6th International Conference on Nanotechnologies and Biomedical Engineering
Proceedings of ICNBME-2023, September 20–23, 2023, Chisinau, Moldova
Volume 2: Biomedical Engineering and New Technologies for Diagnosis, Treatment, and Rehabilitation

Methodology and Use of Experimental Techniques in Analyzing Wound Dynamics of Penetrating Injuries

Roman Tomashevskyi, Oleksiy Larin, Kostyantyn Kolisnyk, Andrey Zuev, Kostyantyn Gumeniuk, Igor Lurin, Volodymyr Nehoduiko

https://doi.org/10.1007/978-3-031-42782-4_23

Abstract

This research paper focuses on the experimental studies of the process of high-speed object penetration into human body simulators and the automated registration of physical phenomena parameters related with this process. It highlights the need for a comprehensive understanding of the physical processes involved and the challenges posed by the lack of biomedical information. It emphasizes the importance of studying the volume and characteristics of damage around the wound channel. The paper also proposes a methodology encompassing mathematical modeling, experimental studies using non-biological simulators, and data processing techniques to investigate wound dynamics. An experimental setup with a distributed information and measurement system is presented, enabling the collection and analysis of physical parameters during penetration impacts. The structure of a distributed information-measuring system has been developed that allows recording the parameters of physical processes that occur during the penetration of a high-speed object into the simulator. The problem of synchronization of many distributed sensors, which is important for recording the parameters of short-term processes, is analyzed in detail. An example of obtaining data when launching a high-speed object into a simulator using an electric mass accelerator within the framework of the proposed system is given. The research aims to enhance medical practices, and protective equipment design, contributing to improved treatment outcomes and patient care.

6th International Conference on Nanotechnologies and Biomedical Engineering
Proceedings of ICNBME-2023, September 20–23, 2023, Chisinau, Moldova
Volume 2: Biomedical Engineering and New Technologies for Diagnosis, Treatment, and Rehabilitation

Keywords: distributed monitoring system, wound dynamics, human body simulators, data processing, wireless communication, medical diagnostics

References

1. Myrhorodsky, D.S.: Gunshot wounds: care tactics and prevention of thrombotic complications. In: Specialized Medical Portal HEALTH-UA.COM (2022). https://health-ua.com/article/69898-vognepaln-poranennya--taktika-nadannya-dopomogi-taproflaktika-trombotichnih (in Ukraine)

2. Roy, I.V., Borzykh, N.O.,Katyukova, L.D., Borzykh, O.V.:Modern approaches to the rehabilitation of servicemen with polystructural gunshot wounds of the upper extremity. Klinichna khirurhiia **86**(5), 34–38 (2019) (in Ukraine). https://pdfs.semanticscholar.org/ae94/b6499c110dfe356d67c02e6e3d348da7ebde.pdf

3. Kutovy, O.B., Sergeev, O.O., Kosulnikov, S.O., Sokolov, O.V.: Experience in the treatment of gunshot injuries of soft tissues and main vessels at the stages of evacuation. Acute and emergency conditions in the practice of a doctor. **5**(47) 31–33 (2015) (in Ukraine). https://urgent.com.ua/uploads/issues/2015/5(47)/oins2015_5_31-33_09f07c3879c0178be2f4a77cf06c1fa5.pdf

4. Cronin, D.:Ballistic gelatin characterization and constitutive modeling. In:DynamicBehavior of Materials, pp. 51–55. Springer (2011)

5. Fountain, A.J., Corey, A., Malko, J.A., Strozier, D., Allen, J.W.: Imaging appearance of ballistic wounds predicts bullet composition: implications forMRI safety. Am. J. Roentgenol. **216**(2), 542–551 (2021). https://doi.org/10.2214/AJR.20.23648

6. Wen, Y., Xu, C.,Wang, H., Chen, A., Batra, R.C.: Impact of steel spheres on ballistic gelatin at moderate velocities. Int. J. Impact Eng. **62**, 142–151 (2013). https://doi.org/10.1016/j.ijimpeng.2013.07.002

7. Pinto, A., Russo, A., Reginelli, A., et al.: Gunshot wounds: ballistics and imaging findings. Semin. Ultrasound CT MRI **40**(1), 25–35 (2019). https://doi.org/10.1053/j.sult.2018.10.018

8. Bolliger, S.A., et al.: Gunshot energy transfer profile in ballistic gelatine, determined with computed tomography using the total crack lengthmethod. Int. J. LegalMed. **124**(6), 613–616 (2010). https://doi.org/10.1007/s00414-010-0503-z

9. Chanda,A., Unnikrishnan,V.:Arealistic 3D computational model of the closer of skinwound with interrupted sutures. J. Mech.Med. Biol. **17**(1), 1–21 (2017). https://doi.org/10.1142/S0219519417500257

10. Kolisnyk, K., Zamiatin, P.: Perfection ofmethods for constructing remote monitoring systems for patients in emergency situations. In: Proceedings of the 3rd International Conference on Intelligent Energy and Power Systems (IEPS), Kharkiv, Ukraine, pp. 371–376 (2018). https://doi.org/10.1109/IEPS.2018.8559526

11. Sokol, E.,Avrunin, O.,Kolisnyk, K.,Zamiatin, P.: Usingmedical imaging in disastermedicine. In: Proceedings of the IEEE 4th International Conference on Intelligent Energy and Power, Istanbul, Turkey, pp. 287–290 (2020). https://doi.org/10.1109/IEPS51250.2020.9263175

12. Kolisnyk, K., Sokol, Y., Avrunin, O., Kolisnyk, V., Klymenko, V.: Applying discriminant analysis to improve telemedicine diagnostics quality. In: Proceedings of the IEEE EUROCON 19th International Conference on Smart Technologies, Lviv, Ukraine, pp. 280–283 (2021). https://doi.org/10.1109/EUROCON52738.2021.9535576

13. Halvorsen, F., et al.: Virtual reality simulator training equals mechanical robotic training in improving robot-assisted basic suturing skills. Surg. Endosc. **20**(10), 1565–1569 (2006). https://doi.org/10.1007/s00464-004-9270-6

14. Tsymbalyuk, V.I., Lurin, I.A., Usenko, O.Y., Gumeniuket, K.V., et al.: Results of experimental research of wound ballistics of separate types and calibers of modern bullets. Medicni perspektivi **26**(4), 4–14 (2021). https://doi.org/10.26641/2307-0404.2021.4.247409

15. Zuev, A., Ivashko, A., Lunin, D.: Diagnosis methods for mechanisms and machines based on empirical mode decomposition of a vibrosignal and the Wilcoxon test. Modern Inf. Syst. **6**(4), 51–57 (2022). https://doi.org/10.20998/2522-9052.2022.4.07

16. Zuev, A., Vodka, O.: Development of a distributed wireless vibration measurement and monitoring system. In: Proceedings of the IEEE 3rd KhPI Week on Advanced Technology (KhPIWeek), Kharkiv, Ukraine, pp. 915–920 (2022). https://doi.org/10.1109/KhPIWeek57572.2022.9916375