

‘Ergopaedics’: the future of ergonomics in orthopaedics

Ergonomics is the scientific study of people and their working conditions, aiming to improve effectiveness. Improved ergonomics of orthopaedic theatres and equipment would reduce the risk of occupational injury and help to encourage more women into an underrepresented specialty.

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Introduction

Ergonomics is the study of people’s efficiency in their working environment. It is more relevant now than ever in trauma and orthopaedic surgery, as it impacts on a number of issues, including a high rate of occupational injuries, perceived barriers of entry for women and the incorporation of novel technologies.

Ergonomics focuses on how the working environment is designed to suit the worker. This includes the design of instruments, machines, systems and environments for safe, comfortable and effective use (Schlussel and Maykel, 2019).

Surgeons face hazardous working conditions as a result of ergonomic deficiencies in operating theatres (Schlussel and Maykel, 2019). Yet there is limited research on ergonomics, particularly in trauma and orthopaedics. The future of orthopaedics is inextricably linked to ergonomics. Without acknowledging this vital link, there is the risk of jeopardising the safety of surgeons, stifling innovation and failing to encourage new staff, particularly women, into the specialty – all resulting in worse patient outcomes.

Reducing musculoskeletal injury

Trauma and orthopaedic surgery involves a high demand on the musculoskeletal system of surgeons. Body positions adopted while operating can contribute to injury (AlQahtani et al, 2016). A study conducted with the Orthopaedic Trauma Association showed that two-thirds of orthopaedic surgeons reported at least one musculoskeletal injury during their career, with the most common injuries being lower back pain (27%) and forearm tendonitis (17%) (AlQahtani et al, 2016). Patient care can be affected, as 36% of injured surgeons reported that their performance in theatre was impacted (Davis et al, 2013), and 27% of orthopaedic trauma surgeons reported that they required time off work as a result of injury (AlQahtani et al, 2016). This can result in financial and psychological consequences, with permanent effects on their career (Davis et al, 2013).

Another issue is protection for orthopaedic surgeons using powered tools and loud instruments. Willett (1991) showed that noise-induced hearing loss can result from years of exposure to orthopaedic instruments. The suggestion of using routine hearing protection has been met with resistance because of the cumbersome nature of the equipment and the risks of impeding communication (Butt et al, 2014). Perhaps the solution could be found within the military? In 2015, the UK Ministry of Defence introduced a tactical hearing protection system featuring lightweight, in-ear protection headsets. These allow situational awareness, comfort and protection against impulse noises and hearing loss (Sumsion, 2017). The orthopaedic community should investigate whether this could be adapted to solve similar problems.

Furthermore, there is limited support for surgeons to help with their recovery from occupational injury. Davis et al (2013) found that only 38% of orthopaedic surgeons who sustained musculoskeletal injuries had institutional support following their injury. The exponentially growing demand for orthopaedic surgeons, retirement age and output will have a crucial impact on the delivery of orthopaedic care. Therefore, the work efficiency and physical health of orthopaedic surgeons needs to become a priority.

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Many opportunities for development stem from these highlighted areas. More research is required into occupational injury in orthopaedic surgery; the risks can and should be reduced. Collaboration with other industries including the armed forces would allow adaptation of proven technology to tackle similar problems. Locally organised training sessions would aid development and ensure efficient ergonomic practice with power tools and instruments. If injuries still result, hospitals should develop resources to support surgeons in their recovery.

Increasing diversity with women in surgery

2021 is the 30th anniversary of the Women in Surgery network. Their mission statement is to encourage, enable and inspire women to achieve their surgical potential (Bhatti, 2020). Patients of female surgeons have fewer complications and lower mortality rates (Wallis et al, 2017). Despite this, orthopaedic surgery has the lowest proportion of women across all surgical specialties (Green et al, 2020). Therefore, it is more relevant than ever to focus on the potential barriers preventing women from entering orthopaedic surgery.

One such barrier is orthopaedic surgical instruments. Many orthopaedic devices are named after their male designers, such as the Trendelenburg table, Kirschner wires and Steinmann pins (Meals and Wang, 2010). Most surgical equipment has been designed 'by men for men' and has not accounted for the anthropometrics of women. Data indicate that surgeons who are men are taller and have larger hands than those who are women. This has implications for the development of tools. In other surgical specialties, smaller hand size is associated with an increased risk of injury as a result of poor equipment ergonomics (Stellon et al, 2017). In 2019, the Women in Arthroplasty committee held a seminar focused on understanding and overcoming the ergonomic challenges that female total joint arthroplasty surgeons may face. This included patient positioning and techniques for optimising prosthesis implantation. This highlighted issues with instrument size and chronic overuse injury (Rapp, 2019). Fram et al (2021) reported issues with the ergonomics of orthopaedic surgical instruments for surgeons who are women. They were more likely to report physical symptoms attributable to surgical instruments, have negative attitudes towards equipment design and identify more instruments as difficult or uncomfortable to use. Using inappropriately designed instruments can lead to stress-induced fatigue, decreased productivity and shortened careers. Manufacturers have been called on to factor in hand size when designing tools (Stellon et al, 2017). Stryker Corp now incorporates ergonomic principles into their design of orthopaedic tools to fit smaller hands. Furthermore, novel devices can assist force generation in high-load orthopaedic actions such as bone cutting for individuals with smaller hands (van Gorkum et al, 2012).

Another barrier to entry is the perceived physical nature of orthopaedics. One study found that 57% of UK medical students who were women cited the physical demands of orthopaedics as a major deterrent for considering the specialty (Farooq et al, 2009). Advances in modern power tools have made strength much less of a prerequisite. The skillset has shifted towards manual dexterity, mechanical ability and three-dimensional visualisation. The British Orthopaedic Trainees' Association is working to raise awareness of this topic. This information should be highlighted to junior trainees and medical students to help counter this incorrect preconception.

There are several areas to target: a national survey of women's experience of ergonomics and injury in orthopaedic surgery would add much-needed data on the subject. Similar strategies have been effective in military studies that identified increased numbers of musculoskeletal injuries in women and as a result they introduced proprioceptive prevention strategies (Roy et al, 2015). Research into orthopaedic instrument design based on the anthropometrics of women could be facilitated by nominated female champions working with industry partners. This would ensure gender equity in the design of orthopaedic equipment and produce role models to inspire others. Providing workshops and educational material to juniors on using tools could help dispel common misconceptions with training and widen access to orthopaedics.

In terms of education, developments in virtual reality devices have benefits to the ergonomics of orthopaedic theatres as they are virtual, light in design and increase operating

Key points

- Ergonomics is the study of people's efficiency in their working environment.
- Trauma and orthopaedic surgery has a high rate of occupational injury and there is limited research, knowledge or institutional support in this area.
- Improved awareness, education and design of orthopaedic equipment would reduce time off work, improve mental health and prolong careers.
- Improvements in the ergonomic design of orthopaedic instruments for the anthropometrics of women would reduce the risk of injury to surgeons who are women as well as hopefully encouraging women into trauma and orthopaedic surgery.
- Solutions include collaboration with the armed forces to implement proven solutions for similar problems, and incorporation of virtual reality devices to benefit orthopaedic theatres, prevent musculoskeletal injury and improve training opportunities.

efficiency. Not only does virtual reality enable surgeons to connect in real time and deliver optimum patient care, it also provides training benefits and reduces musculoskeletal load (Karim, 2020). Such tools could provide solutions for common problems such as reducing intraoperative radiation and increasing training opportunities. This would create a safer working environment.

Conclusions

The future of orthopaedics has exciting potential which can be unlocked by spearheading developments in ergonomics. This is needed to prolong careers, improve patient outcomes, encourage women into the specialty and provide a better training environment. It is crucial that occupational injury is researched and addressed in groups of orthopaedic surgeons, to maintain and optimise physical and mental health and improve work efficiency and longevity of practice. Collaborative efforts between orthopaedic surgeons who are women and industry partners should facilitate more ergonomic designs suited for the anthropometrics of women and lead to a more inclusive culture. These developments can be accelerated by working with other sectors, including the armed forces and the technology industry. It is vital that these issues are addressed to safeguard the future of trauma and orthopaedic surgery.

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References

- AlQahtani SM, Alzahrani MM, Harvey EJ. Prevalence of musculoskeletal disorders among orthopedic trauma surgeons: an OTA survey. *Can J Surg*. 2016;59(1):42–47. <https://doi.org/10.1503/cjs.014415>
- Bhatti F. Deeds not words. *Bulletin*. 2020;102(8):344–344. <https://doi.org/10.1308/rcsbull.2020.193>
- Butt D, Hadjipavlou M, Walczak J. A noise at work assessment in the orthopaedic operating theatre. *Bulletin*. 2014;96(1):32–34. <https://doi.org/10.1308/003588414X13814021676990>
- Davis WT, Sathiyakumar V, Jahangir AA, Obremskey WT, Sethi MK. Occupational injury among orthopaedic surgeons. *J Bone Joint Surg Am*. 2013;95(15):e107. <https://doi.org/10.2106/JBJS.L.01427>
- Farooq S, Kang S-N, Ramachandran M. Sex, power and orthopaedics. *J R Soc Med*. 2009;102(4):124–125. <https://doi.org/10.1258/jrsm.2009.090011>
- Fram B, Bishop ME, Beredjiklian P, Seigerman D. Female sex is associated with increased reported injury rates and difficulties with use of orthopedic surgical instruments. *Cureus*. 2021;13(5):e14952. <https://doi.org/10.7759/cureus.14952>

- Green JA, Chye VPC, Hiemstra LA et al. Diversity: women in orthopaedic surgery – a perspective from the International Orthopaedic Diversity Alliance. 2020. <https://www.boa.ac.uk/uploads/assets/a24ead71-ad82-4e23-98efacf343cbd015/Diversity-women-in-orthopaedic-surgery-IODA-perspectiveupdated-110320.pdf> (accessed 8 November 2021)
- Karim J. Yes, she can! Why medtech needs female innovators now more than ever. *Bulletin*. 2020;102(8):353–355. <https://doi.org/10.1308/rcsbull.2020.201>
- Meals C, Wang J. Origins of eponymous orthopaedic equipment. *Clin Orthop Relat Res*. 2010;468(6):1682–1692. <https://doi.org/10.1007/s11999-009-1221-z>
- Rapp SM. AAHKS Women in Arthroplasty Committee addresses diversity, mentorship. 2019. <https://www.healio.com/news/orthopedics/20191111/aahks-women-in-arthroplasty-committee-addresses-diversity-mentorship> (accessed 11 November 2021)
- Roy TC, Piva SR, Christiansen BC et al. Description of musculoskeletal injuries occurring in female soldiers deployed to Afghanistan. *Mil Med*. 2015;180(3):269–275. <https://doi.org/10.7205/MILMED-D-14-00365>
- Schluskel AT, Maykel JA. Ergonomics and musculoskeletal health of the surgeon. *Clin Colon Rectal Surg*. 2019;32(06):424–434. <https://doi.org/10.1055/s-0039-1693026>
- Stellon M, Seils D, Mauro C. Assessing the importance of surgeon hand anthropometry on the design of medical devices. *J Med Devices*. 2017;11(4):041004. <https://doi.org/10.1115/1.4037257>
- Sumsion L. Protecting the troops - defence equipment and support. 2017. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/625454/July_Desider_2017-small.pdf (accessed 8 November 2021)
- van Gorkum RFP, Dankelman J, Tuijthof GJM. Device to assist force generation in high-load orthopedic actions. *J Med Devices*. 2012;6(1):017530. <https://doi.org/10.1115/1.4026708>
- Wallis CJ, Ravi B, Coburn N, Nam RK, Detsky AS, Satkunasivam R. Comparison of postoperative outcomes among patients treated by male and female surgeons: a population based matched cohort study. *BMJ*. 2017;359:j4366. <https://doi.org/10.1136/bmj.j4366>
- Willett KM. Noise-induced hearing loss in orthopaedic staff. *J Bone Joint Surg Br*. 1991;73-B(1):113–115. <https://doi.org/10.1302/0301-620X.73B1.1991742>