2. Computer Simulator studies: The Insight Arthro VR (GMV, Spain) is a computer surgical skill simulator for arthroscopic shoulder and knee surgery. Basic surgical skills and procedures can be performed on the simulator, with advanced feedback on surgical technique. We have undertaken studies to validate the simulator against the standard plastic surgical skills models and shoulder arthroscopic surgery[2].
3. Online remote Global Rating Scale: We developed an online tool for uploading videos of surgical arthroscopic videos with an adapted global rating scale for the assessment of the quality of the surgical procedure by an independent expert. The system has been validated, assessing intra- and inter-observer accuracy[4].

Results:

1. Navigation score correlated significantly with 4 Flash tests' scores. Instrumentation score only significantly correlated with 1 Flash test score. We also found that non-string instrument players performed significantly better than string instrument players ($p = 0.033$) at instrumentation. Other groups (computer gamers, crafters, drummers, right handedness) performed faster than their corresponding groups in all skills, but not significantly.
2. A significant correlation was found between the triangulation skills at shoulder arthroscopy and the palpation modules of the surgical simulator. Feedback from students training on plastic models and the computer simulator was that the simulator seemed more realistic, provided better feedback and was more enjoyable.
3. Initial results from validation of an online remote global rating scale have shown this to be a useful tool with an intra-class correlation coefficient value of 0.517. The scale does identify poorer performance more accurately and reliably than higher performing arthroscopies, but does require further construct validity studies and refinement before it can be practically used.

Conclusions: It appears that there is a role of online interactive psychometric tests in predicting an individual's ability to arthroscopic navigation and instrumentation. The tools we have developed correlate well with arthroscopic navigation, which is the primary skill required for arthroscopic surgery. Our results show that certain hobbies and demographics may have a role in predetermining the skills required for shoulder arthroscopic surgery. The Insight Arthro VR appears to be an excellent tool for training arthroscopic surgeons, with excellent feedback and good correlation with pre-existing models. An online remote global rating scale for assessing the surgical skills of a surgeon is appealing and with further work will hopefully assist with revalidation and skills assessment of surgeons. There is much work still to be done, but we hope that these technological advances will assist and enhance the selection, training and assessment of future surgeons.

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P-11
Using Multibody Dynamics to Design Total Knee Implants

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Multibody dynamics simulation has helped address several difficult and poorly understood design problems that have arisen in industry during the development phase of a total knee joint replacement system. Computational mechanics methods, such as finite element analysis (FEA) or multibody dynamics, are usually employed toward the end of the design phase of a total joint implant system. It is of greater benefit, however, to utilize these methods early in the design process as a benchmarking tool to compare competitive products, as a screening tool to eliminate poor design concepts, and as a means to virtually test selected designs to determine if they meet the functional requirements prior to cadaver testing in an experimental knee rig.

The use of a purpose-written commercial multibody dynamics programme has provided significant computational advantages for this purpose in an industrial setting, saving an unprecedented amount of time required for addressing design questions, prior to prototype manufacturing and testing. Such programmes can be successfully employed to deal with challenging and clinically motivated design questions like: (1) What aspects of a total knee replacement design are related to the tendency to engender paradoxical anterior motion in knee bending activities, and can the designs be modified to reduce or eliminate such undesirable clinical issues? (2) Does a fixed axis of internal/external rotation in a mobile bearing knee design help or hinder the predicted functional performance, and is the axis positioned in the right place to achieve the desired functional outcome? Several total knee implant patent applications have been developed as a result of using multibody dynamics simulations. In the case of the above mentioned clinically motivated design questions, it was possible to isolate the design-related features that contributed to poor functional performance in simulated use of the implanted components and to modify the designs accordingly.

The use of multibody dynamics analysis early in the design process has increased our understanding of those factors which control total knee implant design kinematics. Further maturation of such commercial software could significantly enhance our ability to develop total joint implant designs with more natural kinematics, lower interface stresses and decreased wear. However, further advancements will require continued vigilance to ensure that simulation models reflect physical reality and evolve in a manner to allow the user to verify and validate both the computational algorithms relevant to the biomechanics and the bio-fidelity of the model in capturing relevant soft tissue restraints without compromising the robustness of the programme structure.

Adoption of commercial purpose-written simulation platforms, which are interchangeable between, and enhanced within, the separate technology areas of implant design, tribology and wear simulation, and computer assisted surgery, would greatly benefit the orthopaedic medical device industry, which employs computational mechanics methods, but often lacks the in-house resources to maintain purpose-written software. Realizing this vision of common platforms would require an increased collaborative effort between software developers, computational biomechanists and the orthopaedic industry.

P-12
Production of Tubular Shape Macroporous Hydroxyapatite Ceramic Tubes Using Electrophoretic Deposition (EPD)

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Hydroxyapatite (HA) ceramics have been recognized as substitute materials for bone and teeth in orthopaedic applications due to their chemical and biological similarity to human bone. Macroporous hydroxyapatite can be used as scaffold materials, if its microstructure is controlled in terms of porosity size and content. The objective of the present work is to produce tubular shape hydroxyapatite scaffolds for biomedical applications using a cost-effective technique of electrophoretic deposition (EPD) which enables to produce 3D complex shapes. Nano hydroxyapatite powders were produced and mixed with multi-walled carbon

nanotubes (MWCNTs) by hydrothermal process. Calcium acetate ($Ca(CH_3COO)_3$), and phosphoric acid (H_3PO_4) were used as starting materials for synthesizing the nano HA powders. Macroporous HA coatings were deposited on carbon rod by EPD at 60 V for 4 min using n-butanol suspensions mixture containing nano HA powders (10–20 nm in diameter and 20–50 nm in length and with 85 m^2/g surface area) and MWCNTs (10–30 nm in diameter, up to 30 micron in length and with 40–300 m^2/g surface area). Nano composite coatings produced were sintered at 1200°C for 60 min to burn-out the carbon rod and MWCNTs. It is shown that MWCNTs provide crackles coating layers after coating and porous structure after sintering. Obtained macroporous HA coatings were coated using different EPD parameters in terms of applied voltage and deposition time. EPD provides a coating thickness of ~200 microns for a depositions time of 240 seconds. The method enabled the formation of coatings with variables thickness depending on the coating durations and applied DC voltage. Synthesized powders and obtained porous HA were studied by X-ray diffraction, FT-IR, electron microscopy and energy dispersive spectroscopy. Hydrothermal mixing of HA-MWCNTs and mechanism of deposition are also discussed. The methods can capable to produce 3D complex shape hydroxyapatite scaffolds for clinical applications. The results demonstrate that the obtained hydroxyapatite tubes are candidate materials as a scaffold for bone repairing and generation.

P-13
Myofascial Force Transmission Has Major Implications for Orthopaedic Remedial Surgery

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In contrast to a widely accepted consideration that muscle functions independent of its surroundings [1], it is not an isolated and independent entity within the context of its intact connective tissue surroundings: (1) collagenous linkages between epimysia of adjacent muscles provide direct, and structures such as neurovascular tracts provide indirect intermuscular connections, (2) compartmental boundaries (e.g., intermuscular and compartmental septa) are continuous with neurovascular tracts and connect muscular and non-muscular tissues at several locations additional to the tendon origins and insertions.

We have shown that epimuscular *myofascial force transmission (MFT)* [2] occurring via this integral system affects strongly the magnitude of muscle force exerted [3] and the determinants of the length-force characteristics [4]. These are some of the key parameters orthopedists aim at controlling in treating e.g., spastic contractures. Therefore, the effects of MFT are clinically relevant when planning and performing surgeries aimed at restoring normal range of motion and functionality.

Surgical treatment may involve transecting the intramuscular aponeurosis. Such "aponeurotomies" aim at increasing a muscle's active range of excursion and weakening it and MFT plays a crucial role in determining the acute effects. Interfering with the myotendinous force transmission alone (creating a discontinuity in the aponeurosis exclusively) was shown to have no notable effect on length-force characteristics [5]. Only after creating an additional discontinuity in the muscles' extracellular matrix (interfering also with the MFT), the desired acute effects were achieved. Moreover, the mechanism of these effects was shown to be dominated by MFT: the increased excursion can primarily be explained by increased sarcomere length heterogeneity, whereas muscle weakening was primarily caused by a zone of very short sarcomeres in fibers distal to the intervention [5]. Because of epimuscular MFT, the acute effects were not unique but mechanical condition dependent [6–7]. Such increased understanding of the effects of aponeurotomies allowed us to optimize the location of intervention [8] and indicated that multiple incisions may not be necessary. Another effect due to epimuscular MFT is the weakening of not only the target muscle but also its non-targeted synergists [4]. Note for a poly-articular muscle that the proximo-distal force differences are indicative of differential mechanical effects at the muscle's origin and insertion [7]. Consequently, when attempting to correct a functional problem at a distal joint, the surgery is likely to alter the mechanics at the proximal joint too. Importance of the role of epimuscular MFT is indicated in designing surgical interventions so as to not cause a desired effect at the target joint but a highly unfavorable effect at non-targeted joints that are spanned by the muscle.

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P-14
Cements in Orthopaedic Surgery

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Disease conditions, such as osteoarthritis, osteoporosis, or rheumatoid arthritis cause degeneration of the joint. Total joint replacement has been widely adopted to treat these debilitating illnesses, as it is often the only course of treatment to alleviate pain and improve the quality of life. The number of joint replacements worldwide is rising and is expected to continue to do so, given the increase in population of the elderly and associated disease and trauma. The success and widespread use of joint replacements in the management of arthritic conditions and trauma has made a significant impact in modern healthcare. Acrylic bone cements[1] have been traditionally used in placing hip and knee joints, which fills the space between the implant and the joint. Surgeons replace a dysfunctional joint using metal alloys and polymeric materials, with a functional, long-lasting prosthesis.

Infection is often a complication following joint replacement surgery and the use of antibiotic impregnated acrylic cements is emerging to be a potentially effective clinical procedure that may assist in reducing the incidence of deep infection. The main advantage of local antibiotic delivery is the ability to achieve high levels of antibiotic at the target site without increasing systemic toxicity. An emerging trend in clinical medicine is the use of combination devices and the bone cement is being exploited as a potential drug carrier. This paper will highlight the effect of inclusion of antibiotics[2] and additives on the properties of bone cements that may decrease the incidence of infection promote