

Re-evaluation of the Emergency Cervical Collar

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Abstract

The novel cervical collar addresses the challenges, consequences, and overall misuse of current rigid cervical collar designs used in standard emergency prehospital care. Basic Life Support (BLS) practices are used throughout New Jersey, which focus on addressing patient airway, breathing, circulation, disability, and exposure. The first three of these are rooted in the cervical region, emphasizing the need for cervical collar use to immobilize the cervical spine and prevent secondary spinal cord injury (SSI). Current designs for rigid collars can exacerbate existing injuries due to excessive manipulation of the cervical spine or incorrect placement during application. The team's project therefore combined both a rigid plastic component (anterior) and a soft vacuum bag component (posterior) to optimize patient safety without sacrificing efficacy to prevent SSI. This device design minimizes patient body manipulation by distinguishing between device application (placement around neck) and fixation (adjustment of neck into a stable position), while still meeting current standards of motion restriction. Verification and validation methods for the cervical collar include image capture and angle measurements during wear, along with EMT user surveys on ease of device application. The following values describe comparisons of maximum ranges of motion experienced with and without the collar, expressed as percent limitation of unrestricted motion: Extension ($33.32 \pm 10.09\%$), flexion ($22.65 \pm 9.73\%$), left lateral flexion ($36.29 \pm 10.32\%$), right lateral flexion ($36.84 \pm 8.11\%$), left lateral rotation ($24.98 \pm 9.73\%$), right lateral rotation ($24.31 \pm 6.77\%$).

Introduction

Current practices for pre-hospital emergency care are concerned with BLS standards, which emphasize the use of rigid, cervical collars. These current designs are problematic in that they:

- Require excessive manipulation
- Uncomfortable
- Incorrect fit up to 89% of the time [1,2]
- Improperly distinguish device application and fixation



Therefore: There is a need for a **novel cervical collar** which addresses issues with available rigid cervical collars by **lowering the amount of patient spinal manipulation and time needed to safely apply the device**, while also supporting the cervical spine to **limit neck motion**.

Design Inputs

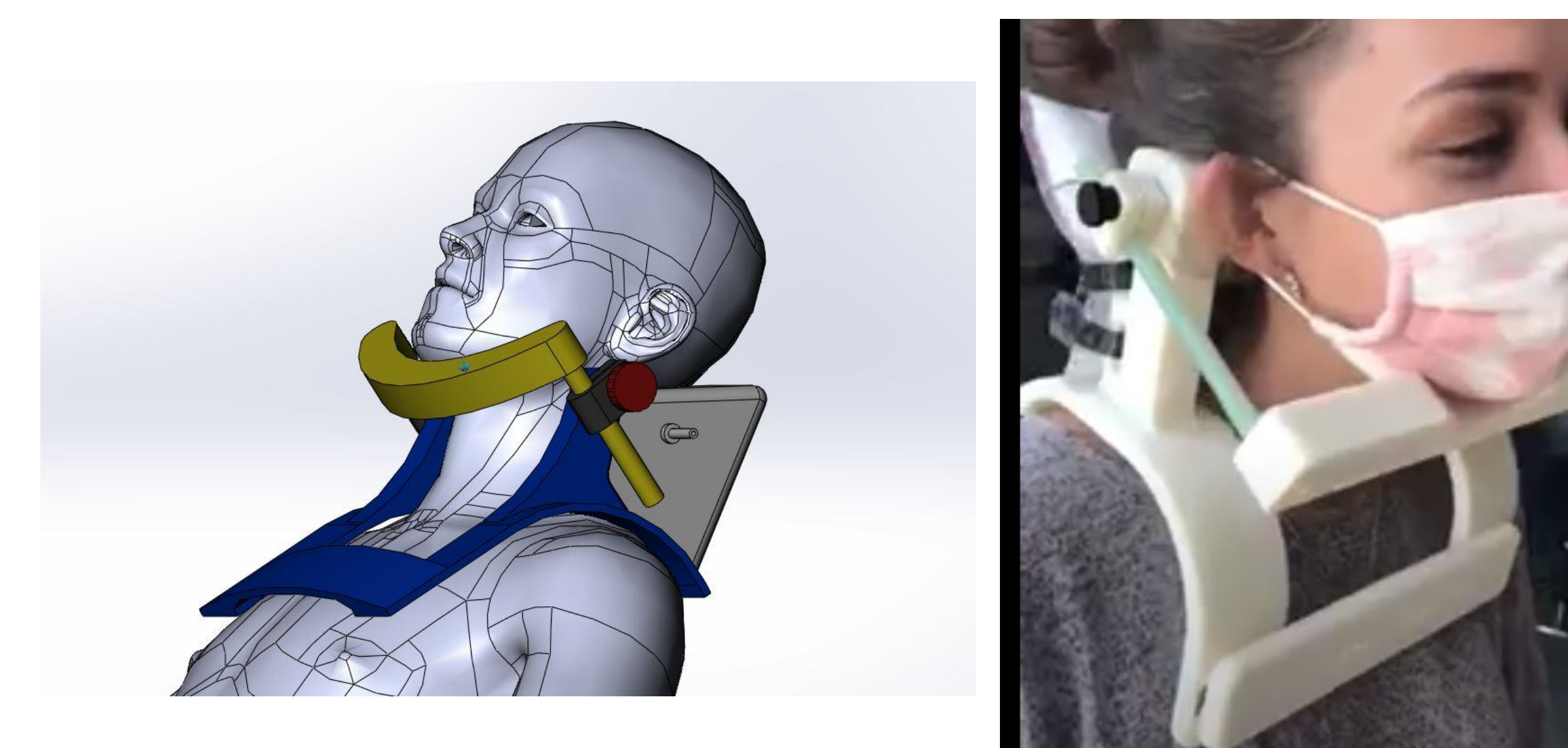
The device must...

1. Limit the six major neck motions
2. Comfortable and lightweight
3. Be applied with minimal manipulation
4. Easily stored
5. Allow for additional emergency procedures
6. Allow for natural respiratory and circulatory function
7. Be applied and fixed in a clinically acceptable time period



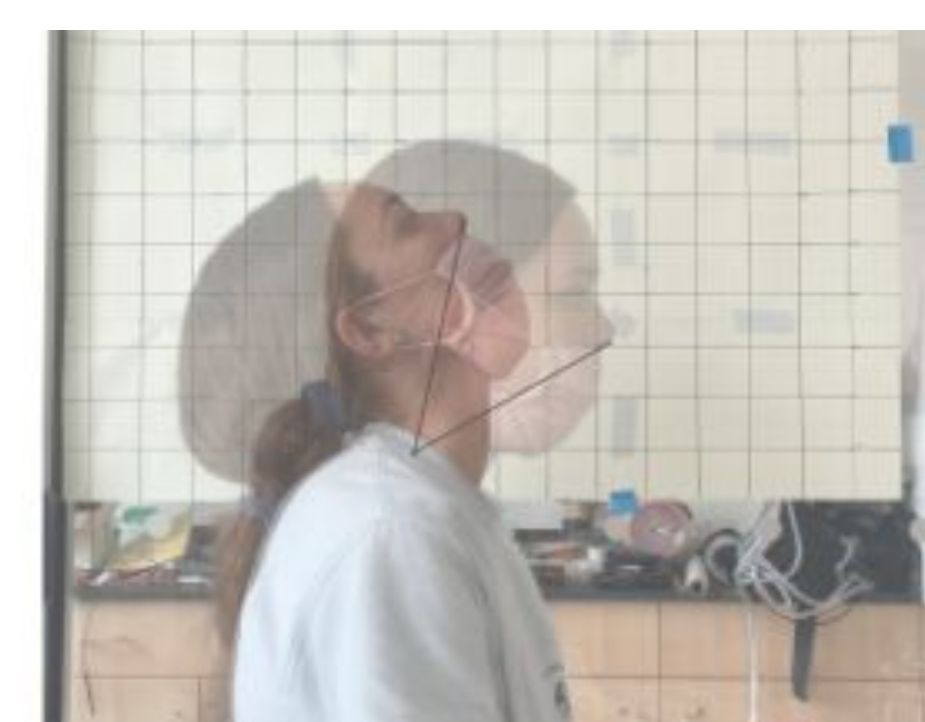
Design Solution

- Hybrid collar design
 - Adjustable, rigid front piece
 - 3D printed, ABS plastic
 - Comfortable, soft posterior piece
 - Vinyl bladder, vacuum beads
- Efficient, adjustable velcro interface
- Applied in a range of positions
- Differentiation between application and fixation
 - Application: placing collar around neck
 - Fixation: adjusting and securing the device such that the neck is in a stable position



(Left) Solidworks design with adjustable portions indicated in color. (Right): Fully assembled prototype for the hybrid cervical collar

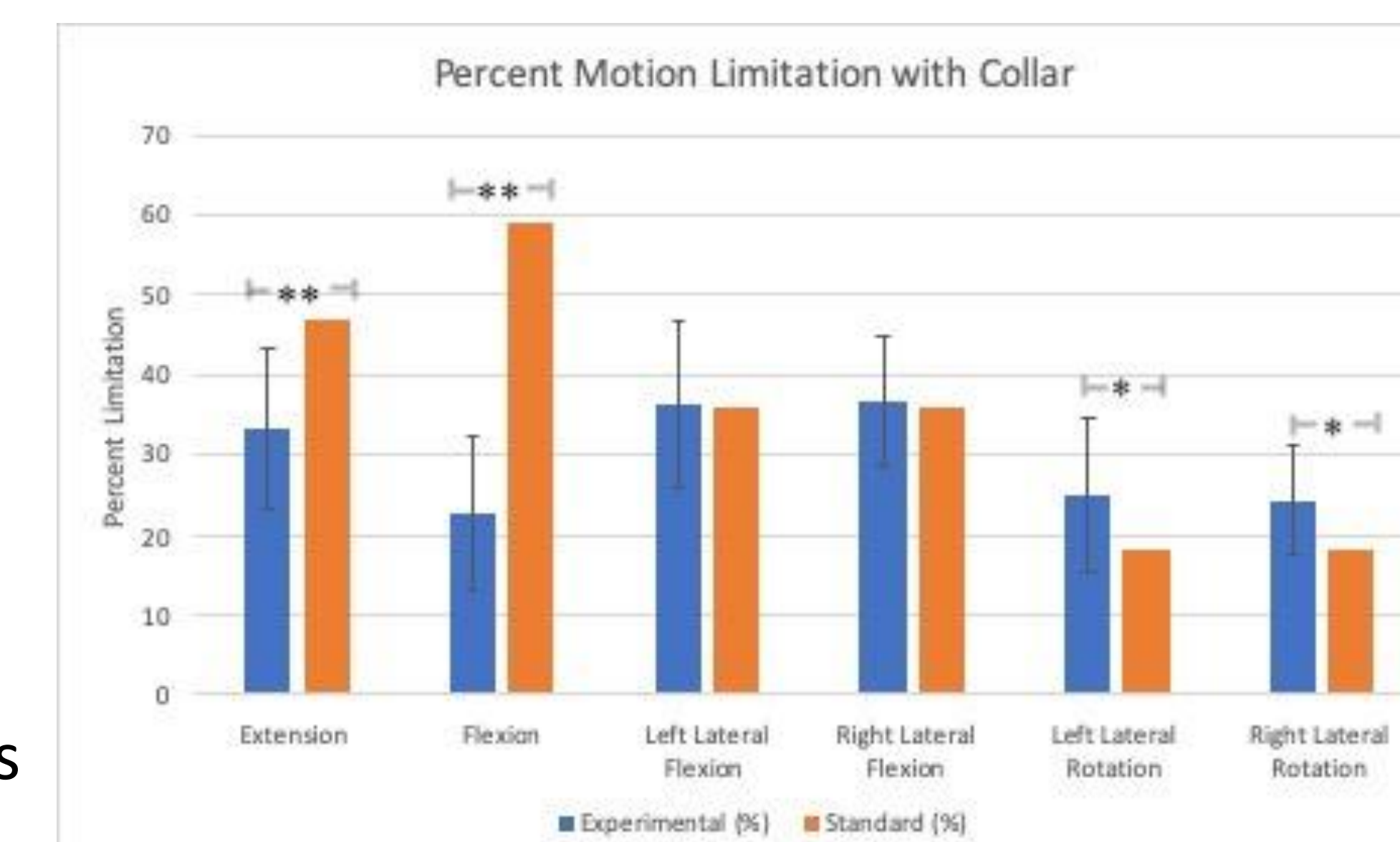
Testing



Verification testing (shown to the left) was conducted to analyze the collars ability to limit the six major neck motions. Results (presented as average \pm SD) are shown to the right. Of the 6 motions, both right and left lateral rotation were found to fall short of expectation, and did not restrict to the degree of other available collars.



Additional testing with user surveys, provided context into user comfort, and professional opinions on the device's intended use.



Conclusions

Our device has successfully met all functional requirements concerning limiting cervical neck motion and ability to conduct additional procedures. Additional investigations are still to be complete to understand user's opinion, including comfort for wearer, and efficiency for the medical professionals that will be applying the device. All this data can be used to further improve the practices in emergency care.

References

- [1] "CPR - Adult and Child after Onset of Puberty: MedlinePlus Medical Encyclopedia." *MedlinePlus, U.S. National Library of Medicine*, 2019.
- [2] M. Yuk, W. Yeo, K. Lee, J. Ko, and T. Park, "Cervical collar makes difficult airway: A simulation study using the LEMON criteria," *Clin. Exp. Emerg. Med.*

Acknowledgements

We would like to thank our advisor, Dr. Alvandi, Dr. Wagner, and all of the emergency medical professionals who aided in this endeavor.