Sports MRI - How Next Generation Imaging Systems are Giving Greater Insights

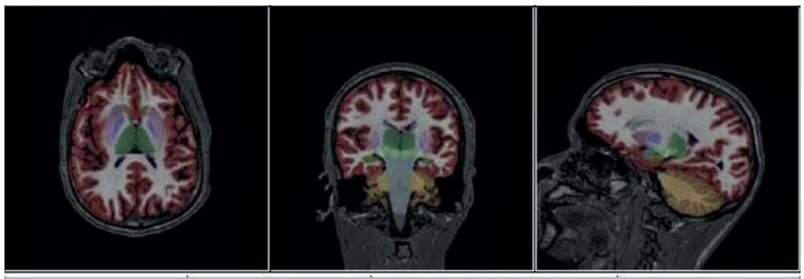
Dr Steve McNally, Head of Football Medicine & Science at Manchester United Football Club, examines how the rich depth of innovative MRI imaging better supports health surveillance, performance management & injury grading, with the ultimate aim of improving sporting outcomes.

There has been a long standing need for diagnostic imaging information to help quickly identify, prevent and treat injury in valuable elite athletic assets, such as footballers in the Premier League. Demand to pre-empt future conditions and manage the long-term performance of players through proactive health surveillance is now on the increase. The long-term value of a sports person impacts the bottom line at many sporting organisations, and therefore a breadth of medical imaging modalities and technologies is required to unlock information from deep within the body.

We are lucky in sports medicine that the pace of innovation in next generation imaging systems is evolving swiftly. Whilst ultrasound has to date been the quick de-facto choice, the depth of information delivered by the larger modalities such as MRI is expanding through next generation developments, giving much more data to base decisions on. The procedural times of MRI, for example, were once considered a negative factor but are now discernibly quicker as innovative software applications automate operational and clinical processes. In addition, image outputs are greatly improved to give rich clarity of detail to assist with sports science management.

MRI in sports health surveillance

Cardiac screening for proactive health surveillance is firmly on the radar for all sporting organisations. This is not only to identify undetected anomalies that could put life and health at risk, but also to monitor for the onset of coronary artery disease as players age. Indeed, from youth teams to the veteran professional footballer, anyone undertaking vigorous training and competitive matches is regulated to receive cardiology profiling every 2 years[1].



Hippocampus	Volume (cm³)	% of ICV (5%-95% Normative Percentile*)	Normative Percentile*
Left	2.69	0.18 (0.20-0.28)	< 1
Right	4.68	0.31 (0.20-0.28)	>99
Left-Right Asymmetry Index**: -54			< 1

Fig 1: Next generation MRI is being used to gather data on brain tissue volumes

The imaging tool that has traditionally been used is ultrasound echocardiography, looking at the structure of the heart at rest and during stress exercise. Now, and increasingly, the structure and functionality of the heart is examined via the latest generation of MRI. For example, new developments have accelerated the examination time for cardiac MRI, with fewer patient breath holds needed to deliver much more detailed, richer image outputs that give another level of screening and profiling of the more subtle presentations of cardiac anatomy.

MRI is also an excellent choice of tool for the diagnosing and monitoring of Chronic Traumatic Encephalopathy (CTE), the result of brain trauma from repetitive blows to the head and repeated episodes of concussion, which in football may have come from player contact or heading the ball. It is a hot topic in all contact sports such as boxing, rugby and martial arts and follows research at the University of

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California, Los Angeles (UCLA), using MRI as the option to explore CTE without any dose implications to patients[2].

From this season at Manchester United Football Club, we have started to gather data by using MRI (see fig 1) to measure volumes of brain tissue in specific areas, to monitor for a decrease in volumes over time. If the volumes become unusual or deviate from the norms that we would expect, it may help us identify early changes of CTE that need closer monitoring. This is a new, long-term data gathering study in our cohort of players that has been facilitated with the new next generation MRI[3] now in place at our medical centre.

Advanced MRI applications will also assist in the surveillance of joint and articular cartilage health, a key consideration in athletic populations, that could limit and impede sporting careers or restrict performance capacity. New generation MRI will also assist alongside ultrasound in primary and secondary muscle injury prevention.

Managing player performance using imaging innovations

Using MRI Spectroscopy over the last four years, we have been able to undertake 'muscle talent scans' as part of managing player performance. This has enabled us to code the muscle fibre type of all our young professional players and estimate the measures of carnosine content in soleus and gastrocnemius muscles. This is a much more accepted and non-invasive approach to muscle fibre typing than undertaking muscle biopsies. Muscle fibre typing tells us who can twitch their calf muscles quickly or more slowly. We know that this can correlate to performance characteristics indicating those that are sharp and quick versus those that are more endurance based. This information helps us manage the player's and the squad's performance over the long term. For example, a very fast twitcher would suggest that muscles will fatigue more readily and require extra rest or nutrition, so informing our care plan.

The power of MRI to pick up subtle injuries

Even the smallest injury in elite sports has implications. Having the right diagnostic tool at the peak of its development is vital to diagnosing subtle injuries that could impact player health. Using high resolution MRI therefore helps to identify very minute intra-articular joint injuries, muscle oedema changes or very small fibre tears (see fig 2).

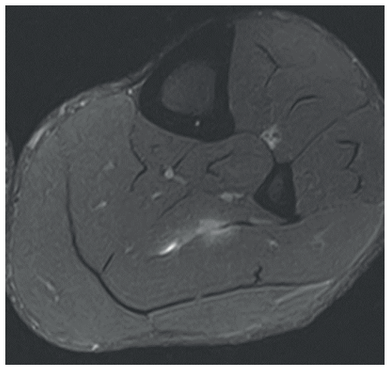


Fig 2: Very small fibre tears identified using high resolution MRI

Detailed diagnostic information is crucial to then accurately give the injury a grading using classification systems[4]. This grading severity then translates into an estimate of the mean number of player and training days that will be lost. Although there is conflicting research about the value of using MRI to determine time out, undoubtedly having higher clinical confidence in injury analysis by using high clarity imaging outputs from new generation systems has the potential to be intrinsically linked to the rehabilitation and recovery time of the player. This, of course, also impacts long term asset performance and financial value.

The advancement of sports imaging techniques

The ongoing advancement in research and development of imaging systems, in part due to clinical research partnerships pushing systems further than ever before, is an exciting time for us sports clinicians. Gaining wider diagnostic information about the structure and function of the body will steer our decision making, to improve and speed up accuracy and expand surveillance of elite sports people. Next generation MRI is undoubtedly an increasingly vital tool in elite sports medicine management. //

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