16-18 April 2018 - Santiago de Compostela, Spain

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Joint Replacement surgery today is a mature but segmented industry, with the same technology and materials delivering successful outcomes in the hip, with many patients having a single operation that will last lifelong. More expensive and rather less effective outcome is obtained by total knee joint replacement, with the risks of surgery being finely balanced with the benefits in many people. In the spine, disc replacement has been around for years. But it has been stopped in several developed countries because of problems.

The burden of disease in society is almost the opposite of this: far more people suffer from degenerative spinal pain than from any other joint. Next most common is knee pain. Damage to the medial compartment is very much more prevalent than in the hip in every country in the world. The societal burden of wearing out is large and increasing, for the obvious reason that we are all living longer and putting more ‘ miles on the clock’ that any generation before. The technology solutions we can offer today are well short of delivering the ‘lifetime guarantee’ that could reasonably be expected by a patient with a worn joint. Superior Interface technologies are needed, as part of the revolution in joint surgery, minimising the size of the device, while maximising its effectiveness. To meet the growing demand for comfort in older age, it is essential that we optimise the benefit and reduce the risks of surgery.

Three examples will be given of practical problems with huge societal consequence, where our current technologies are barely fit for purpose: much is needed from biomaterial research.

Hip resurfacing is a more conservative, safer and more effective intervention that hip replacement. However until now this device type has required a hard-on-hard metal articulation. Problems of wear, resulting in wear debris causing local and systemic issues.

The next generation of resurfacings are in the very early stages of clinical trial, using either hard-on-hard ceramic bearings, or a hard-on soft metal on plastic alternative. These will be described and the issues of their interfaces discussed.

In the knee, the mechanical environment is more complex. The three separate compartments have very different loading patterns: the medial compartment is almost a ball and socket joint, while both the lateral and patella-femoral joints have combination rolling and sliding articulations , so a monolithic replacement of stiff metal has interfaces that are far from ideal: the medial side may have a loading pattern of pure compression, while the lateral side may actually experience tension at the time of peak loading. The implications for device design, both monolithic and multicompartmental, and the opportunities for invention will be explored.

In the spine, a much more limited range of motion is required of a disc arthroplasty, but access remains hard, and the requirement for a stable interface with bone is paramount, as displacement may cause paralysis or death or both. With ageing, the spine commonly loses bone mass. When this natural process is combined with stress shielding owing to a stiff device, collapse of the bone is a common consequence. The opportunities for novel devices and interfaces here will also be explored.

Finally the hard/soft tissue frontier will be explored: the interface between soft tissue and bone is a natural fatigue point, leading to painful avulsions. Fatigue failure may result in extrusion of a meniscus or disc, and secondary problems both up and downstream. The problems and opportunities that this soft tissue failure brings will be discussed, with examples of opportunities.