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Central Venous Catheter Use in Burn Patients: Complications and Preventive Measures

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Abstract **Original Research Article**

Summary: The use of a central venous catheter (CVC) is essential in the management of burn patients, especially due to the difficulty of venous access, the length of hospitalization, and the need for routine fluid replenishment and medication administration, particularly antibiotics. ***Aim of the study:*** The aim of this study is to identify the rate of complications associated with central venous catheters in the context of burn patients to discuss its indications and the benefit/risk ratio. ***Methods:*** This descriptive retrospective study was conducted in the Plastic Surgery Department of CHU Mohamed VI in Marrakech, involving patients who received a central venous catheter during their admission to the burn unit from March 2023 to March 2024. Data collection included basic demographic data, comorbidities, burn mechanism, burn depth, percentage of burned body surface area (BSA), central catheter location (subclavian, femoral, jugular), the site (healthy/burned), the duration of catheter placement, complications (infection and venous thrombosis), detection of germs during culture, and the length of hospital stay. ***Results:*** Infection and venous thrombosis were identified as the most frequent complications of CVC use. Further research is needed to evaluate the role of regular CVC changes (every 10 to 15 days after insertion) in preventing infections and to establish a clear anticoagulation protocol for preventing deep vein thrombosis (DVT). ***Conclusion:*** While CVCs can be a valuable resource in the treatment of burn patients, they are associated with significant risks, some of which may be life-threatening. The duration of CVC placement should be minimized, and blood cultures (preferably from the CVC tip) should be systematically sent after 10 days or at the first suspicion of complications to reduce the incidence and severity of CVC-related infections.

Keywords: Central venous catheter (CVC), Burn patients, Complications, Infection, Venous thrombosis.

I. INTRODUCTION

Central venous catheters (CVCs) are crucial for fluid resuscitation and the immediate management of shock in burn patients, especially for large volume fluid replenishment and nutritional supplementation (via parenteral nutrition). However, they also provide a source of infection and sepsis in burn patients due to generalized immunodeficiency, resulting in significant morbidity and mortality in hospitalized patients. These patients require prolonged hospital stays, extended stays in the intensive care unit, and extended CVC placement, especially when the central venous catheter is placed near the burn site, particularly in cases where large surface areas are burned.

II. MATERIALS AND METHODS

This descriptive retrospective study was conducted in the Plastic Surgery Department of CHU Mohamed VI in Marrakech, involving patients who received a central venous catheter during their admission to the burn unit from March 2023 to March 2024.

Data Collection: Data included basic demographics, comorbidities, burn mechanism, burn depth, burned body surface area (BSA), catheter location (subclavian, femoral, jugular), the site (healthy/burned skin), the duration of catheter placement, complications (infection and venous thrombosis), detection of germs during catheter culture, and length of hospital stay.

Central Venous Catheterization:

- Double-lumen catheters were inserted using the Seldinger technique, preferably on healthy skin (not affected by burns) and secured with a transparent Tegaderm™ dressing or Betadine® when not available.
- Coagulation profiles (PT/INR/aPTT) were performed every 48 hours, and the CVC tip was sent for culture at the time of CVC removal.

Catheter-Related Sepsis:

- The diagnosis of catheter-related sepsis requires that the same organism be cultured from the catheter tip and the blood, and that clinical signs of infection resolve after catheter removal.

The main observation of this study was the rate of catheter-related infections and symptomatic deep vein thrombosis (DVT). All patients who developed DVT were treated with intravenous heparin. CVC removal was performed when the patient developed symptoms suggesting sepsis, thrombosis, or limb edema.

III. RESULTS

A. Epidemiological data :

1. **Age:**
   - The average patient age was 38 years, ranging from 1 to 94 years.

2. **Gender:**

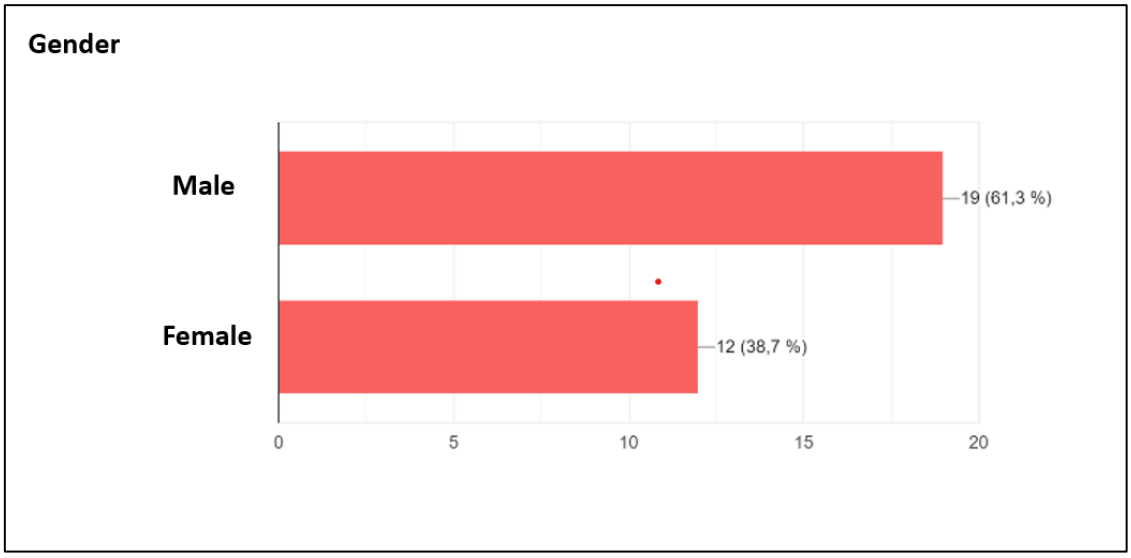

Figure 1: distribution of patients by gender

3. **Burn mechanisms:**

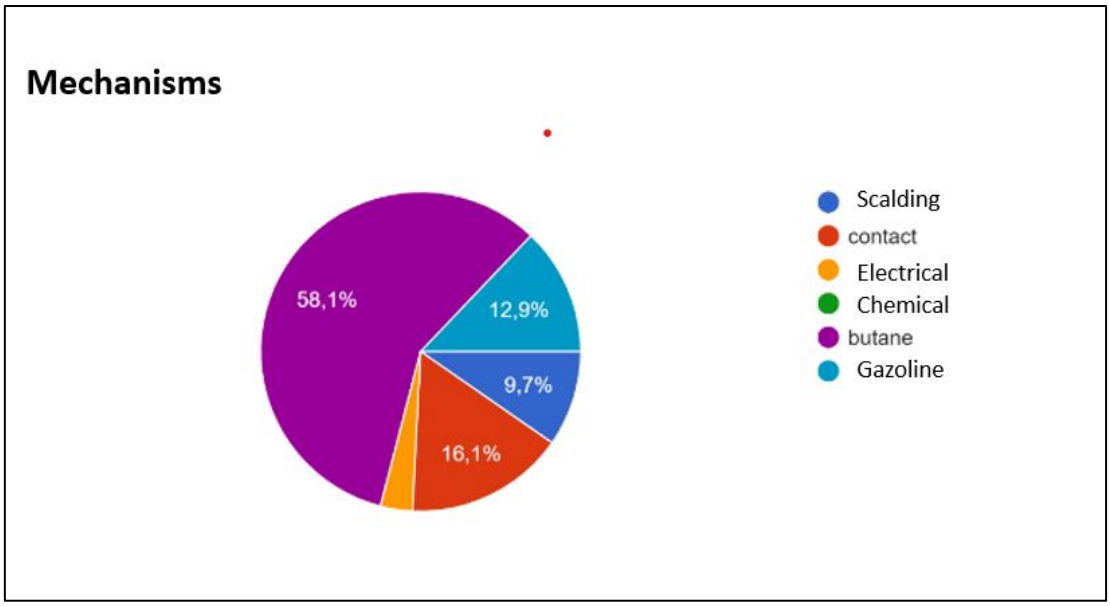

Figure 2: The distribution of burn mechanisms

B. Clinical data :

- **Burned body surface area:** The average burned body surface area was 32%, ranging from 12% to 95%.
- **Hospital stay:** The average length of hospital stay was 28.57 days, with a range from 1 to 117 days.

- **CVC location :**

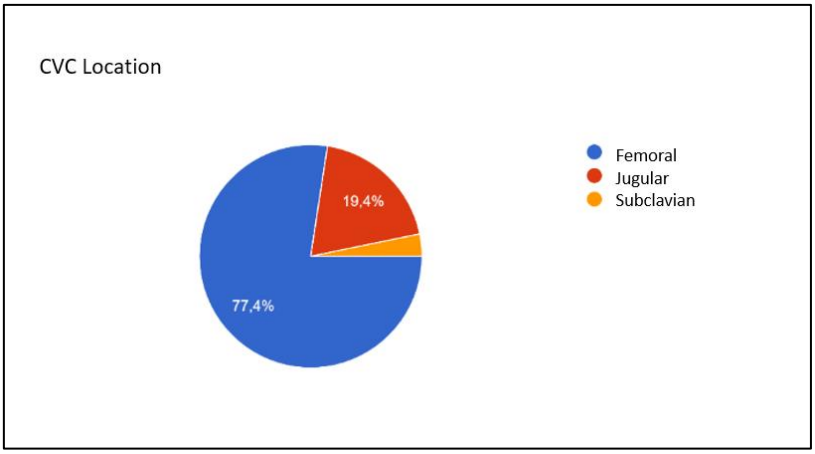

Figure 3 : Distribution of CVC locations

- **CVC Placement:** 897% of CVCs were placed in healthy skin areas, while 103% were placed in burned skin areas due to the extent of the burns.
- **CVC duration:** The average duration of CVC placement was 10.4 days, with a range from 1 to 21 days. Femoral CVCs had the longest average duration.
- **CVC Remplacement:** The average number of CVC replacements per patient was 1.5 to 2 times during their hospital stay, though some cases ranged from 0 to 7 replacements.

C. Infections and Complications

- **Positive CVC Culture:** Positive CVC cultures were observed in 23.3% of cases. The main pathogens identified were:
  - *Acinetobacter baumannii*
  - *Pseudomonas aeruginosa*
  - *Staphylococcus aureus*
- **Thrombosis:** Thrombosis was diagnosed in 10.3% of cases.

D. Deaths and CVC related complications:

- Among the reported deaths, 7.7% were related to CVC complications. These deaths included:
  - 1 case of septic shock associated with CVC
  - 2 cases of pulmonary embolism from deep vein thrombosis (DVT) following CVC insertion.

IV. DISCUSSION

Central venous catheters (CVCs) play a crucial role in the acute management of severely burned patients, both during the initial resuscitation phase and for administering antibiotics and conducting routine assessments. However, their use is associated with various complications, which must be discussed to optimize their management.

Factors increasing the risk of CVC-associated sepsis in burn patients include extremes of age, comorbidities, large burned skin areas, deep burns, catheter access through burned skin, and injury mechanisms such as exposure to hydrocarbons or contact with other harmful agents [1].

Traditionally, CVC insertion sites are the subclavian vein, internal jugular vein, and femoral vein. Each site carries specific risks of complications. For short-term CVCs, the risk of catheter colonization and thrombotic complications is higher for femoral access (14.2% versus 2.2% for colonization, and 21.6% versus 1.9% for thrombotic complications) compared to subclavian access [2]. Additionally, subclavian vein catheterization is associated with an increased risk of pneumothorax compared to jugular or femoral vein access [3]. Local risk factors, such as poor hygiene, moisture around the CVC site, the use of transparent occlusive dressings, nasal colonization by *Staphylococcus aureus*, and the presence of contiguous infections, promote bacterial colonization [4].

The main complications of CVCs can be classified into infections and thrombosis. The diagnosis of CVC-associated sepsis is suspected in a patient presenting with fever, chills, unexplained hypotension, and no clear localized signs. Symptoms include vomiting, high fever, chills, hypotension, and altered mental state [5].

CVC is an independent risk factor for deep vein thrombosis (DVT). CVC-related thrombosis can be symptomatic or asymptomatic. Symptomatic thrombosis manifests as swelling, pain, erythema, and fever in the affected limb, and is diagnosed using Doppler ultrasound. Asymptomatic thrombosis is usually identified through screening or incidentally during imaging and can result in CVC occlusion. The rates of CVC-related thrombosis vary from 2% to 67%, with symptomatic thrombosis rates ranging from 0% to 28% [6].

CVC-related infections are often treated with intravenous antibiotics, even without catheter removal, although removal is recommended. Empiric treatment should cover Gram-positive pathogens, Gram-negative bacilli, and *Candida* species, especially in cases where the line is maintained for prolonged periods with multiple antibiotic therapies [7]. Routine anticoagulant prophylaxis to prevent CVC-related thrombosis is generally not recommended [8].

The ideal duration of CVC use before replacement or removal remains uncertain. In practice, CVC removal is typically done when clinically indicated, considering the difficulty of reinserting a subsequent access line and the risks associated with prolonged placement. In our practice, routine removal was done when fluid resuscitation was no longer required (after 10-15 days) or at the time of discharge [9].

Infection was the most common complication associated with CVCs in our study, often manifesting as persistent fever despite antipyretics and empiric antibiotics, generally resolving after CVC removal. Distal deep vein thrombosis occurred in 10% of patients and was the second most frequent complication, treated with intravenous heparin. Femoral vein access was favored due to the extensive burns in the majority of patients, with no other viable access sites. Dehydration and protein leakage, typical complications of severe burns, justified the use of CVCs [10].

Routine culture of the catheter tip should be conducted, or performed at the first suspicion of complication, to reduce the incidence and severity of CVC-related infections in burn patients. The incidence rate of CVC-related infections in our study was 23.3%, lower than the results reported by Agrawal *et al.*, [11], where the rate was 18.70% per 100 catheter days. However, our results align with those of Alexander Miller *et al.*, who reported an incidence of 23.14% [12]. The work of Sheridan and Weber showed that catheter-related sepsis significantly increases after 10 days, which may explain the low incidence of infections in our study, with a mean CVC duration of 10.4 days [13].

The pathogens responsible for CVC-related infections were predominantly Gram-negative (86%, versus 83% for Agrawal) and Gram-positive (14%, versus 17% for Agrawal), with the most frequent being *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. This was higher compared to the study by Krishnan *et al.*, [14], where Gram-positive cocci accounted for 27% of isolates, and Gram-negative bacilli for 56%.

We implemented specific interventions to reduce the rate of CVC-related sepsis, such as systematic catheter changes every 10 to 15 days after insertion. However, this study has several limitations, including the fact that it comes from a single burn center, limiting the generalizability of the results. Additionally, due to the small sample size, data on CVC-related infections were limited by the low number of catheter tips sent for culture. Future studies should address this limitation by ensuring that catheter tips are systematically analyzed for culture.

Despite these limitations, this study provides a valuable preliminary analysis of CVC-related complications, contributing to a better understanding of the morbidity and mortality associated with these devices in burn patients.

V. CONCLUSION

Central venous catheters (CVCs) play a crucial role in the acute management of severely burned patients, not only during the initial resuscitation phase but also as a vital access point for ongoing treatment. Despite the well-established link between CVCs and a higher incidence of infections, they remain the preferred method of access in burn care due to their multi-functional utility.

Conflicts of interest: The authors declare no conflict of interest.

VI. ACKNOWLEDGMENTS

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