ABSTRACT

Optimal pain management is challenging in Tactical Combat Casualty Care (TCCC), particularly in remote and austere settings. In these situations, appropriate treatment for prehospital analgesia can be limited or delayed due to the lack of intravenous access. Several guidelines suggest to implement intranasal (IN) analgesia in French Armed Forces for forward combat casualty care (Sauvetage au Combat), similar to the US TCCC. Four medical teams from the French Medical Military Service were deployed to the Middle East and Sahel from August 2017 to March 2019 and used IN ketamine for analgesia in 76 trauma patients, out of a total of 259 treated casualties. IN administration of ketamine 50mg appeared to be safe and effective, alone or in addition to other opioid analgesics. It also had minimal side effects and led to a reduction in the doses of ketamine and morphine used by the intravenous (IV) route. The French Military Medical Service supports current developments for personal devices delivering individual doses of IN ketamine. However, further studies are needed to analyze its efficacy and safety in combat zones.

KEYWORDS: military medicine; casualties; intranasal; ketamine; prehospital analgesia

Introduction

Optimal pain management is challenging in tactical combat casualty care, particularly in remote and austere settings. In these situations, appropriate treatment for prehospital analgesia can be limited or delayed because of the lack of intravenous (IV) access. To cope with such problems, the intranasal (IN) route might be useful for pain control, as it is both rapid and non-invasive. Although it has long been a well-known technique, its use is uncommon, especially for war casualties. The onset and efficacy of drugs delivered by the IN route depend on absorption across the nasal mucosa. This absorption is determined by three factors: the size of the droplets (depending on the device used), pH, and drug lipo-solubility. Many drugs can be administered by the IN route, but three of them are very interesting for analgesia: ketamine, sufentanil, and fentanyl. Ketamine is a dissociative anesthetic agent and analgesic that has several applications in the wilderness setting. In smaller doses, it can be used either alone or in combination with opioids to enhance pain control. Ketamine is well-known by military physicians because it is reliable and efficient in controlling acute pain on the battlefield. At doses of 0.5mg-0.75mg/kg, IN ketamine is considered as a rapid and effective drug for acute pain control in civilian emergency departments. Several procedures have been proposed to implement IN analgesia in the French Armed Forces for forward combat casualty care, similar to the Tactical Combat Casualty Care (TCCC). However, there is still a paucity of information in the literature on the IN route for prehospital analgesia. Four medical teams from the French Medical Military Service were deployed in the Middle East and the Sahel from August 2017 to March 2019 and used IN ketamine for analgesia in trauma patients. The objective of this case series is to report the prehospital use of IN ketamine for analgesia in penetrating trauma patients.

Materials and Methods

Study Setting

French Armed Forces have been deployed in military overseas operations in the Sahel and the Middle East for several years. The doctrine of medical support during French military operations is based on a triptych: forward medical stabilization with damage control resuscitation, damage control surgery, and early strategic aeromedical evacuation. Very large zones, such as the Middle East or the Sahel, impose extremely long delays for evacuations with fixed or rotary wings. This medical chain begins with the field medical team (Role 1) and continues with a first light surgical structure (Role 2), continuing the damage control strategy. As French and coalition military casualties are then evacuated to a Role 3 or 4, civilians and local forces casualties are usually evacuated to local hospitals for definitive treatment. Regarding pain management in combat zones, every soldier has in his combat first aid kit two 10-mg morphine subcutaneous (SC) auto-injector devices. IV morphine titration is often impossible at the point of care and may be performed sometimes 30 minutes or one hour later. In such austere conditions, the IN route for analgesia appears to be a good solution.
Study Population
As part of a deployment in the Middle East, medical teams from the French Military Medical Service were deployed for 4-month rotations from August 2017 to March 2019. These medical teams experienced care of multiple combat casualties, close to the frontline settled in Role 1 casualties' collection points (CCP) in austere conditions. They took care of French, coalition, or local forces, civilians, and even wounded enemies. To perform early and quick analgesia, those medical teams sometimes used the IN route with the Mucosal Atomization Device (MAD) nasal device. Adapted for use with a syringe, the MAD nasal device (Teleflex, https://www.teleflex.com/usa/en/product-areas/anesthesia/atomization/mad-nasal-device/index.html) provides better bioavailability due to atomization of 300-μm droplets. This MAD nasal device was used for administration of IN ketamine prepared in a Luer Lock type syringe containing 50 mg/mL. Contraindications for the use of the IN route for ketamine administration were unconsciousness and craniofacial trauma. For this series due to the language barrier, which mostly comprised Kurdish or Malian casualties, the medical teams did not use a numeric rating scale (NRS) to evaluate and monitor pain severity. Instead, the medical teams used the Wong-Baker Faces Pain Rating Scale (W-BFPRS) from 0 to 10 before and 10–15 minutes after administration of analgesia. Patients presenting penetrating or blast trauma and W-BFPRS >7 were retrospectively included. They were treated either with regular analgesia protocol including opioids (SC/IV Group) or with IN ketamine 50mg at the Role 1 CCP, before placement of a peripheral venous access (IN group). This IN ketamine 50mg dose was administered alone, or concomitantly with a SC morphine 10mg injection from the personal first aid kit by a combat medic. Pain was considered as controlled with W-BFPRS < 3. If necessary, IN analgesia was completed with IV medications (ketamine or opioids). The forward medical card was filled out by the physician at the point of care, and statistical analysis was performed retrospectively. Patients with an uncompleted casualty card (lack of dose, route, or W-BFPRS, or without analgesia needed) were excluded.

This retrospective study has been successfully submitted to the French health service ethical committee (Comité d’évaluation éthique de la direction de la formation, de la recherche et de l’innovation (C2E-DFRI)).

Results
Two hundred fifty-nine patients were treated in Role 1 over the study period (16 civilians and 243 soldiers). One hundred and forty patients were included retrospectively in the study (Figure 1). Inclusion criteria were W-BFPRS >7 and fully completed casualty card (lack of dose, route, or W-BFPRS, or without analgesia needed) were excluded. Improvised explosive device (IED) was the main mechanism of injury (Figure 2). The average Injury Severity Score (ISS) (based on the square of the three highest Abbreviated Injury Scale (AIS) scores from 1 to 6) was 22.2 (Min: 1; Max: 75). In the IN group, the average ISS was 28.2 (Min: 1; Max: 75) and in the SC/IV Group was 16.4 (Min: 1; Max: 75). In the IN group, for 59 casualties (77.6%), W-BFPRS was < 3 after 10 minutes and did not need IV access for analgesia. Nine were treated with IN ketamine alone, and 50 received SC morphine 10mg at the same time (Table 1). Only one minor complication was observed (<1.3%): a psychodylsyptic phenomenon with dizziness, which was successfully treated with another dose of ketamine. Additional doses of IV morphine and IV ketamine were lower in the IN group than in the SC/IV group to reach W-BFPRS < 3 (Table 2).

Discussion
This case series reports the use of IN ketamine for pain management of combat casualties, with satisfying results: a high rate of efficacy, without significant side effects. With IN administration, ketamine is detectable in the blood after two minutes.13 A maximum concentration is reached after 30 minutes, and it is estimated to be effective for a maximum of three hours. The average bioavailability of ketamine delivered via the IN route is 40%, within a range of 33% to 71%.12-15 It is an interesting route in the case of massive casualties and triage when a peripheral IV is not always available. A specific device such as the MAD is not mandatory, and adding drops in a

FIGURE 1 Flow chart.

FIGURE 2 Mechanism of injury for the 76 patients treated with intranasal (IN) ketamine.

*N=76
**W-BFPRS: Wong–Baker Faces Pain Rating Scale from 0 to 10
***IN Group: Patients treated by intranasal ketamine
****SC/IV Group: Patients not treated by intranasal ketamine
SC = subcutaneous, IV = intravenous, IN = intranasal, NATO = North Atlantic Treaty Organization

*RPG: Rocket propelled grenade

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