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Editorial Open Access

Biomechanical Motion Analysis in the Clinical Environment: The Dawn of a New Era?

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Human locomotion has been studied, since the time of ancient Greece. Locomotion is a complex and rapid activity and therefore, difficult to record visually. As a result, locomotion studies have been heavily dependent on the available technology. The scientific observation of human locomotion originated in the 19th century, with the introduction of the photographic camera. The work of Marey and MuyBridge [1,2] established the fundamental parts of the gait cycle. Bresler and Frankel [3], and later Paul [4] incorporated force plate technology with motion data, to give a full kinematic and kinetic analysis of gait. Over the last 40 years, this basic technology has improved to include television based camera technology, inexpensive 3D force plates, and latterly video cameras tuned to infra red light for motion capture. My own department of Biomedical engineering here at the University of Strathclyde, Glasgow, UK (formerly the Bioengineering Unit), has played a key role in these developments over the last 50 years.

By the end of the 20th century, the field of biomechanical motion analysis had become well established with the International Society of Biomechanics, counting its membership in 1000's. In many ways, the scientific implementation in the field developed in advance of the technology, which remained expensive to implement ($400,000) and complex, and costly to run. As a result, biomechanical motion capture has remained generally limited to academic facilities around the world and specialised clinical centres, where the data these systems gave was specifically used to determine treatment (e.g. in cerebral palsy surgery), or required for outcome evaluation (e.g. orthopaedic arthroplasty surgery).

Interestingly, this biomechanical technology has been more broadly applied in the sportswear and sporting excellence arena, where funding and commercial value are more readily available. Shoe wear for sports has changed radically based on biomechanical analyses, as has sporting equipment. Training of elite sports personnel have also benefitted from the biomechanical approach. The power of this combination of state of the art equipment and training regimes based on biomechanics, was a major contributor to the success of UK cycling and UK rowing in the recent 2012 Olympic Games in London. It is now common to find biomechanical analysis technology used to sell sporting equipment on the high street (e.g. running shoes), or to evaluate amateur sports people (e.g. Golf or Tennis swings).

Due to the relatively small market for academic, clinical and sports human movement analysis, the companies involved in the field tended to be small or a small subsidiary of a larger company. This limited their ability to progress the technology, the user interfaces and procedures, and to lower the price with the benefits of scale in production. However, since the beginning of the 21st century, this situation has been disrupted by the rapid development of animated films and computer gaming. As an illustration of this in 2002, I commissioned a laboratory in Edinburgh, UK, using 12 motion capture cameras, and I was asked to put my order in rapidly, as they had an order coming in from a well known children's animated film company for 600 cameras!

The involvement of the gaming and animation industries provided the sizable market required to accelerate technological development and lower costs in the motion capture field. The "artists" involved in these fields were not prepared to put up with the clunky procedures, we in clinical motion analysis had tolerated for years. We witnessed the introduction of a whole range of time saving devices and procedures, such as calibration wands, automatic calibration, simplified setup, better processing software, better visuals to check data, quick marker identification, the use of asymmetric clusters to provide automatic limb segment tracking, etc. The animation and gaming industries have also brought forward techniques for visual representation of the data.

Such is the improvement in the motion capture technology, that new fields of use have been developed. In the clinical field, we have seen the introduction of motion capture technology in orthopaedic surgery, where the system can be set up in 10 minutes and relied upon to conduct highly accurate surgical procedures, such as knee arthroplasty. My clinical biomechanics team are heavily involved with two such technologies for haptic robotic surgery (MAKO, Bluebelt), and this has made us aware of how much room for improvement there is for clinical movement analysis. On the animation front systems, such as the Optitrak, have been developed to allow budding film makers to produce animations of human movement in their car garage at home. These systems can be obtained for $6000-$10000, i.e. more than an order of magnitude less than previous system.

My own journey to posing the question of this article, "are we at the beginning of a new era for clinical motion analysis?" was brought about by my participation in a grant, exploring the locomotion capabilities of older adults in Glasgow (EPSRC EQUAL ref number GR/R26856/01). This study was collaboration between Strathclyde University and Glasgow School of Art. In this study, we recorded the biomechanical capabilities of 84 older adults (from 60 to 94) to undertake a range of mobility related functional tasks. One of the terms of our grant was to feedback the results to the older adult participants. This presented us a problem, as our data was in traditional biomechanical output formats, such as tables and graphs, and we were aware that these were difficult for non-biomechanists to comprehend. We therefore, animated our data as walking avatars with the force data at the joints over laid as spheres at the joint centre (visit www.envisagerehab.co.uk). We found to our surprise that the older adults when presented the data this way were able to interpret it correctly, and discuss the biomechanical difficulty experienced by the subject displayed.

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Subsequently, we undertook a follow up New Dynamics of Aging study led by Professor Alastair Macdonald of Glasgow School of Art called Envision (http://www.newdynamics.group.shef.ac.uk/envision.html), using focus groups which included older adults, health and medical practitioners and designers. This study confirmed our previous finding that these augmented visualisations were comprehendible and interpretable by the general public, and further that they mediated communication between older adult and healthcare workers. For the last three years, we have been exploring the ability of these visualisations to contribute to the rehabilitation of muscular-skeletal and neurologically injured patients with considerable success, as part of our Envisage project (Envisage Collaboration LLHW MRC ref 090092, www.envisagerehab.co.uk) which also includes Glasgow Caledonian University.

It seems to me that we now stand at the point at which three dimensional biomechanical motion analysis can be implemented efficiently and with low cost in the clinical arena. The technology is available and affordable, and continues to reduce in price. It is not inconceivable that webcams will posses sufficient pixel densities and good enough lenses to form the basis of these systems in the near future, especially if video conferencing technology continues to develop at pace. Many labour saving procedures for setup and data capture are readily available and could be implemented in our field. It is conceivable that a therapist could have a system in their gym, permanently installed at a cost similar to a treatment couch and which when turned on, is already calibrated and could be used immediately. If we develop suitable data capture protocols with automatic recognition and real time tracking of asymmetric marker clusters on the limb segments, as we are doing in our Envisage grant, then we can provide biomechanical visualisations immediately in the clinic to the clinician and patient, as part of the therapeutic process. We need to make sure the software produced is accurate, reproducible and most important of all, simple to use and fit for purpose. If these applications are developed, there is nothing to stop motion capture becoming a central part of therapy.

A major element of the role of physical rehabilitation staff, such as Physical therapists, Prosthetists, Orthotists, Podiatrists, and Occupational therapists is to re-educate patient mobility. We have asked ourselves over the last 20 years, how we can do this effectively if we cannot measure the movement or our impact on it. In my opinion, this is no longer the case. The technology and methodology is available to achieve this vision, and I would encourage all who read this article with an interest in motion capture to join my research group in this agenda. We must make sure the applications are fit for purpose by working with clinicians and patients in their development and continue to provide biomechanical education to support data interpretation. As you can see, I think we are at the dawn of a new era in which cheap, accessible and usable, clinical, 3D, Biomechanical, motion analysis with visualisation of data in real time is possible. Of course, the proof of the pudding will be in how this data is used to progress patient diagnosis, treatment, efficacy and efficiency. However in 5 years time, we will not be able to make the excuse that we cannot measure it in the clinical environment.

References

1. Marey EJ (1895) Movement. William Heinemann, London, UK.
2. Muybridge E (1902) The Human Figure in Motion. Dover Publications, New York.
3. Bresler B, Frankel J (1950) The forces and moments in the leg during level walking. Transactions of the ASME 72: 27-36.
4. Paul JP (1967) Loading on normal hip and knee joints and on joint replacements. Engineering in Medicine. Advances in artificial hip and knee joint technology, Springer Verlag, Vol 2, London, UK.