 9Fr, 10 cm) whereas long catheters with small diameter are more appropriate for safe drug administration (choice of 7Fr, 20 cm 3 lines catheters). Catheter insertion was performed either by a resident in training, under supervision by a consultant intensivist (trauma leader) or by a consultant intensivist. In both centers, the catheters inserted in the emergency setting of the trauma room were supposed to be withdrawn within the first 48 h. Ultrasound was not systematically performed to identify the vessels for insertion but always available.

Data collection

Since 2010, the clinical files of trauma patients were standardized in both hospitals to allow a reproducible and homogenous data collection. Demographic and clinical data were collected from scene to discharge. The Abbreviated Injury Scores (AIS) for each region, Injury Severity Score (ISS), and Simplified Acute Physiology Score (SAPS II) were calculated after anatomic and physiologic assessments had been completed. An ISS >15 defined 'major trauma' [13]. A Glasgow Coma Scale ≤ 8 and AIS head ≥ 2 defined patients with 'severe TBI'. Vasopressor infusion or hypotension (systolic blood pressure <90 mmHg) upon arrival in hospital defined patients in 'Shock'.

For all patients receiving fAC-CVC in the trauma bay, complications were systematically assessed and classified. Only the emergency catheters inserted during the initial management in the trauma resuscitation room and before the CT scan or the theatre were analyzed. Infectious complications included arterial or venous catheter colonization defined as a positive catheter tip culture ($>10^3$ colony-forming unit [CFU]/mL) and no clinical symptoms. Catheter infection was defined as a positive culture of the catheter tip and local or systemic clinical symptoms. Catheter-related bloodstream infections were defined as presence of a positive catheter tip culture associated with secondary bacteremia over 48 h before or after catheter withdrawal, due to the same bacteria and in the absence of another focus of infection with the same bacteria [14]. Infectious complications were expressed as per 1000 catheter days. When catheters were withdrawn, they were sent for culture to the microbiology laboratory only if catheter-related sepsis was suspected.

Thrombotic complications included femoral or iliac venous thrombosis. Mechanical complication included, hematoma (if diameter >20 mm), arterial dissection, arterio-venous fistula, *trans*-arterial positioning of venous catheter and air in the hepatic veins. These complications were all identified by a systematic review by a senior radiologist (MR) of all the CT scans following admission of the patients.

Endpoints

The primary endpoint was the description of the use of femoral AC-CVC (fAC-CVC) in the trauma resuscitation room.

Secondary endpoints were the prevalence of complications related to fAC-CVC: infectious (colonization, blood stream infection), thrombotic and mechanical complications, and the time spent in the trauma resuscitation room for patients.

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