ERGONOMIC AND HUMAN FACTORS ANALYSIS OF RAM PARACHUTE RIPCORD/HANDLE SYSTEMS

PART I: TORSO POSITION

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INTRODUCTION

Parachute ripcordhandle positioning on the parachute harness in both military and civilian ram parachute assemblies have not formerly been subject to a comprehensive ergonomic and human factor analysis. Some studies have analyzed strength requirements and release capabilities of ripcords/handles for certain populations, however to date little work is available defining torso position based on an ergonomic and human factor analysis[1-2]. A study of this nature is important. Parachute ripcords/handles are used to deploy main parachutes, 'cut-away' a malfunctioning parachute, and deploy the reserve parachute. These procedures require precise hand-arm-eye coordinated movements which are executed in a freefall and stressful environments. In the military setting this situation is magnified due to the added problems of equipment weight and bulk, clothing bulk, gloves, and in certain circumstances life support systems.

This study conducted an ergonomic and human factors analysis of ripcordhandle system positioning on the harness of conventional present day military ram air parachute assemblies. Specifically, vertical and horizontal positioning on the harness was studied to define arm movements required to activate the system and to identify the optimal positioning to ensure ease of grasp, excessibility, visibility and biomechanical advantage. In Part I of the study, the main deployment handle was analyzed. This is located on the right riser of the harness.

METHODS

The primary method of analysis was based on a biomechanical computer model that was designed to simulate the upper arm movements around the ripcordhandle along the front right of the torso. The model used a geotrigometric solution solving for elbow angle, and posterior shoulder rotations necessary to reach and grasp the ripcord/handle without flexing the wrist. Fixed variables in the model were based on a three dimensional input which included shoulder declination, position of the ripcord on the torso, and the protrusion of the ripcord beyond the side of the torso. The model is based on the 95th centile arm length with component segments calculated from regression models from US Army male anthropometric data[3]. Three dimensional graphic surfaces were generated to describe the output and the define the associations between the output variables. The model was run in iterative sequences mapping out contours of elbow angle required to reach and activate the ripcordhandle. The model assumed a properly fitted and adjusted harness.

RESULTS

Military ram air parachute assemblies show poor ergonomic and human factor design of the ripcordhandle system positioning. Ripcordhandles are placed in positions that require extreme elbow flexion and posterior shoulder rotation with wrist flexion to acquire and activate the system. Military parachutists are therefore forced to use awkward arm movements and positions to activate the parachute. The biomechancial model also defmed and quantified the required arm movements. This showed that ripcords and handles are commonly too high (headward) up on the front of the chest. The model demonstrated by lowering the ripcordhandle downward (towards the waist) on the front of the chest. the angles at the elbow, posterior shoulder rotation, and wrist flexion could be optimized thus ensuring a less awkward ripcord/handle operation.

It was found that the ideal position for a ripcordhandle is dependent on the individuals arm length, torso length, clothing bulk, and chest depth. The ideal location for the ripcord can be identified using an anthropometric land mark, the olecranon. This is used by placing a 90 degree flexed elbow against the side of the body in the vertical plane and using the olecranon to mark the mid-point of the ripcordhandle position on the side of the torso. Here the ripcord/handle should be placed on the riser of the harness.

CONCLUSION

The governing principles underlying the placement of ripcordhandle systems on the parachute harnesses is visibility, accessibility, ease of grasp, and force to activate. All of these criteria are improved by keeping

the positioning low rather than high on the torn. This analysis has begun to formalise and define parameters of upper arm movement that will provide parachute designers With guidelines to make ripcord/handle system with better ergonomic and human factor design.

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