INVESTIGATING CERVICAL COLLAR DESIGN AND FIT: INTERFACE PRESSURE AND DISCOMFORT

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Introduction

Cervical collars form part of the standard immobilization procedures for patients with a suspected cervical spine injury. However, several issues with their use have been identified [1]. Where the collars provide mechanical constraint to movement, there is a risk of soft tissue damage from prolonged pressure and shear loading. In addition, an altered microclimate can increase susceptibility to damage. The literature evaluating collar designs predominantly consists of observational studies and one-to-one comparisons between collars. Observational studies, reporting pressure ulcer incidence, have identified that time in a collar is a significant predictor of risk [1]. Some studies have compared the interface pressure and range of motion between collars, demonstrating significant difference between designs and materials [2]. The implications of poor design and fit of cervical collars on skin health have not been thoroughly investigated. This study aimed to evaluate four popular cervical collars against several bioengineering measures previously used for evaluating medical device interfaces and pressure ulcer risk.

Methods

A convenience sample of 25 participants was recruited for a randomized cross-over trial. Participants were randomized to two of four cervical collars commonly used in the emergency and rehabilitation settings (Miami J, Stiffneck, Philadelphia, Aspen Vista). Participants donned the collars in a supine position for 20 minutes. Interface pressure was measured at four locations (occiput, right/left mandible, chin). Microclimate was evaluated with combined temperature and humidity sensors at the device skin interface at three locations. Skin hydration and trans-epidermal water loss were measured under the chin before and after applying the collar. 3D scans were taken of each participant with and without the collars in situ, to estimate neck geometry measurements.

Results

Interface pressure was significantly higher at the occiput than at other locations for the Stiffneck, Philadelphia, and Aspen Vista collars (Figure 1). The Miami J collar showed little variation between measurement sights, indicating a more even interface pressure distribution. Interface pressure at the occiput was significantly higher for the Stiffneck collar compared to the other three ($p < 0.05$). This agrees with previous studies comparing the Stiffneck to the Aspen Vista [3].

Several participants experienced very low pressure at the chin (n = 4). Additionally, participants reported areas of concentrated pressure at different locations along the jaw and chin. This was observed to be due to differences in shape between the participant's jaw and the collar chin rest. Indicating that variability in head geometry contributes to the distribution of interface pressure.

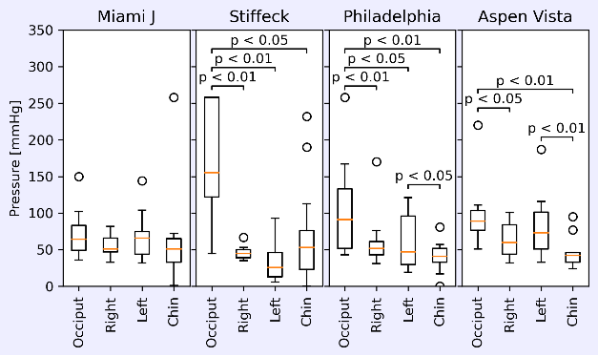

Figure 1: Interface pressure for each collar

Participant-reported discomfort was significantly higher for the Stiffneck collar ($p < 0.05$). Although not statistically significant, higher discomfort was reported for the Philadelphia collar compared to the Miami J and Aspen Vista ($p = 0.06$ and $p = 0.07$ respectively).
Humidity was significantly higher for both Stiffneck and Philadelphia collars than Aspen and Miami J ($p < 0.001$). No significant difference was found between the Stiffneck and Philadelphia or Aspen and Miami J.

Discussion

This study identified significant variability in interface pressure distribution and evidence that this varies with head shape and size. Future analysis of this data set will evaluate the contribution of anthropometric differences to each experimental variable. This is a feature that has not been investigated in the current literature. Further investigation is warranted to fully understand the significance of anthropometric variability on collar fit and pressure ulcer risk.

References

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