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Ionising Radiation

# Three Game-Changing Studies for Imaging in Sports Medicine

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## Introduction

It has been known for several years that there could be some cancer risk for young people from low-dose ionising radiation. With respect to diagnostic imaging, examinations such as nuclear medicine bone scans, CT, fluoroscopy and x-rays are all associated with exposure to ionising radiation.[1] In 2001, Brenner *et al* [2] found that there was a significant increase in lifetime cancer risk attributable to radiation from paediatric CT scans relative to adult CT scans. The Image Gently Campaign by the Alliance for Radiation Safety in Paediatric Imaging has aimed to raise public awareness of 'opportunities to promote radiation protection in the imaging of children'.[3] It is thought that young people are at higher risk because cell division is fast and organs are therefore more sensitive to radiation at a younger age.[4]

## *BMJ* and *Lancet* Studies

Three landmark papers from *Lancet* [5] and *BMJ* [6] published in the past year have confirmed that the theoretical increased risk of cancer does bear out in follow-up studies. Pearce and colleagues' study in *Lancet* looked at the excess risk of leukaemia and brain tumours for children and adolescents exposed to CTs. They found that children exposed to cumulative doses of 50 mGy (3–5 CTs) may have triple the risk of leukaemia, and doses of 60 mGy may have almost triple the risk of brain tumours.[5] Though this appears to be a very large increase in risk, the authors point out that these cancers are still relatively rare, causing an estimated one excess case of leukaemia and one excess brain tumour per 10 000 head CTs. Moreover, although not specific to the discussion of paediatric patients, the lifetime cancer risk of developing cancer in the general population of 1 in 3 needs to be considered. Nonetheless, the importance of this effect is emphasised by the fact that 12 other groups from 15 countries are studying the risk of scans on children.[7]

The Pijpe *et al* [6] GEN-RAD-RISK paper published recently in *BMJ.* This study showed that when women who carry a specific mutation associated with breast cancer (BRCA1/2), and who were exposed to diagnostic radiation before the age of 30, had almost twice the risk of breast cancer (with a dose–response pattern). This study involved lower doses which we had previously considered to be fairly 'safe' (eg, 4 mGy from a single mammogram or shoulder x-ray). Therefore, BRCA1/2 carriers, with an already increased risk of a very common cancer, would be particularly at risk from exposure from radiating scans at a young age.

Most recently, the Matthews *et al* Australian data linkage study,[8] with an enormous cohort (11 million) showed that the adjusted overall cancer incidence for young people exposed to a CT scan was 24% greater than for those who were not exposed. That is, one in every 1800 scans resulted in an excess cancer case. The relative risk was higher for many different types of cancers and exhibited a dose-response relationship. This is particularly striking as the mean follow up time was 9.5 years, suggesting the true lifetime risk may be much higher. The researchers assumed a typical radiation dose of 40 mGy per scan. They concluded that the increased cancer incidence was mostly due to radiation from CT scans.

## Relevance for Sports Medicine Practice

Sports and exercise medicine is a field in which many patients are relatively young; it is also a field in which diagnostic imaging is very common. There are rare occasions where a cancer, for example, is detected in a patient who presents with a sports injury and these remind us of the potential life-saving value of imaging. However, there are other occasions in sports medicine in which radiating imaging is requested/used where evidence suggests that better alternatives are available, for example

- A recent study showed that the supine tape measure method had excellent validity compared with CT for measuring leg length, suggesting that CT could be avoided for most leg length measurements.[9]
- A Finnish study (not restricted to sports medicine) found that of 200 CTs performed on patients under 35, about 30% were unjustified based on European Commission imaging guidelines.[9] In particular, they found that 77% of the lumbar spine CTs, 36% of the head, 37% of the abdomen and 20% of the nasal sinuses were unjustified. The authors note that most of these scans could have been replaced with MRI.
- CT and nuclear medicine scans are often used in the investigation of adolescent low back pain. There is no doubt that these tests can provide extra information about pathological anatomy to the clinician, but there would often be doubt about whether this information changes the clinical scenario above and beyond what would be known from an MRI scan (ie, non-radiating) information only.

Good clinical sports medicine involves weighing up the risks and benefits of all management and this obviously needs to include imaging. It is important to note that, in certain clinical scenarios, even MRI may not correlate well with clinical outcome and may not necessarily be required.[11]

## Shades of Grey: Radiation Dosages From Scans and Variation

In general, imaging should conform to the as low as reasonably achievable (ALARA) principle for radiation. Radiation doses from CTs are often many times higher than for x-rays.[1] It is worth noting that radiation doses are generally much lower when newer-generation multidetector CT scanners are used and when combined with techniques used to reduce radiation. For example, the radiation exposure can be reduced by scanning only the area required, reducing the tube output and by using single phase studies.[3] So, even for one type of CT scanner, the effective dose of radiation can vary significantly depending on the machine and the protocol. For example, a recent study found that there could be a 13-fold difference in radiation dose between the same scan performed at different sites.[12]

There have been advances made by the major CT vendors in dose reduction. Claims have been made of up to 65% reductions for specific techniques and machines. While these numbers may be achievable in laboratories, longer term studies in the general population will show the potential benefits of these reductions through various techniques such as Adaptive Statistical Iterative Reconstruction (ASiR) and filtered back projection (FBP) Iterative reconstructions.[13] While Europeans have for some time been more conscious of radiation dose levels than Asia, Australasia and the USA, many countries are now moving to low-dose technology.

## Where to From Here?

Ideally, these landmark papers should result in a review of imaging guidelines by a number of bodies. Initially, specialist colleges could work together with radiologists, radiation physicists and epidemiologists to develop consensus statements about the appropriate/recommended use and non-use of scans involving ionising radiation. The UK already has the Ionising Radiation Medical Exposure Regulations (IRMER) relating to radiation protection, dose restrictions and dose justification.[14] Other jurisdictions which do not have regulations should consider implementing similar frameworks. This would provide evidence-based guidance for clinicians, professional bodies and patients.

Even under a paternalistic model, a good clinician should be weighing up the risks of ionising radiation in imaging referral decisions. These recent studies raise the question of whether the risks are now established to the point that the patient needs to be specifically informed of them at the time of referral, scan or both.[15] The existing evidence of a lack of public understanding about radiation doses[16] suggests that patients need additional education about risks compared to benefits in order to give informed consent.

Further, based on the consensus recommendations, governments, insurers and other health-funding bodies should review their current funding arrangements to ensure that there are no inappropriate funding incentives towards the use of certain scans. Clearly, it would raise ethical questions for a health system to be funding (offering a financial incentive) to have a test which can increase a patient's risk of cancer when a non-risky test with equivalent diagnostic efficacy is available but unfunded. Such an approach could, in some countries, require substantial investment in equipment for alternative scans, in particular MRI units.

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**Contributors**

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