GNG2101

Design Project User and Product Manual

User Manual for a Soft Cervical Collar

Submitted by:

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BOM	Bill of materials

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Term	Acronym	Definition

1 Introduction

This User and Product Manual (UPM) provides the information necessary for users to effectively use the waterproof soft cervical collar and for prototype documentation. It is intended for soft cervical collar users, caretakers of cervical collar users, and KODAR's design and QA testing team.

A waterproof soft cervical collar has been created for clients looking for a waterproof, and chemically resistant solution that is both supportive and comfortable. Founding team KODAR has made several assumptions, some of which may affect usage, thus they will be listed. To begin, this user manual guide assumes that the user has zero knowledge of how to wear a standard cervical collar. This process will be fully explained from start to finish and needs no prior knowledge. Secondly, an assumption has been made that the collar will only be exposed to a predefined list of chemicals, including Chlorine, Salt, as well as standard hand wash and detergent soap. If exposed to other chemicals not listed in this document, KODAR may not be liable to any damaged product. Next, it is assumed that the product will only be cleaned as is instructed in this manual.

Section 2 will begin by providing an overview of KODAR's motive, the product description, and product warnings used in the document. This section is also to be referred to when any special conventions such as symbols or syntax are used. **Section 3** will be used to guide the user on how to assemble the collar, explain user and configuration considerations, and finally show how to put the system away for storage. **Section 4** will explain in depth how to use the system, including documentation of several features and their subsystems. **Section 5** will guide the user on troubleshooting any potential product issues, and maintenance considerations, as well

as where to seek support from KODAR's head office. **Section 6** will provide a separate and in-depth product documentation for each subsystem, including the foam base, synthetic leather cover, and velcro attachment mechanism. **Section 7** will summarize final thoughts and lessons learned by group KODAR, as well as recommendation for future project work.

Security and Privacy Statement

This document is only intended for use by authorized members and may not be disclosed without official permission.

2 Overview

People with neck mobility issues from injuries or disabilities require a cervical collar for neck support. These people still want to participate in intensive physical activities but the collars on the market only have solutions for durability and comfort. The collars on the market lack water resistance and the ability to resist an abundance of sweat and chlorine which is an integral part of playing many sports and performing physical activity. This is an important problem to address as it will lift the limitations on users who want to be highly physically active but their neck mobility prevents them.

The fundamental needs of the user include a durable and comfortable waterproof collar that will not deteriorate when exposed to sweat chlorine. Additionally, the collar must have a slim profile so it is not a hindrance in day-to-day tasks.

The key differentiation between this product compared to the products on the market is the water and chemical resistance. This collar is better as it is designed with those two features in mind while still competing with the best collars available in durability and comfort.

Figure 1. Front of Collar

Figure 2. Back of Collar

The main features of the collar include the attachment mechanism which is made using velcro. The water-resistant cover is implemented with a synthetic leather fabric. Lastly, the inside of the collar is a premade foam base.

2.1 Conventions

Bolded and underlined blue text indicates that the reader should click it as it will link them to that part of the document.

2.2 Cautions & Warnings

Ensure that the collar is not too tight around the neck as it can lead to restricted airflow and breathing which is fatal.

3 Getting started

To assemble the soft cervical collar, remove the collar from the packaging and lay it out on a flat surface. There are no additional parts required to assemble the product.

To use the collar, wrap the piece around the user's neck and attach the two end pieces using the velcro straps. The collar is curved, with the dip being where the user's chin will rest and the bow being at the lower part of the neck and resting on the clavicle. The velcro attachment goes at the back of the neck. To remove the collar, simply pull one strap to detach the velcro pieces and the collar will come off.

3.1 Configuration Considerations

The cervical collar consists of a single piece with one place of attachment. The structure of the collar is curved (similar to the letter C), where the lower part is meant to rest at the bottom of the neck close to the clavicle. There are two velcro straps attached to the collar on either extremity and can be attached to use the collar. The patch with hooks goes on the bottom and the patch with loops fastens over top to attach the two sides of the collar together.

There are no additional tools required to set up and use the collar aside from the product itself. Depictions of the collar configuration can be found below.

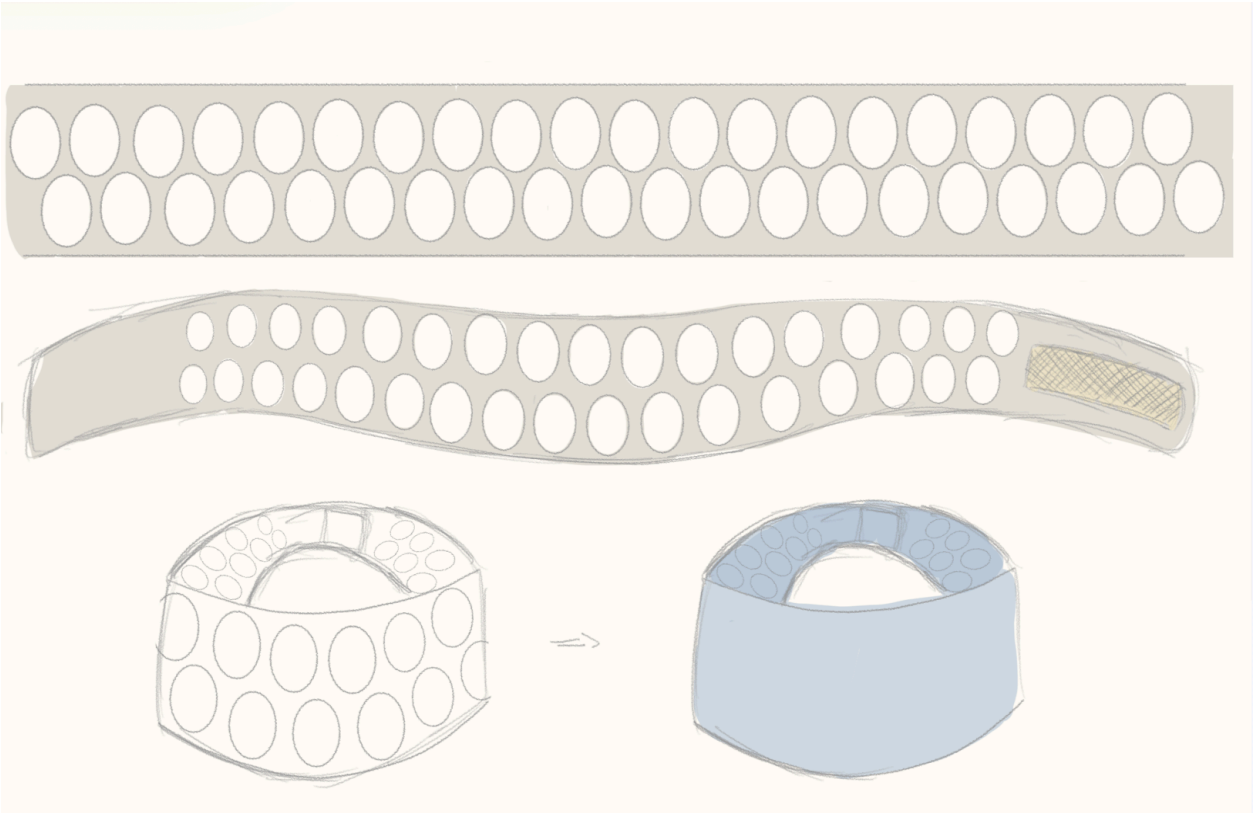

Figure 3. Concept Photo of Collar Base and Cover

3.2 User Access Considerations

This collar is meant to be used by people with disabilities and/or neck injuries. It is made to support the head in place of the neck, and may restrict movement in order to provide the proper support. The collar consists of a single piece, which attaches via two velcro pieces on either extremity of the collar.

Some limitations to consider when using the collar include mobility limitations and restriction of neck movement, restriction of head movement up and down, and side to side, and difficulty attaching and detaching the velcro pieces.

A small amount of force is required to attach and detach the velcro pieces, which may be difficult for those with limited dexterity or weakening strength. In this case, users may ask other persons for assistance with attachment and detachment of the soft cervical collar.

3.3 Accessing/setting up the System

To set up the system, the user must remove the collar from the packaging and orient it correctly. Since the collar consists of a single piece, there are no additional steps to assembly, aside from putting on the collar.

To put the collar on, first place the collar on a flat surface and ensure it is oriented correctly. For correct orientation, the collar should have a dip at the top where the chin will rest and a bump at the bottom where the collar will rest on the clavicle. Ensure that the velcro strap with loops is facing outwards, and that the velcro strap with hooks is facing away towards the surface.

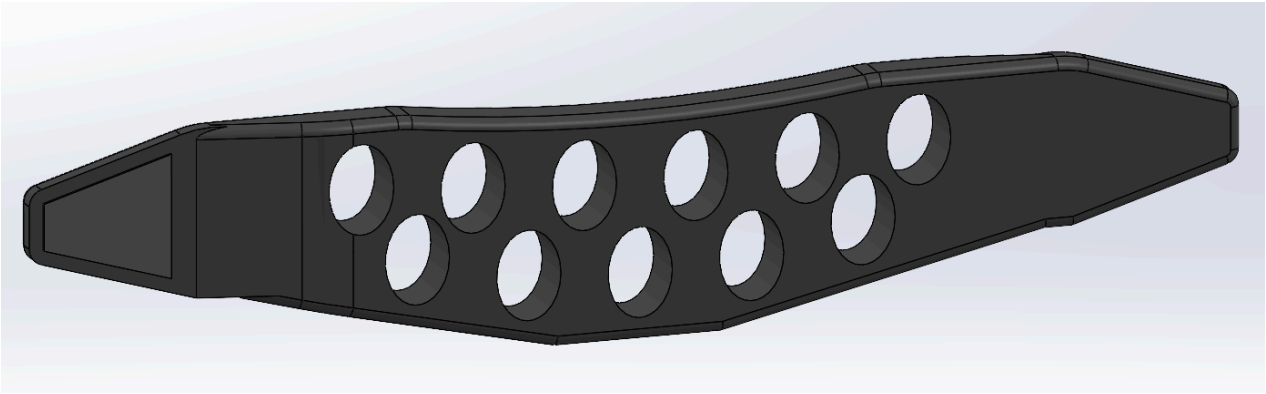

Figure 4. CAD Model of Collar Base

Next, bring the collar to the user's neck such that the chin is resting comfortably on the dip of the collar, and the two velcro straps are towards the back of the neck. Pull the two ends of the collar together until the desired tightness and attach the velcro straps together to secure the collar in place. The collar should fit snug, but should not restrict breathing.

If adjustment is needed, the collar may be loosened or tightened by moving the two ends of the collar closer together or further apart, and attached using the velcro pieces.

3.4 System Organization & Navigation

The main component of the soft cervical collar is the single foam piece which makes up the body. Accessories to the collar include a single removable sleeve which can be used to cover the main part of the collar. The removable sleeve is a single, hollow piece of cloth which the collar can be slid through (like putting on a glove) in order to cover the collar.

The collar consists of two velcro pieces at either end of the collar, which when brought together will hold the collar in place in a circular shape. The outside of the collar is made with synthetic leather, and is held together by a double stitch sewn piece.

Figure 5. Back of Collar

3.5 Exiting the System

To put the soft cervical collar away, remove the collar from the user by detaching the velcro pieces. The user can remove the sleeve, but this is not required. Next, the collar can be stored as it is in a safe place, or it may be folded up to fit into smaller areas.

To fold the collar, place it on a flat surface and bring the two extremities in to meet at the center of the collar. Next, fold the collar in half such that the two ends of the collar are on the inside of the fold. The collar may then be placed into a bag, or stored in a drawer or on a shelf.

Another method to store the collar is to attach it to a backpack or walker by fastening the collar around a secured and closed place.

4 Using the System

4.1 Adjustability

Velcro is used for this feature and allows the user to adjust the circumference of the collar.

Steps

1. The user must first wrap the collar around their neck to the desired circumference such that it is snug but not restricting their breathing.
2. Once the perfect circumference is set the user must join the two ends of the collar by overlapping them, ensuring that the velcro is attached.

Figure 6. Adjustability Mechanism (Light Gray Velcro Rectangle)

The figure above depicts one side of the adjustability mechanism of the collar that must be overlapped with the other piece of velcro that is on the left side of the collar on the opposite face. The user may encounter a caveat where the collar is not large enough for their neck in which case a larger size is needed.

4.2 Water-proof cover

There are no explicit steps in attaching the waterproof cover as the collar arrives with it already attached. However, there are some considerations that the user must keep in mind. After using the collar in water, the user should lightly dry it to ensure the chemicals and water remaining on the collar don’t irritate the user's neck when using it throughout the rest of the day.

Washing the collar is best done by hand using a detergent of the user's choice. This will ensure the longevity of the collar and prevent the synthetic leather cover from detaching from the foam base. However, the collar can be machine-washed on a low-cool wash.

5 Troubleshooting & Support

Potential Errors and Solutions

1. **Chafing or Skin Irritation**
    - **Likely Cause**: Prolonged use, material incompatibility, or improper collar adjustment.
    - **Corrective Action**: Ensure the collar is adjusted properly to minimize tightness. Wash the collar as per instructions to remove any irritants. Use a thin protective layer (e.g., a soft cloth) if irritation persists.
2. **Difficulty in Adjusting Size**
    - **Likely Cause**: Faulty Velcro or pant adjusters, or limited user dexterity.

- **Corrective Action**: Replace worn Velcro or even faulty adjusters. Make sure mechanisms are lubricated or clean as appropriate.

3. **Water Leakage or Degradation**
    - **Likely Cause**: Damage to waterproof or chlorine-resistant materials.
    - **Corrective Action**: Inspect for visible tears or punctures. Use silicone adhesive to seal small tears. Avoid prolonged exposure to chlorine by rinsing the collar with fresh water after use.
4. **Lack of Neck Support**
    - **Likely Cause**: Deformation or wear of the collar's structural elements.
    - **Corrective Action**: Check for deformation. Replace internal supports or padding as necessary.

5.1 Special Considerations

Environmental Use: Where water related uses are involved, it is recommended that the collar is dried up after use to avoid the growth of microbes or material breakdown.

Mobility Constraints: The collar's setting may need to be adjusted by another person in case someone has low motor skills for hand movement. It is suggested to come up with a less complex adjustment mechanism when developing the next version of the system.

Allergy Concerns: Users should check on compatibility of certain materials or better still contact the manufacturer for advice.

5.2 Maintenance

Basic Maintenance Processes

Cleaning

Hand wash the collar with mild soap and warm water after every use especially after washing with chlorine or salty water. Some of the liquids can easily penetrate the fabric and hence it should be air dried before being stored.

Material Inspection

Check monthly for the first signs of wear for instance frayed fabric or a weakening Velcro band. The damaged parts should be fixed as soon as possible to give the equipment the best performance possible.

Adjustment Mechanism

Check often the Velcro or adjusters for the tightness of the Velcro or the ability of the adjusters to hold on without coming loose or tearing off. Sometimes they get covered with debris; use a soft brush to clean them.

Storage

Always keep the collar in a dry area, and do not expose it to direct sunlight since it will cause the material to depreciate.

5.3 Support

Emergency Help Line and Control Centre

Points of Contact

For urgent inquiries or support, users may contact the following:

Name: [KODAR GROUP 2.5]

Email: [KODAR_LIFE@gmail.com]

Address: 123 Lisgar Street, Kanata, Ontario

Reporting Problems

Users should provide their report through the support email and describe the problem, the context of use, and what has been done to try to solve it. Please add photographs if any for quicker settlement.

Security Incidents

If the collar is believed to be dangerous to health because it is contaminated or if it has seriously failed, stop using it. Call support in case you need replacement or assistance. Report in the steps given above, emphasizing on the health concern that is binds to the situation.

6 Product Documentation

The final prototype was split into three subsections; the foam base, synthetic leather cover, and velcro for the attachment mechanism. The foam base is required to calculate the necessary dimensions for the cover and is found by tracing the foam base along the synthetic leather sheet. An additional 1-2 cm gap is needed to be considered with the tracing to allow for the double stitching that makes the collar waterproof. The collar itself must be the Velpeau foam collar or anything similar (ie. A soft foam collar).

The synthetic leather used for the cover was considered and chosen from a list of several options. These listed options were synthetic leather, lycra, and neoprene. Although the latter two materials were not tested, existing information confirms that neoprene similarly to the synthetic leather used in the prototype is waterproof. The lycra material is not waterproof. The synthetic leather was used in the prototype as it was much more accessible in bulk through the makerspace which allowed for testing where required. It should be considered that when making the covert, two flat sheets of synthetic leather are traced and stitched with the interiors on the outside, the collar is then flipped inside out to hide the stitching; minimizing any risk of the stitching tearing and allowing for a seamless finish to be presented.

The velcro for the attachment mechanism is hand-stitched onto the cover. The particular velcro model used has an adhesive on the backside, allowing for easier placement on the collar.

6.1 Subsystems of Prototype

6.1.1 BOM (Bill of Materials)

Item Name	Description	Quantity	Unit Cost ($)	Source	Links
Velpeau Collar	Foam cervical collar.	1	24.99	Amazon	https://www.amazon.ca/VELPEAU-Neck-Brace-Stabilizes-Stabilized/dp/B08R51YF85?ref_=ast_sto_dp&th=1
Velcro	Material for the attachment mechanism.	1	5.99	Canadian Tire	https://www.canadiantire.ca/en/pdp/velcro-industrial-strength-extreme-strips-black-4-in-x-2-in-0611835p.html?rq=velcro+strips
Total cost:	Pre-tax and shipping		30.98		
Total cost:	With tax and shipping		35.01		

6.1.2 Equipment list

1. Sewing machine
2. Hand sewing kit
3. Scissors
4. Tape
5. Marker

6.1.3 Instructions

1. Gather the specified materials and equipment
    a. Foam base
    b. Velcro
    c. Synthetic leather sheet
    d. Sewing machine
    e. Hand sewing kit
    f. Scissors
    g. Tape
    h. Marker
2. Trace the foam base outline on the synthetic leather sheet and ensure there is a 1-2cm gap on all sides
3. Cut out the piece of synthetic leather and repeat step 2 again

4. Sew the two pieces together inside out (the leather on the inside) and leave one end of the collar open
5. Flip the stitched collar inside out and put the collar base inside. Map out where to put the velcro ensuring there is enough room for the two velcro pieces to overlap one another fully
6. Remove the base from the cover, stick on the velcro and hand sew the perimeter of the velcro patches
7. Put the base inside the cover and stitch the remaining side closed.

6.2 Testing & Validation

The prototype underwent several evaluations/tests to gather information on project directions and the validity of the methods used to develop the final design. The tests used are as listed.

1. Determining minimum collar width to ensure any deformations under an applied load (weight of a human head) are minimized.
2. Determining a comfortability rating of the collar through a generalized survey to account for the subjective scaling of the test.
3. Determining the water-proofing capabilities of the collar cover and in particular, the stitching used to seal away the foam base.
4. Determining the horizontal range of motion of the collar.

The first test took into account that the client had wanted to keep the collar width to a minimum, through CAD model analysis, the minimum width the collar had to remain while undergoing minimal deformations under the specified load was 2.5 inches.

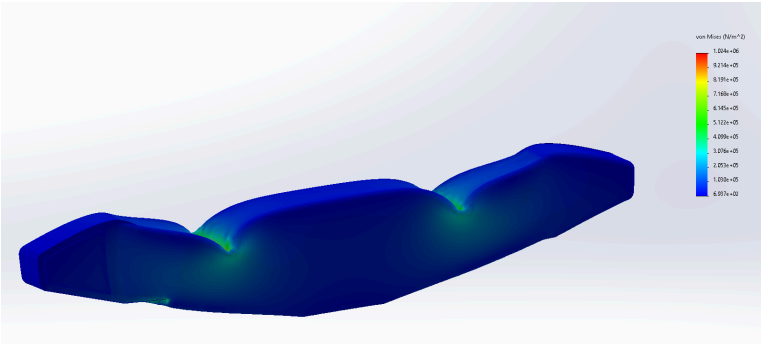

Figure 7. CAD Simulation Model

The second test took a survey on the comfortability of the collar from a number of participants and had required an 80% comfortability rating to pass.

The third test was to determine whether or not the collar performed its required task. The prototype was taken swimming for 30 minutes and was tested by measuring its mass before and after being submerged in water for a prolonged time to see if there was any absorption in the foam piece. The most mass percentage gain the collar was permitted was an additional 10% of the initial prototype mass. This test was passed.

The final test was determining the horizontal range of motion of the collar, based on initial benchmarks agreed upon with the client, a horizontal range of motion of 90° was required. Because of some oversight with the final prototype, the velcro overlap was minimal creating a very loose connection between both ends of the collar. This meant if someone tried to turn their head horizontally with the collar on, the velcro would undo itself. This test was failed.

7 Conclusions and Recommendations for Future Work

Throughout the course of this project, KODAR has learnt a great deal of lessons. Firstly, effective communication skills were effectively gained. By meeting on a weekly basis with other members, as well as having online meetings, the group stayed in constant contact. This helped the group coordinate efforts for deliverables, and serves as an important lesson of how work should be conducted in the future. Next, the group learned effective time management skills. By using MS Project for every stage of the project, it was made clear what subtasks were due at what time, helping the group stay on task and finish deliverables on time. Lastly, the group learned a valuable lesson on how to adapt. By using the agile method, the group was able to respond quickly to unintended and unexpected situations by quickly updating plans for the project and effectively communicating.

Whether it'd be KODAR itself, or other groups, KODAR recommends future project contributors to focus on the following list of elements. Firstly, long-term durability should be focussed on. By conducting an extended period of stress testing, groups can evaluate material wear, water resistance and structural integrity more reliably, and make changes where needed. Secondly, another area of focus is aesthetic customization. Unfortunately, KODAR was not able to meet this need, however future groups should focus on providing covers with an extensive selection of colours and patterns. Offering a personalized design system is also another option, offering a wide range of selection, and adaptability to different customers. Lastly, future groups should focus on scalability and design for mass-production. This includes identifying

cost-effective material solutions, more standardized neck collar sizes, all to streamline the production process.

If the group had a few more months to work on this project, it would focus on the just mentioned points, to truly improve and refine the product. In terms of things abandoned, there were a few materials and a small sub system that did not make it to production. Firstly, the usage of Neoprene and the Silicone did not make it to final production. This was due to supply chain issues, with amazon not being able to deliver the product by the due date. Secondly, the subsystem of the customizable collar was abandoned, however this did not affect any of the functionality the collar had to meet.

To conclude, KODAR has been more than happy to work on this project, with the assigned client. The group is looking forward to working on more products in the future!

APPENDICES

8 APPENDIX I: Design Files

Please refer to the maker repo:

https://makerepo.com/rowankovacs/2180.kodar-soft-cervical-collar