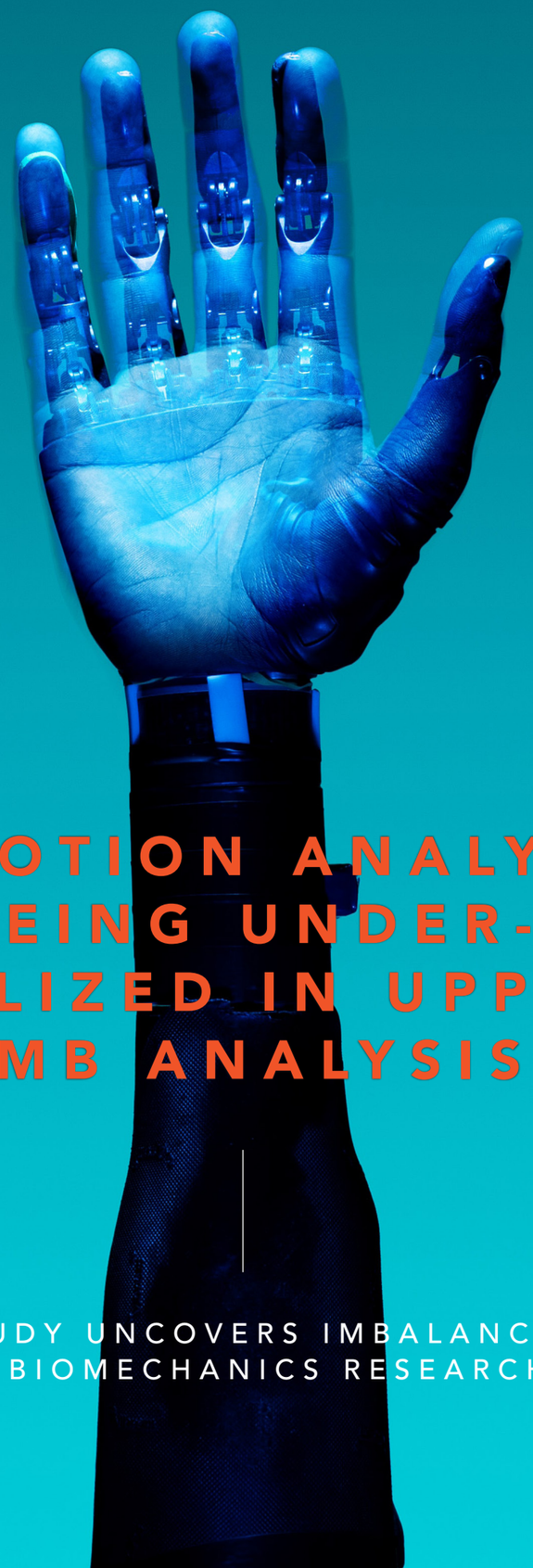

IS MOTION ANALYSIS BEING UNDER-UTILIZED IN UPPER LIMB ANALYSIS?

STUDY UNCOVERS IMBALANCE IN BIOMECHANICS RESEARCH

The core work of Fraser Philp, a clinical academic based at the University of Liverpool, is on upper limb dislocations in children and a rare neuromuscular disease known as FSHD. While his use of motion analysis for these studies is quite focused, it has led him to a much wider inquiry into the state of motion capture in upper-limb assessment, and it could have a broad impact on the world of biomechanics.

Fraser Philp, Clinical Physiotherapist and Lecturer in Physiotherapy and Rehabilitation Science. University of Liverpool

"I started a process of looking at whether we could identify models that are appropriate for the upper limb for my work," says Fraser. "I found that motion analysis of the lower limb is frequently used for clinical and surgical decision making, and there was a clear link between the type of movement that they were assessing and any therapy or surgical outcomes, and then specifically what biomechanical data they needed to get out of it.

"But as I started to get into more upper-limb studies, I was quite surprised. The upper limb is more complex in some ways, but we aren't using equivalent technology to help us to answer questions about it in the same way."

ASSESSING THE STATE OF THE ART

In a bid to shed some light on the issue Fraser undertook a survey of labs using motion analysis for biomechanical research. Beginning with labs contacted through the Clinical Movement Analysis Society of UK and Ireland (CMAS), then incorporating a number of international facilities, Fraser gathered 55 responses.

"The main finding is that practice is quite variable," says Fraser. 75 percent of the respondents performed some sort of upper-limb assessment, with 44 percent doing so for clinical purposes. However, only 33 percent used 3D movement analysis. Furthermore, even among the labs performing motion capture, there were differences in practice between facilities accredited by the Clinical Movement Analysis Society of the UK and Ireland and other international societies and affiliate laboratories. Namely, in the UK and Ireland there was a more clinical focus compared to a research-focused approach overseas.

Barriers to upper-limb analysis identified by the study include funding, clinical need, and the availability of standard reference tasks and protocols. Beneath these factors, however, there may be other issues contributing to how 3D motion analysis is used by clinicians and researchers, largely stemming from how complex the upper limb is and the multiple ways we can perform movements and tasks with our arms.

Chief among these issues is the fact that walking enables people to meet most of the functional requirements of daily life, says Fraser. "If you need to do anything in life, you pretty much need to walk and there are only so many ways you can do that," says Fraser. Upper-limb issues, while debilitating, are less likely to affect a patient's ability to function in everyday life in quite such a profound way. Again, this is because we can complete upper-limb tasks in multiple ways whereas the options for the lower limb are more limited.

"Where upper-limb assessment was used in a clinical practice, it was often the case that these labs had a group of patients and they had motion capture technology, and they were saying, well, we've got these resources, what else can we do with them?" In other words, the upper-limb assessments that the labs were performing were an extension to the care they were already providing for patients on the lower limb. And many labs are set up primarily for gait. "Then when you start doing more arm- and finger-analysis, you're moving to a different setup," Fraser adds.

"And the more research-based labs were exploring more musculoskeletal, orthopedic conditions. It was more about understanding mechanisms, and trying to find something that can be translated into clinical practice later," Fraser adds.

STICKING WITH WHAT YOU KNOW

Adding to the challenges is the fact that upper-limb movement is simply more complex than that of the lower limb, something that was reflected in the early practice of biomechanical motion analysis. The impact of that can still be seen today.

"I think some of it is a case of researchers doing what we've always done," says Fraser. "When motion analysis started, walking was the activity we studied because it was a nice, repeatable reference task. It was comparable between people and it was less complex. Walking, to a degree, can be explained in a two-dimensional component, then 3D expanded our understanding of the other planes of motion.

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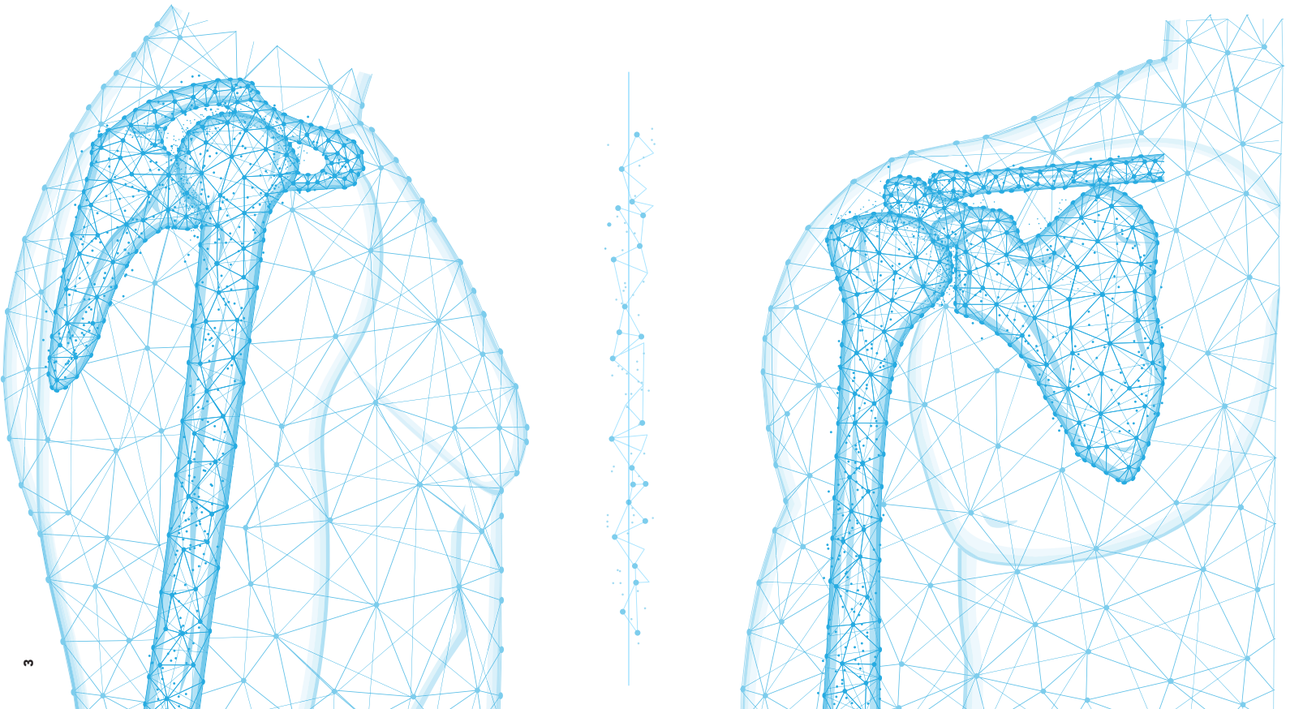

"But I think it's also because there's a canon – we know what to do, we know what marker sets to use, and the ease with which those practices can be expanded is quite helpful."

These different issues all feed into one straightforward, pragmatic concern. "I think that perceived clinical need and justification of cost, or business case, is probably the biggest factor," says Fraser. "If you're a surgeon wanting to do a procedure in the upper limb, you can do virtual surgery, but if you don't know that 3D motion analysis exists, or how you get someone to do it or to run that process, then you're less likely to want to use it."

IMPROVING PROCESSES FOR BETTER OUTCOMES

Ultimately, Fraser's goal for the study is simple: "Better clinical decision-making on the basis of improved measurement is probably the thing I'd like to see on this," he says.

"The whole process needs to be made a bit more streamlined. At the moment, if you want to look at the upper limb you've got to start building custom marker sets and custom models and working on the issues around the interpretation of that data.

"Some really good examples of practice and some workflows that other people can emulate would probably be the thing that would help. If there's a flagship example of practice, and it's executed well and the knowledge is out there and available, people can seek to emulate that activity. But what we found is that there's no really clear, well-defined, robust example for people to copy."

Fraser says that his study is already helping with that. "This research has made the issue visible. And as a result, we have a starting point." And so there have been some discussions that have happened off the back of Fraser and his team's paper. People are starting to look at expanding the use of this tech and develop a wider community of practice.

"There does seem to be lots of really good, exploratory work among Vicon users to find these answers so that it can be translated."

Fraser gives an example from his own experience. "We've worked closely with another lab in Leuven in the planning stages. Or there's the European Society for Movement Analysis in Children (ESMAC) – people were using their marker set and their model a little bit. So, there's this element of collective behavior."

Overall, Fraser is optimistic that more widespread and systematic upper-limb study is coming down the pipeline.

"I think it's an exciting and developing area, and on the basis of the study people are starting to look at some novel applications for upper-limb analysis – spinal cord injury, FSHD, shoulder instability, all those things are quite new," he says. "And there are other avenues where impairments are common – post-stroke, or muscle repairs and reconstructions. All those subjects are exciting areas of study."

For more on the barriers to upper-limb assessment using motion analysis, see the paper Fraser Philp, Robert Freeman and Caroline Stewart wrote on the subject, published by Science Direct.

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