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Commentary

Robotics in Hip and Knee Arthroplasty: Real Innovation or Marketing Ruse

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We have just entered the second half century of total hip and total knee arthroplasty, surgical procedures that are arguably among the greatest feats of modern civilization. Despite the immense success of total joint arthroplasty, the orthopedic community has continued to "innovate." With survivorship of arthroplasty approaching 98% at 10 years and 95% at 20 years, there is little room for improvement and any innovation must clear a high bar [1,2]. Presently, the chance of improvement is equaled by the risk of failure. In fact, many innovations in recent years have failed their mission leading to the suffering of patients. Metal-on-metal bearing surfaces and modular femoral stems for primary hip arthroplasty come to mind.

We are dancing on the asymptotic apex of a concept—the replacement of arthritic joint surfaces with prosthetic materials—where any change must be substantiated by the principles of the scientific method that for centuries has served us so well. Much of today's innovation is fostered by industry rather than by academia. Most have some investment in the hope that a biologic solution—the resurfacing of eburnated bone with new articular cartilage, rather than metal and plastic—will surpass our current solutions. A Nobel Prize awaits the inventor of that technology. Abrasion chondroplasty, microfracture, cartilage metabolites, and most recently stem cells have yet to withstand the test of scientific scrutiny.

Most orthopedic companies have placed their biggest bet on robotics. Their hope is that these devices will expedite recuperation, improve kinematics and functions, extend longevity, and decrease premature implant failure. None of the authors of this editorial uses robotics. We all share conflicts of interest. These hopes are all awaiting clinical substantiation. We are not Luddites and we embrace innovation. Were robotics proven truly beneficial and cost-effective, the rewards to industry and to the patient would be substantial.

The great promise of robotics is to reduce outliers, and that is entirely possible. But soft tissue balancing trumps alignment, manual dexterity, "feel," and decision-making are paramount. They are unlikely to be replaced by even the amazing pattern-recognition capabilities of artificial intelligence. Just as companies are unlikely to affect a "rep-less" operative experience, a "doc-less" arthroplasty is even less plausible. For now, at least, our job security is not threatened.

Malcom Gladwell, in *Outliers*, wrote famously of the 10,000 hours of practicing a skill—playing the cello, transsphenoidal hypophysectomy, foul shooting—necessary for mastery of that art. The best total joint surgeons largely share that experience. So, will robotics short cut that threshold and make arthroplasty successful for all? Or will it rob these young surgeons of the chance to achieve that mastery and succeed even if someone pulls the plug?

The cost of robotics is minimized by its proponents. But the devices are hugely expensive, require technological support staff beyond the sales associate, and demand a requisite number of eligible cases per year to break even—which can affect clinical judgment [3,4]. Paradoxically, those high-volume surgeons who can afford it, do not need it; low-volume surgeons who need it, cannot afford it. In addition to the high, fixed start-up cost of the

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robotic device and per-case cost of disposables, current robotic technology requires a computed tomography scan, which comes at both a cost and an inconvenience to the patient, in addition to the radiation. In the era of value-based healthcare, new innovations should improve the quality of arthroplasty care to justify their increased cost to the healthcare system.

Improved long-term outcomes have yet to be seen, despite much short-term phenomenology buoyed by marketing incentives. The one incontestable fact is that the robotic cases take more operative time [5,6], which is linearly related to complications—particularly infection and thromboembolisms [7]. Are we merely exchanging outliers without clinical benefit for complications without clinical solutions?

In a recent *Journal of Bone and Joint Surgery* issue, a superlative robotic overview [8] was immediately preceded by an excellent evidence-based article showing no clinical benefit to computer-assisted surgery over 15 years! [9]. The overwhelming majority of orthopedists would probably prefer their own total joint be performed by a very experienced surgeon than by an expensive robot.

The promise of robotics remains seductive and should be pursued. Objective scientific evidence must necessarily precede its general implementation. And one cannot ignore the subjective aspects of unsophisticated patient demand, marketing allure, possible psychological patient satisfaction, and the "Dumbo's feather" effect for the inexperienced surgeon. Yet one should not forget the impact of computerized electronic medical record on the timeliness, volume, convenience, quality of care, and patient/physician satisfaction. Bringing a robot to your operating room may be much like bringing the electronic medical record to your clinic.

References

[1] Callaghan JJ, Bracah P, Liu SS, Piyaworakhun S, Goetz DD, Johnston RC. Survivorship of a Charnley total hip arthroplasty. A concise follow-up, at a minimum of thirty-five years, of previous reports. J Bone Joint Surg Am 2009;91:2617–21. https://doi.org/10.2106/JBJS.H.01021.

[2] Jauregui JJ, Cherian JJ, Pierce TP, Beaver WB, Issa K, Mont MA. Long-term survivorship and clinical outcomes following total knee arthroplasty. J Arthroplasty 2015;30:2164–6. https://doi.org/10.1016/j.arth.2015.05.052.

[3] Williams SB, Prado K, Hu JC. Economics of robotic surgery. Urol Clin North Am 2014;41:591–6. https://doi.org/10.1016/j.ucl.2014.07.013.

[4] Banerjee S, Cherian JJ, Elmallah RK, Jauregui JJ, Pierce TP, Mont MA. Robotic-assisted knee arthroplasty. Expert Rev Med Devices 2015;12:727–35. https://doi.org/10.1586/17434440.2015.1086264.

[5] Bellemans J, Vandenneucker H, Vanlauwe J. Robot-assisted total knee arthroplasty. Clin Orthop Relat Res 2007;464:111–6. https://doi.org/10.1097/BLO.0b013e318126c0c0.

[6] Song E-K, Seon J-K, Yim J-H, Netravali NA, Bargar WL. Robotic-assisted TKA reduces postoperative alignment outliers and improves gap balance compared to conventional TKA. Clin Orthop Relat Res 2013;471:118–26. https://doi.org/10.1007/s11999-012-2407-3.

[7] Bohl DD, Ondeck NT, Darrith B, Hannon CP, Fillingham YA, Della Valle CJ. Impact of operative time on adverse events following primary total joint arthroplasty. J Arthroplasty 2018;33:2256–2262.e4. https://doi.org/10.1016/j.arth.2018.02.037.

[8] Chen AF, Kazarian GS, Jessop GW, Makhdom A. Robotic technology in orthopaedic surgery. J Bone Joint Surg Am 2018;100:1984–92. https://doi.org/10.2106/JBJS.17.01397.

[9] Schemitsch EH. In younger patients with end-stage knee osteoarthritis, computer-assisted versus conventional total knee arthroplasty did not improve function at 15 years. J Bone Joint Surg Am 2018;100:1982. https://doi.org/10.2106/JBJS.18.00917.