Development of a Novel Helmet System to Prevent Head and Neck Injuries

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Abstract

The use of helmets is an important requirement in today's use of land and aircraft due to the safety of the user and sometimes additional requirements. The helmet is the primary protective equipment for safety purposes, especially for motorcycle and bicycle users. In situations that require the common use of this protective equipment by more than one person, incompatibility occurs because there are different sized head structures and the helmet leaves the user's head in the event of an accident. In this case, the helmet loses its protection. In this case, head and brain injuries and deaths occur. The same happens when the single-user helmet is incompatible with the user head sizes. In this study, a completely new system has been developed for the prevention of injuries and deaths caused by dimensional mismatch in helmet use. The developed system will be an economical solution source with its pneumatic structure. It has been determined that with the use and spread of the developed system, it is possible to prevent accidental damage, especially head injuries.

Keywords*:* Helmet, Pneumatic, Design, Mechatronic, Device.

I. INTRODUCTION

When the shareholder factors among deaths and injuries worldwide are examined, it is seen that traffic accidents are at the forefront. The number that we encounter only as loss of life is 1.2 million people / year, as well as a large number of injuries. The issue also has an economic dimension, and traffic accidents are an important cause of financial loss for countries [1].

There is a rapid increase in the use of two-wheel motor vehicles (motorcycles) and bicycles worldwide. This increase significantly increased the accident exposure rate of motorcycles and cyclists with less visibility. The reason for this increase is the low visibility of two-wheeled motor and non-motorized vehicles, no attention, sudden maneuvers of other 4-wheeled vehicles, etc. It can be listed as. The size of injuries caused by accidents is also much larger since they are not in a protective area. A significant part of injury accidents and fatal accidents are caused by bumps in the head and neck region. This result has once again become more evident in the importance of using helmets, which are particularly necessary for the use of such vehicles. Because, helmets have been identified as the most important cause of injury or death as they are not used or misused in accidents that occur. Helmet with a general description; It is a protective equipment designed to protect the head during a collision. When mortal traffic accidents are examined for motorcycles and bicycles, it has been determined that the rate of fatality or misuse of accidents in deaths is 75% for European countries. This rate rises to 88% in some countries [2,3].

On the other hand, such injuries (head, neck) require costly treatments that take an extremely long time [4]. This reveals the importance of the subject in another aspect. The main features expected from a helmet; It has a protective outer body, dampers the collision effects to the head, providing comfort conditions and staying in the head in the event of an accident. There are studies to examine the effects of motorcycle helmet and bicycle helmet in the process [5-6]. Within the scope of this study, an extra safe helmet was developed for the current user, which can easily adapt to user changes during helmet use. Thus, it was ensured that the effect of possible accidents to be reduced and the same helmet can be used by different users.

II. MATERIALS and METHODS

The necessity for the same helmet to be used by different users often emerges especially in jobs with task changes. For example, there are many police officers using the same motorcycle, pilots using the same aircraft, and dispatchers who go out with the same vehicle. In these cases, it is not possible to supply different helmets for each user in financial aspects. Helmet; while it has the protective effects that it will provide in the event of an accident, it should also provide the feature to remain in the head of the user at the time of the accident. If the helmet can provide all of these

features for different users, it will be possible to obtain common use. In this study, a protective helmet that can adapt to different sizes of head sizes of different users has been developed. This protective helmet is given in Figure 1.

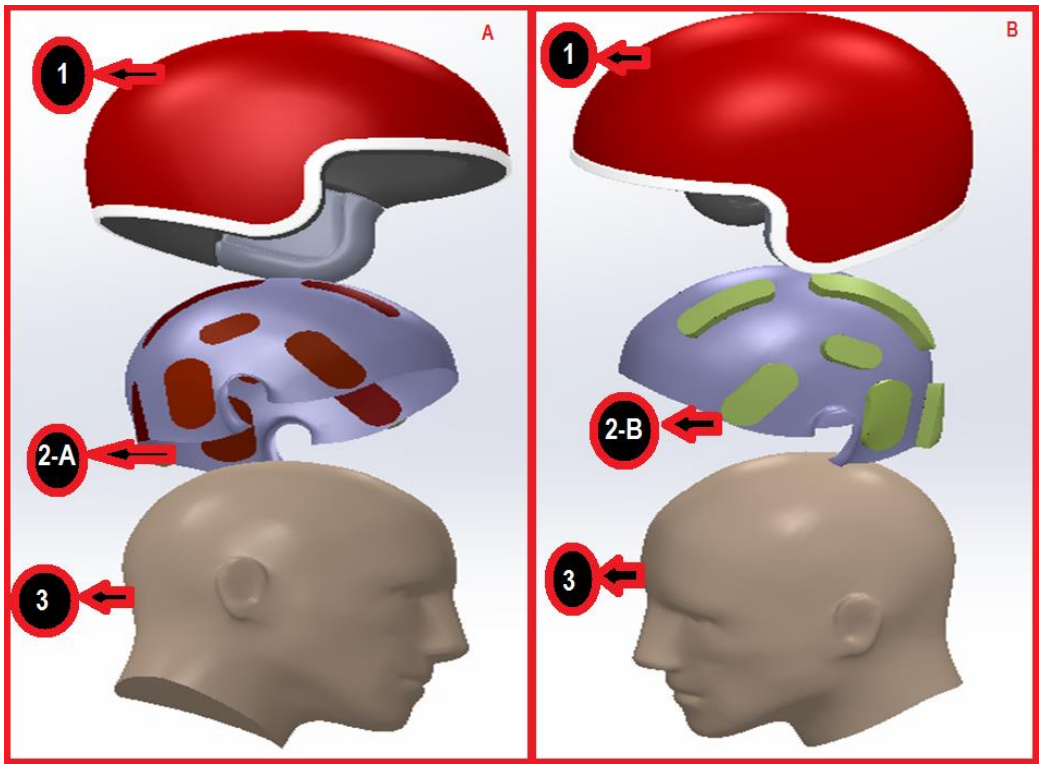

Figure 1. Developed Helmet System (A: Membrane Not Pressurized, B: Membrane Pressurized)

Part 1, given in Figure 1, is the outer body of the helmet, made of material that will provide durability to survive with minimal damage in the event of impact, has a design suitable for operation, the necessary air ducts. The protective outer body has a design that can absorb the indoor unit enough load. The picture item shows 3 different users. The 2-A element given in the figure is a membrane structure made of rubber-based material, developed for different head sizes, with fixing elements on the outer body of the helmet and with ventilation channels, designed with pneumatic inflatable areas. In Figure 2-A, there is a component operating like a balloon whose unpressurized status is shown. In Figure 2-B, it is shown as pressurized. The system has a completely pneumatic structure, the balloon areas swell during pressurization, a pneumatic compressor operated with the help of a battery carried on the helmet is used to create this swelling effect. System pressure is kept under constant control with adjustable pressure regulation valve. Each of the pneumatic balloons act jointly and operates like a single acting pneumatic actuator. When the work done by wearing a helmet is completed, the discharge of the compressed air inside the balloon is carried out with the pressure exhaust valve. Thanks to the check valve placed after the compressor, the return of the

pressurized air from the balloon is prevented. The pneumatic circuit diagram of the developed system is shown in Figure 2.

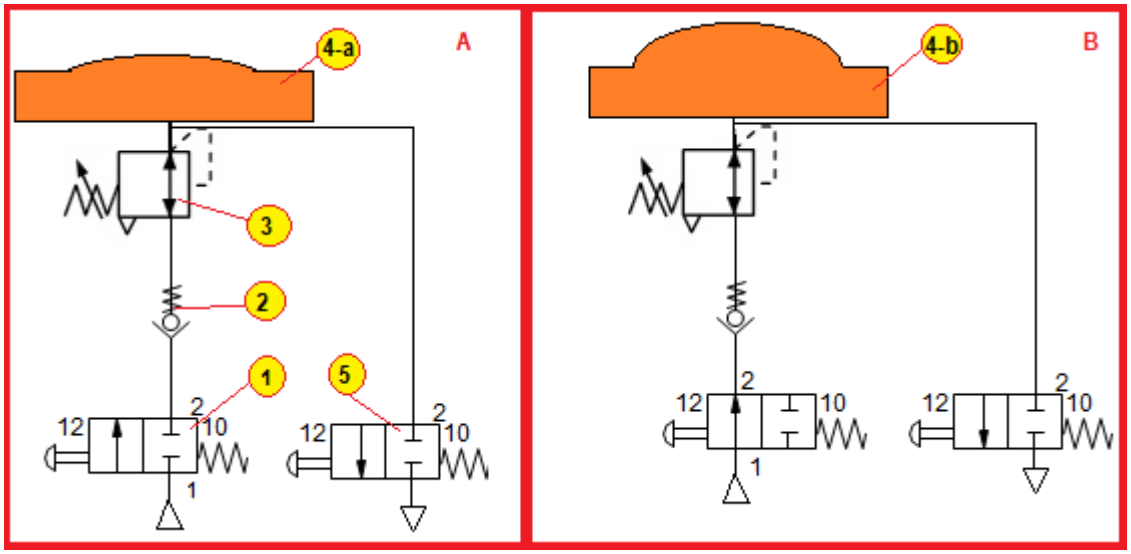

Figure 2. Developed helmet system pneumatic circuit diagram (A: Without pressurization, B: Pressurised)

Within the scope of the study, 2 3/2 button controlled, spring return valves are used. The first one (1) ensures that the compressed air source is sent to the system or not. When the air coming from the compressor by the user is sent to the system with the help of valve 1, check valve (2) is used to prevent the return of compressed air. The pressure regulator (3) is used to ensure that the system pressure remains at the desired value. In the initial state, the non-pressurized membrane structure (4-a) swells like a balloon after pressurization and provides the necessary compression on the head surface (4-b). When the helmet needs to be removed, compressed air is exhausted with the other button-controlled 3/2 spring return valve (5). Thus, it is ensured that the helmet stays in the head in the event of a possible accident.

III. Results

In this study, a helmet was developed, which can be expanded as a result of elastic deformation and remain stable on the head of the user. A pneumatic structure has been created for the necessary shape change. This helmet allows multiple use with its design suitable for use by different users. At the same time, it ensures the prevention of injuries and deaths caused by incompatible sizes between the current helmet user and the helmet. If the system becomes widespread, it will be possible for many military and civilian helmets to maintain their protective properties until the end of the accident. In

addition to the use of the developed system in a completely reproduced helmet structure, it is also possible to commercialize it as an additional apparatus and to allow the modification of existing helmets.

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