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Verification of Low-Dose Diagnostic X-Ray as a Tool for Relating Vital Internal Organ Structures to External Body Armour Coverage

Authors : Natalie A. Sterk, Bernard van Vuuren, Petrie Marais, Bongani Mthombeni

Abstract : Injuries to the internal structures of the thorax and abdomen remain a leading cause of death among soldiers. Body armour is a standard issue piece of military equipment designed to protect the vital organs against ballistic and stab threats. When configured for maximum protection, the excessive weight and size of the armour may limit soldier mobility and increase physical fatigue and discomfort. Providing soldiers with more armour than necessary may, therefore, hinder their ability to react rapidly in life-threatening situations. The capability to determine the optimal trade-off between the amount of essential anatomical coverage and hindrance on soldier performance may significantly enhance the design of armour systems. The current study aimed to develop and pilot a methodology for relating internal anatomical structures with actual armour plate coverage in real-time using low-dose diagnostic X-ray scanning. Several pilot scanning sessions were held at Lodox Systems (Pty) Ltd head-office in South Africa. Testing involved using the Lodox eXero-dr to scan dummy trunk rigs at various degrees and heights of measurement; as well as human participants, wearing correctly fitted body armour while positioned in supine, prone shooting, seated and kneeling shooting postures. The verification of sizing and metrics obtained from the Lodox eXero-dr were then confirmed through a verification board with known dimensions. Results indicated that the low-dose diagnostic X-ray has the capability to clearly identify the vital internal structures of the aortic arch, heart, and lungs in relation to the position of the external armour plates. Further testing is still required in order to fully and accurately identify the inferior liver boundary, inferior vena cava, and spleen. The scans produced in the supine, prone, and seated postures provided superior image quality over the kneeling posture. The X-ray-source and-detector distance from the object must be standardised to control for possible magnification changes and for comparison purposes. To account for this, specific scanning heights and angles were identified to allow for parallel scanning of relevant areas. The low-dose diagnostic X-ray provides a non-invasive, safe, and rapid technique for relating vital internal structures with external structures. This capability can be used for the re-evaluation of anatomical coverage required for essential protection while optimising armour design and fit for soldier performance.

Keywords : body armour, low-dose diagnostic X-ray, scanning, vital organ coverage
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