Journal of Orthopaedic Translation 20 (2020) 1–2

Contents lists available at ScienceDirect

Journal of Orthopaedic Translation

journal homepage: www.journals.elsevier.com/journal-of-orthopaedic-translation

Editorial

Translation of engineering to medicine: A focus on finite element analysis

When discussing translational research, one often hears the phrase "bench-to-bedside" and more recently "bench-to-bedside and back to bench". Translational medicine focuses on connecting basic research, clinical applications, and societal improvement, to ensure that all three elements continuously benefit and improve one another. However, we can no longer ignore a fourth element, engineering.

Engineering encompasses a vast field, which may include computer modelling, imaging, biomaterials and devices, and robotics, to name a few. This special issue focuses on some of these areas and opportunities they provide for the orthopaedic field, to better treat patients and study diseases.

Finite element analysis (FEA) has been used for many years by engineers to determine how devices or structures may behave under different circumstances. This has been greatly enhanced by more powerful and advanced computer systems and has benefitted the field of orthopaedics because of the wide use of implants and devices. Devices made using this technology take different scenarios and movements into account, making them safer and more effective.

McCollough et al. [1], Lee et al. [2] and Feng et al. [3] described three novel screws that were designed using FEA, which have the potential to reduce screw failure, improve surgical success, and stabilise fixations. Using medical imaging, we can also perform FEA on tissue of patients. Jiang et al. [4] used a combination of magnetic resonance imaging, computed tomography, and FEA to determine the biomechanical changes in patients with knee osteoarthritis, which may help to improve patient welfare and prevent further injury. Zhang et al. [5] used a combination of FEA, magnetic resonance imaging, and gait analysis to determine how athletic taping affected plantar fascia strain during running, which could lower the risk of injury in athletes. Wang et al. [6] also used gait analysis and imaging to determine biomechanical outcomes after total knee arthroplasty, which may help to establish better surgical options and techniques.

Similarly, imaging techniques are becoming more advanced, helping to develop computer models and new devices. Gueorguiev-Rüegg et al. [7] developed generic Asian pelvic bone models by using computed tomography imaging and computer modelling, which helped to develop a new artificial bone model for a population subset that does not benefit from the current artificial bone models so far. Yang et al. [8], Mao et al. [9], and Liu et al. [10] demonstrated three unique studies on how plain radiography may be used to develop improved reporting systems and outcome measures with the aid of advanced statistical analysis.

Biomaterial engineering has helped to advance orthopaedic medicine in recent years, with the help of chemical engineering, imaging, and computer modelling as well; Yang et al. [11] developed a novel cement for screw fixation, which relies on the aforementioned technology. Similarly, Nowakowski et al. [12] used imaging and computer modelling to test the biomechanics of total knee endoprostheses.

Robotics is a complex application of multiple fields of engineering and is helping to transform medicine. One example is presented by Chen et al. [13] who tested a robotic system that could provide a guidance trajectory for screw insertion during spinal surgery. Pan et al. [14] discussed robotic hip exoskeletons in their review, presenting novel technologies that could assist patients with simple tasks such as walking, or more challenging tasks such as lifting heavy objects.

Finally, this special issue presents a review on novel guidelines for spinal cord injury developed by clinicians, for clinicians. Feng et al. [15] developed guidelines to assess and treat spinal cord injuries; these guidelines are regularly updated with advanced technologies and devices that may aid patients.

The methods and techniques described in this special issue are at the forefront of bioengineering and advanced medicine, which will only be enhanced in coming years. Great strides have recently been made in the fields such as biochemical engineering, robotics, and quantum computing; with these new developments, translational medicine will continue to advance and develop alongside technological developments.

References

[1] Mau Jonquil R, Hawkins Kevin M, Woo Savio L-Y, Kim Kwang E, McCullough Matthew BA. Design of a new magnesium-based anterior cruciate ligament interference screw using finite element analysis. J Orthop Transl 2019;(20):25–30.

[2] Yang Jesse Chieh-Szu, Chen Cheng-Fong, Lee Oscar K. Benefits of opposite screw insertion technique in medial open-wedge high tibial osteotomy: a virtual biomechanical study. J Orthop Transl 2019;(20):31–6.

[3] Cai L, Zhang Y, Zheng W, Wang J, Guo X, Feng Y. A novel percutaneous crossed screws fixation in treatment of Day type II crescent fracture–dislocation: a finite element analysis. J Orthop Transl 2019;(20):37–46.

[4] Li L, Yang L, Zhang K, Zhu L, Wang X, Jiang Q. Three-dimensional finite-element analysis of aggravating medial meniscus tears on knee osteoarthritis. J Orthop Transl 2019;(20):47–55.

[5] Chen TL, Wong DW, Peng Y, Zhang M. Prediction on the plantar fascia strain offload upon Fascia taping and Low-Dye taping during running. J Orthop Transl 2019;(20):113–21.

https://doi.org/10.1016/j.jot.2019.12.001

[6] Zeng YM, Yan MN, Li HW, Zhang J, Wang Y. Does mobile-bearing have better flexion and axial rotation than fixed-bearing in total knee arthroplasty? A randomised controlled study based on gait. J Orthop Transl 2019;(20):86–93.
[7] Ahrend MD, Noser H, Shanmugam R, Burr F, Kamer L, Zaman TK, …, Gueorguiev-Rüegg B. Development of generic Asian pelvic bone models using CT-based 3D statistical modelling. J Orthop Transl 2019;(20):100–6.
[8] Pan M, Ge J, Li Q, Li S, Mao H, Meng B, et al. Percutaneous vertebral augmentation in special Genant IV osteoporotic vertebral compression fractures. J Orthop Transl 2019;(20):94–9.
[9] Peng P, Chen K, Chen H, Zhang K, Sun J, Yang P, et al. Comparison of O-arm navigation and microscope-assisted minimally invasive transforaminal lumbar interbody fusion and conventional transforaminal lumbar interbody fusion for the treatment of lumbar isthmic spondylolisthesis. J Orthop Transl 2019;(20):107–12.
[10] Ji W, Zhang YJ, Zhou F, Mao HQ, Yang HL, Liu T. Comparing clinical outcomes of using 3 versus 5 titanium miniplates in laminoplasty for multilevel cervical myelopathy: a prospective cohort study. J Orthop Transl 2019;(20):67–72.
[11] Sun H, Liu C, Li X, Liu H, Zhang W, Yang H, et al. A novel calcium phosphate–based nanocomposite for the augmentation of cement-injectable cannulated pedicle screws fixation: a cadaver and biomechanical study. J Orthop Transl 2019;(20):56–66.
[12] Stöbe C, Hoechel S, Müller-Gerbl M, Nowakowski AM. Systematic effects of femoral component rotation and tibial slope on the medial and lateral tibiofemoral flexion gaps in total knee endoprostheses. J Orthop Transl 2019. in press.
[13] Zongze Li, Chen Jianting, Zhu Qing-An, Zheng Shaoli, Zhong Zhaoming, Yang Jincheng, et al. A preliminary study of a novel robotic system for pedicle screw fixation: a randomized controlled trial. J Orthop Transl 2019;(20):73–9.
[14] Chen B, Zi B, Qin L, Pan Q. State-of-the-art research in robotic hip exoskeletons: a general review. J Orthop Transl 2019;(20):4–13.
[15] Huang H, Young W, Skaper S, Chen L, Moviglia G, Saberi H, et al. Clinical neurorestorative therapeutic guidelines for spinal cord injury (IANR/CANR version 2019). J Orthop Transl 2019;(20):14–24.

Ming Zhang[a,*], He Gong[b]
[a] *Department of Biomedical Engineering, The Hong Kong Polytechnic University, China*
[b] *School of Biological Science and Medical Engineering, Beihang University, China*

[*] Corresponding author. Department of Biomedical Engineering, The Hong Kong Polytechnic University, China.