Andrew Franklyn-Miller, Eanna Falvey
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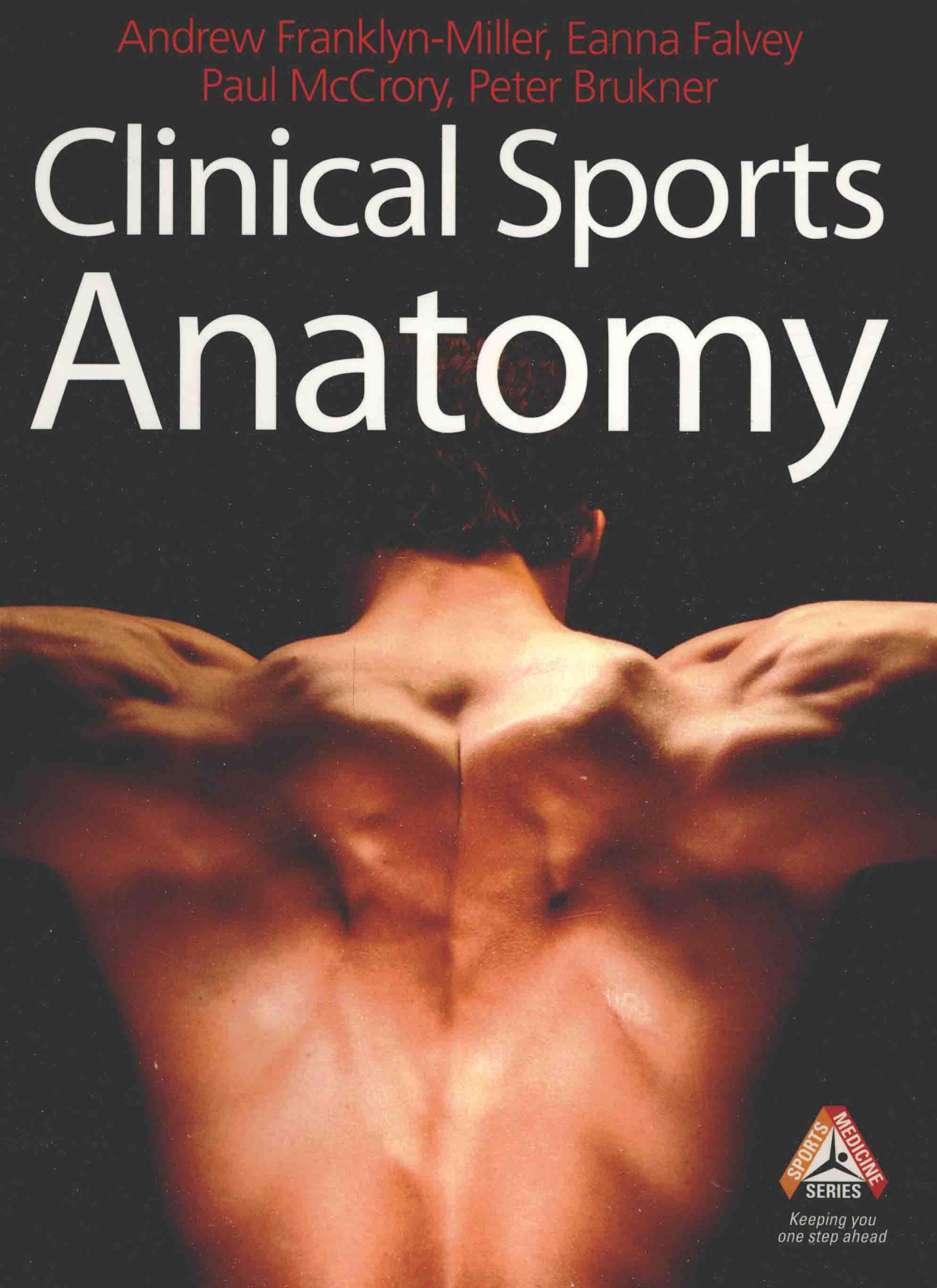
Clinical Sports Anatomy



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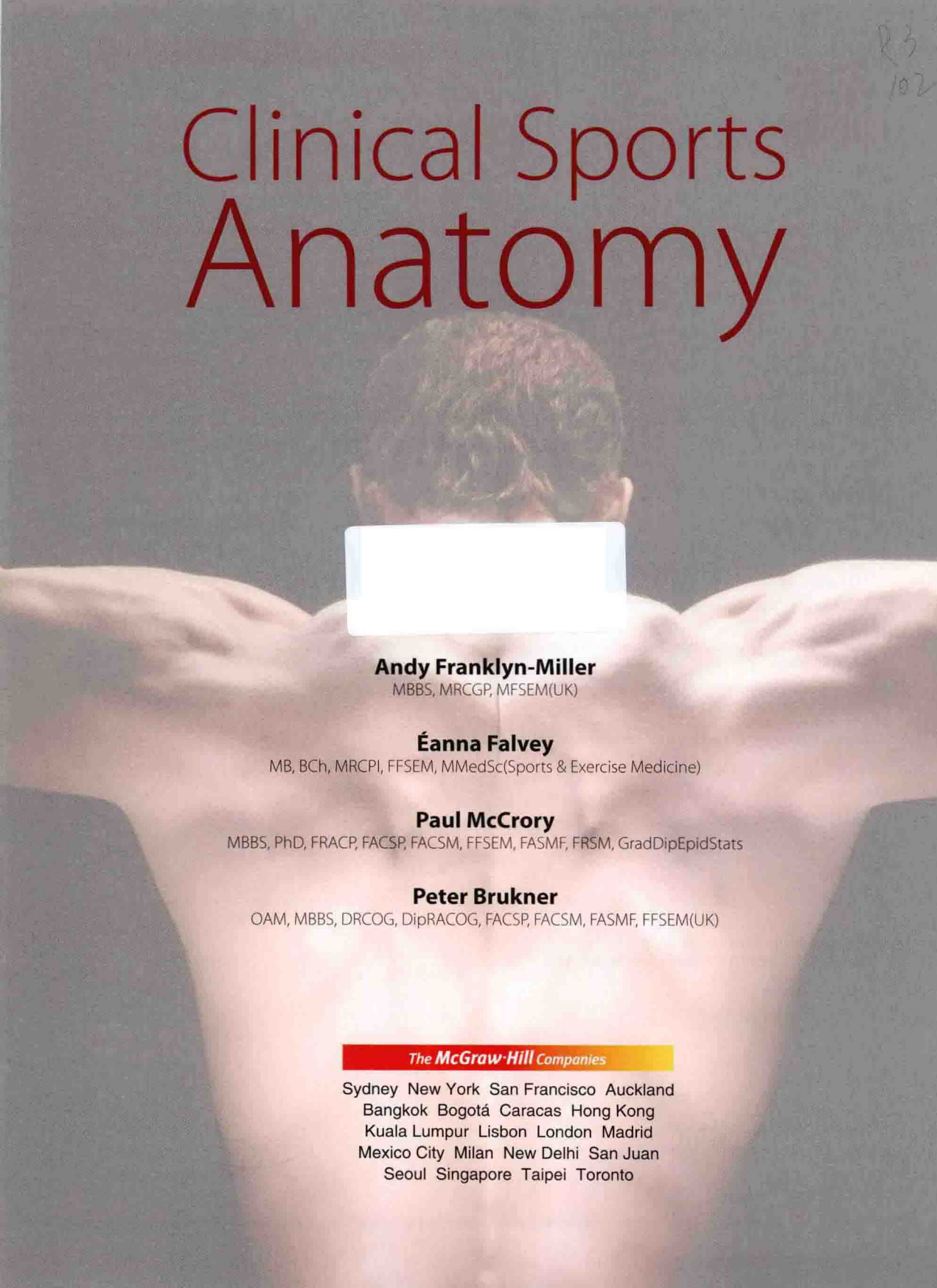
Clinical Sports Anatomy



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Foreword

The subject of clinical anatomy has undergone tremendous changes in profile over the years .

In the 1800s it provided all the novel data available—it was the MRI of its time. In more recent years the vogue has been to regard anatomy as a thing of the past, which is certainly an unfortunate trend for sport and exercise medicine. Diagnosis is the key to successful treatment, and anatomy is the key to accurate musculoskeletal injury diagnosis.

During my medical training, attention to the "clinical" part of anatomy was an aspirational goal. My recollection is of dry textbooks, reflecting the rather dry lectures that preceded dissection.

Clinical Sports Anatomy changes all that, with numerous innovations that will launch future clinicians on a much more enjoyable, and thus more productive, experience in anatomy teaching. The book is particularly timely when anatomy dissection time has been sliced and, as a result, the critical musculoskeletal anatomy curriculum has all but disappeared.

The graphics In *Clinical Sports Anatomy* are exceptional; the text is clear and clinically focused, and the idea of functional triangles is inspired. I was delighted to see clinical scenarios and jewels at the end of every chapter. This book truly represents a substantial step forward in pedagogy.

The authorship team is critical to any textbook, and here we see a terrific alliance among experts from both the Northern and Southern hemispheres. Drs Franklyn-Miller and Falvey have completed rigorous sport and exercise medicine specialization in the recent past; Drs McCrory and Brukner have been household names for several decades, but continue to represent the leading edge of sports medicine, both academically and in their active careers with individual athletes and sporting teams. This combination provides the innovation that comes with new blood, tempered with the experience of knowing how to make messages "stick". The final product is attractive, comprehensive and eminently useable.

I commend any clinician whose work includes musculoskeletal diagnosis and treatment, to examine this book carefully—it makes a wonderful addition to McGraw-Hill's Sports Medicine Series.

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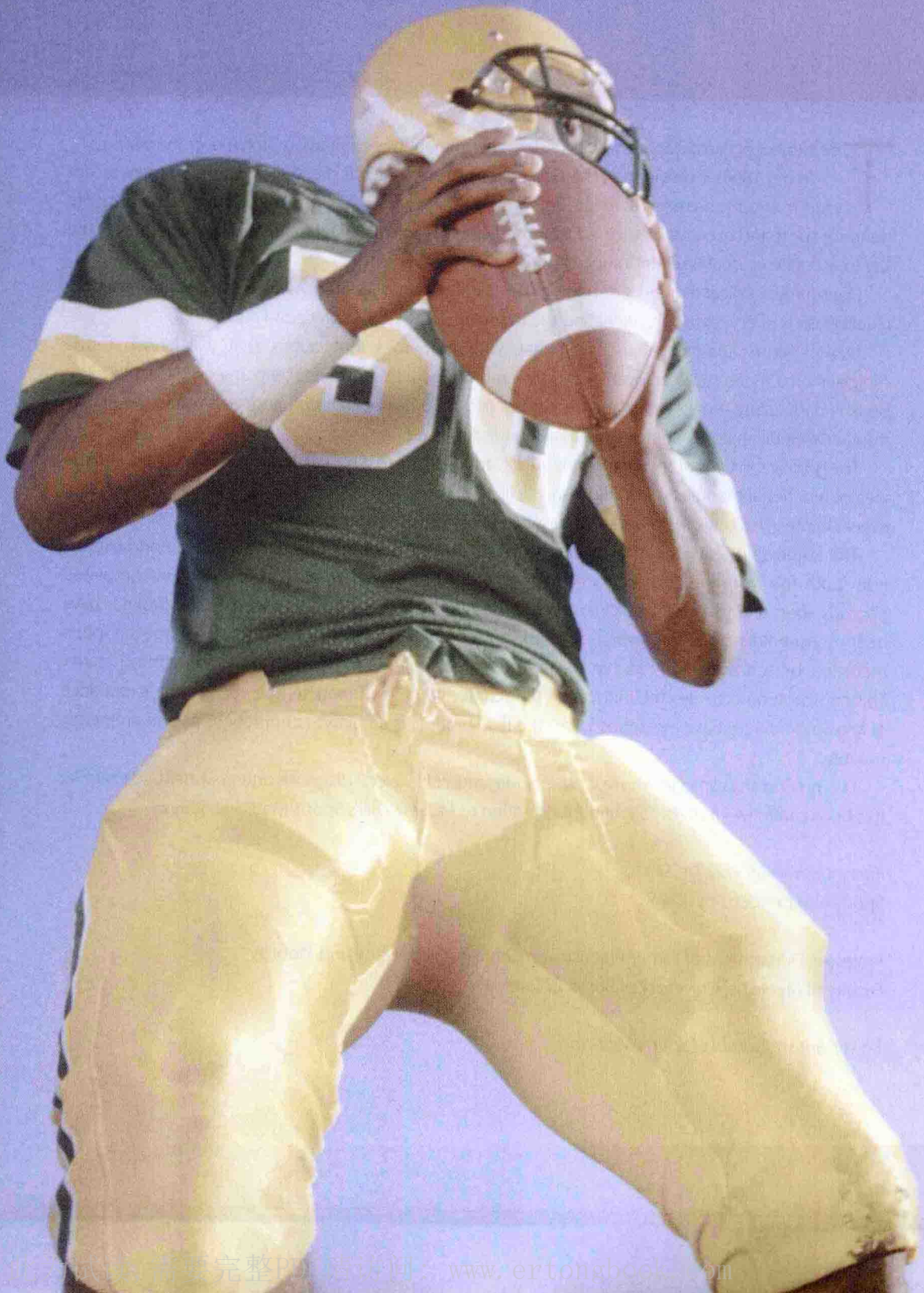

About the authors

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Dr Andy Franklyn-Miller is one of the first doctors in the United Kingdom to hold a substantive consultant post in sports and exercise medicine. He is Director of the Centre for Human Performance, Rehabilitation and Sports Medicine at the Defence Medical Rehabilitation Centre, Surrey, London. A clinician and academic, he holds fellowship of the Faculty of Sports and Exercise Medicine and is part of the Education Committee of the British Association of Sports and Exercise Medicine and the European Faculty of Sports and Exercise Medicine. He remains a fellow at the Centre for Health, Exercise and Sports Medicine at the University of Melbourne, Australia, and his research interests lie in the role of fascia in lower limb injury, the physiological demands of rehabilitation, and the cardiovascular risk of complex trauma.

Having been team doctor and medical and performance advisor for a variety of international organizations including the men's Great British Rowing Team, Melbourne Storm Rugby League Football Club, New Zealand Women's Rugby Football Union, UK men's Athletics and England U16 RFU among others, he maintains currency in the optimisation of athlete performance, altitude, and acclimatisation strategies, and the prevention of lower limb injuries.

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Dr Eanna Falvey is one of a few clinicians in Ireland to specifically train for, and gain speciality recognition in, sports and exercise medicine. He is currently Director of Sports Medicine at the Sports Surgery Clinic in Dublin, Ireland, working as a Consultant Sports Physician. As a Fellow of the Centre for Health Exercise & Sports Medicine at the University of Melbourne, Eanna is a member of the musculoskeletal research group which has produced work on groin pain and the role of fascia in lower limb injury. He is published in sports injury epidemiology and EIB, is a reviewer for the BJSM and BMJ, and enjoys post-graduate sports medicine teaching

A former international amateur super-heavyweight boxer, Eanna retains a keen interest in boxing, hurling, gaelic football, and rugby. He is team physician to the Irish Senior Rugby Team and the Irish Amateur Boxing Association's high performance unit. He has worked in professional rugby since 2003, and has team experience in hurling, football, athletics, Australian rules football, and water polo. Eanna's clinical interests include tendinopathy, groin pain, and hamstring pathology.

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Dr McCrory is a consultant neurologist, general physician, and a sports and exercise physician. He has extensive clinical and research experience, particularly in the area of management of sport-related neurological injury including brain, peripheral nerve, and spinal cord injury. For 15 years, he was team doctor for a professional Australian football club and he also worked at the Sydney 2000 Olympic Games, as well as in individual athlete care. He is past-president of the Australasian College of Sports Physicians and an executive board member for the Institute of Sports and Exercise Medicine in the UK, as well as serving on a variety of committees for national and international bodies. He has an extensive publication record and is the former editor-in-chief of the *British Journal of Sports Medicine*, as well as an associate editor of the *Clinical Journal of Sports Medicine*, and an editorial board member of *Physician and Sports Medicine* and *Current Sports Medicine Reports*. He is founding member and co-chair of the Concussion in Sport Consensus Group formed following the 1st International Conference of Concussion in Sport in 2001, and does ongoing consulting work for the medical commissions of The British Horseracing Authority, the International Olympic Commission, the International Rugby Board and FIFA. He has an ongoing professional interest in eHealth, and is currently involved in the design and production of medical software for general practice.

Peter Brukner

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Peter Brukner is a specialist sports and exercise physician and founding partner of the *Olympic Park Sports Medicine Centre* in Melbourne, Australia. Peter is a world-renowned sports medicine clinician and researcher, and is currently Associate Professor in Sports Medicine at the Centre for Health, Exercise and Sports Medicine at the University of Melbourne. He has served two terms as President of the Australian College of Sports Physicians, during which time he was instrumental in the establishment of a specialist level training program in Australia for sports medicine physicians.

Peter has published widely internationally with a number of books, book chapters, and original research articles. He is the co-author of *Clinical Sports Medicine*, a best-selling general sports medicine text now in its third edition, as well as *Stress Fractures, Food for Sport* and the *Encyclopedia of Exercise and Sport Health*. Peter has been team physician for Melbourne and Collingwood AFL clubs as well as national athletics, swimming, soccer, and men's hockey teams. He was an Australian Team Physician at the Atlanta and Sydney Olympic Games, and Socceroos Team Doctor for the 2010 World Cup. In 2010 he commenced as Head of Sports Medicine and Sports Science at Liverpool Football Club in the United Kingdom.

His contribution to sports medicine has been recognised by the award of the inaugural Citation for Distinguished Service by the Australian College of Sports Physicians, and the Citation Award of the American College of Sports Medicine. In 2006 Peter was awarded the Medal of the Order of Australia (OAM) for services to sports medicine.

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Elizabeth Walton, who believed in us, cajoled us, and never appeared flustered despite Professor Karim Khan's warning that whatever the time we believed it would take us to write, triple it and then we might be close (he was correct). Lizzie, thank you for your guidance and patience!

The staff at the Olympic Park Sports Medicine Centre in Melbourne, Australia, who welcomed us during our respective fellowships and provided unrivalled clinical experience and inspiration.

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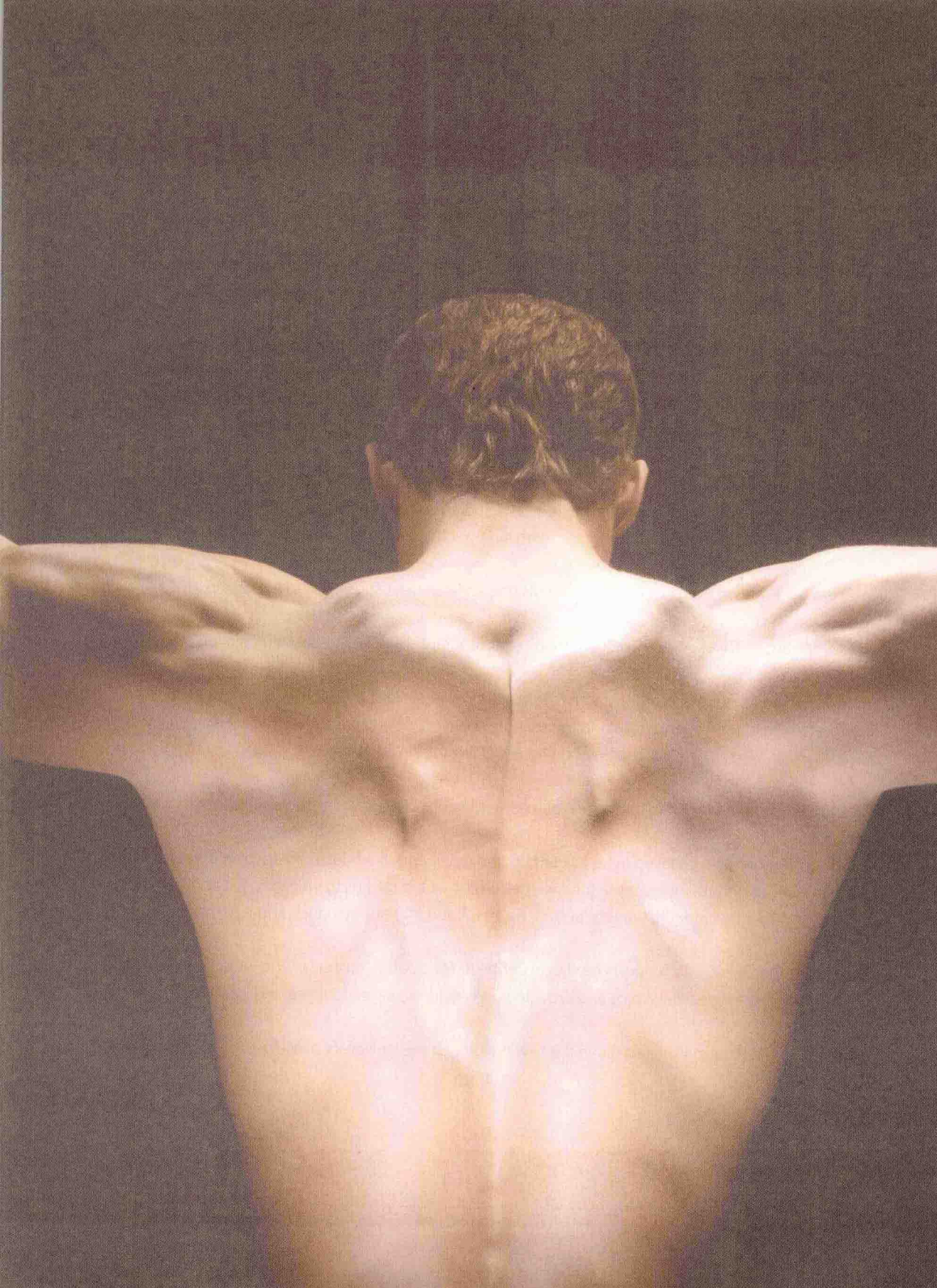

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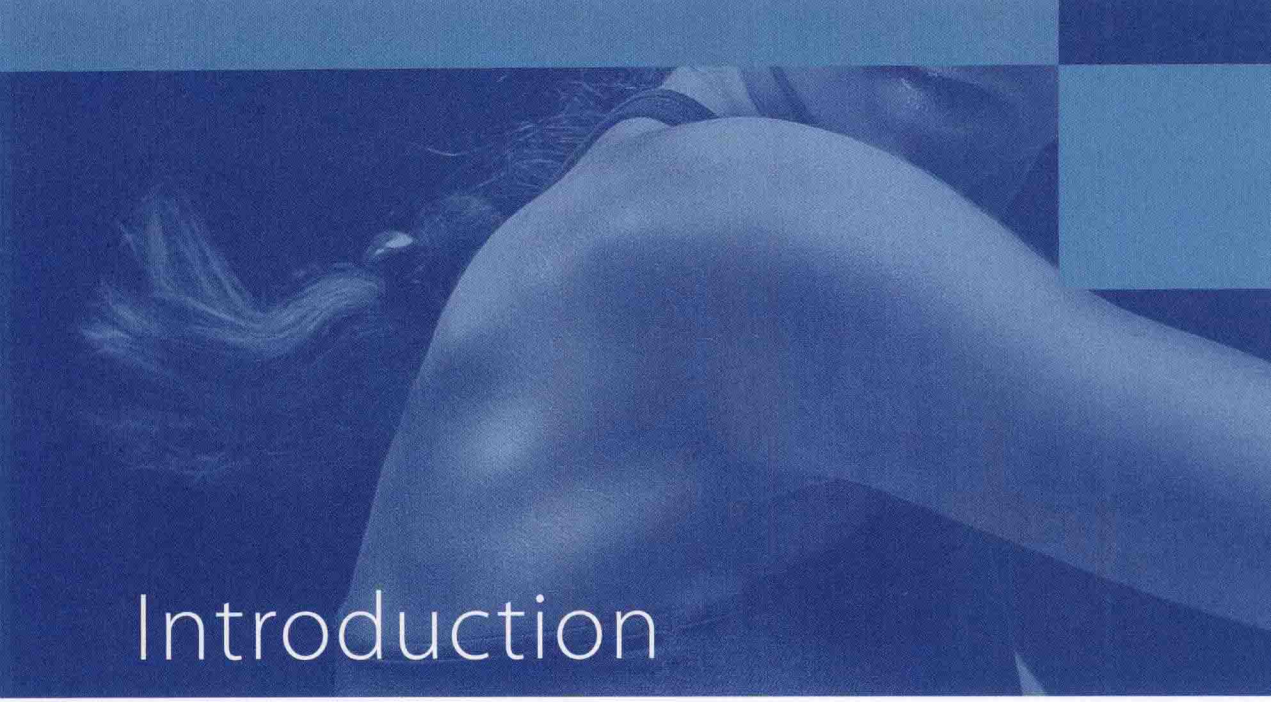


Introduction

History of anatomy teaching

Alcmaeon of Croton in the mid-5th century BC is the first person reported to have performed human dissection; this was in a misguided quest to find "intelligence" rather than from a burning desire to study anatomy. The first anatomical descriptive work came from Herophilus (335–280 BC), the so-called "father of anatomy", who publicly dissected convicted criminals, and so laid the foundation stones of the science of anatomy. The guiding ethical principle of his work, similar to that of modern anatomy, was that from the suffering of few, the many will be helped.

Claudius Galen (129–c200 AD) was arguably the first professional sports physician (Fig. 1). Given his medical training in the great center of learning of Alexandria, and his professional role as a physician for the gladiatorial contests in Permagmum in Asia Minor, he was in an ideal position to consider the anatomical aspects of the injuries he saw in his daily professional life. Perhaps driven by a quest to understand such injuries, he performed a number of documented dissections of animals, which formed the basis of his medical tracts, of which over a hundred survive. His work *On the use of the parts of the human body* was a significant step forward in anatomical knowledge. However, his use of primate, rather than human, dissection resulted in many fundamental errors which took almost 1500 years to correct, although his theory that the constituent of arteries was blood, not air, was proved accurate.

Leonardo da Vinci (1452–1519), the archetype of the Renaissance man, is renowned as a painter whose understanding of the human form was firmly based on anatomical study. Leonardo's master, Andrea del Verrocchio, had insisted that all his pupils learn anatomy. As a successful artist, he was given permission to dissect human corpses at the Hospital of Santa Maria Nuova in Florence, and later at hospitals in Milan and Rome. In 1510, he collaborated with Marcantonio della Torre on an anatomical treatise (*Treatise on painting*), for which Leonardo

Figure 1 Claudious Galen's work on injured gladiators and animal dissection advanced anatomical knowledge

made more than 200 drawings. It was first published in 1680, some 161 years after his death. Leonardo's vivid series of anatomical drawings detailing the structure of bone, visceral organs, the brain, and musculature took medicine to the next level.

One of his most enduring anatomical images is the *Vitruvian man* (Fig. 2), which illustrates the proportions of the human body. It is perhaps the first study of anthropometrics, and has become a cultural icon in its own right. The Vitruvian man demonstrates the relationships of proportion in a way that we have borrowed for this book, in order to create a number of new anatomical points as references for the triangle concept contained here. These reference points rely on the reliable transference of proportion from one skeleton to another, regardless of body habitus or size.

Andreas Vesalius (1514–1564) was an anatomist, physician, and author of one of the most influential books on human anatomy, *De humani corporis fabrica* (*On the structure of the human body*), published in 1543. Vesalius is often referred to as the founder of modern human anatomy. His insistence on studying human, rather than animal, anatomy corrected many of the inaccuracies which had persisted since the work of Galen almost 1200 years earlier.

Change in current teaching

Modern anatomical texts largely stem from the work of the British anatomist and surgeon, Henry Gray (1827–1861). In 1858, Gray published the first edition of his book *Anatomy*, which covered 750 pages and contained 363 figures (Fig. 4). He had the good fortune of securing the help of his friend Henry Vandyke Carter, a skilled draftsman and former demonstrator of anatomy at St George's Hospital. The success of the book was undoubtedly due in no small measure to the excellence of its illustrations. Gray's death from smallpox came just three years after the publication of *Anatomy: Descriptive and surgical*, which is now in its 40th edition.

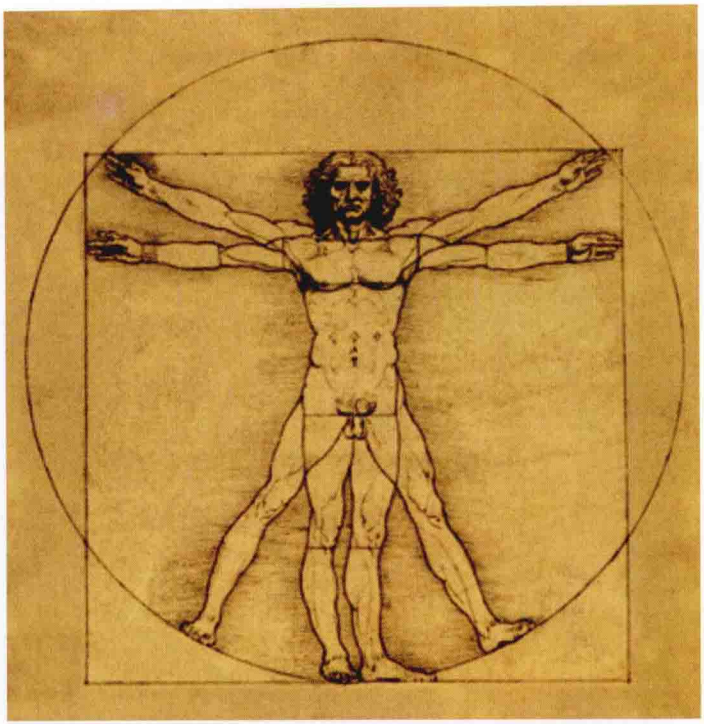
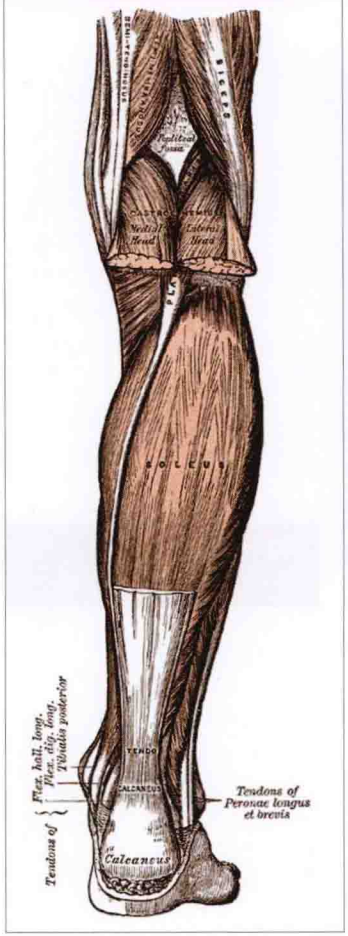


Figure 2 Leonardo da Vinci's Vitruvian man

Figure 3 Anatomy class from a 15th century German engraving

Anatomy is currently of great interest to the public[1, 2], which of course includes the sporting population, whose understanding of anatomical functions is likely to be above that of the lay person. Traditional anatomical texts often do not relate the clinical pathology to the structure responsible, nor indeed concentrate on the functional aspects of musculoskeletal anatomy in

Figure 4 *Gray's Anatomy* of the leg



any great detail. Von Hagens' *BodyWorks* (Fig. 5), although it relates dramatic cadaveric images to function, does not inform in sufficient detail regarding pathology, although it is certainly a step forward.

Figure 5 Professor Gunther Von Hagens' plasticized cadavers on public display.

The authors have been fortunate to spend 12 months preparing for this book by performing original anatomical prosection under the guidance of Associate Professor Christopher Briggs and Dr Priscilla Barker in the human anatomy laboratory of the University of Melbourne. As practicing clinicians, the authors have been able to relate the anatomical difficulties in complex clinical diagnosis directly to cadaveric dissection. This approach brought success in the sports medicine clinic, and thus the concept of *Clinical Sports Anatomy* was conceived.

A thorough understanding of anatomy is essential in musculoskeletal and sports medicine, in order to make accurate diagnoses. Anatomy teaching has been in steady decline over recent years in the United Kingdom, the United States, and Australia.[4, 5] Students of today's generation are exposed to significantly less anatomy teaching than their predecessors[6], and there is concern from professional medical colleges over the resultant reduction in anatomical knowledge at the graduate level[7], although this concern has unfortunately brought about little change to modern teaching methods[8] in undergraduate curricula.

The transformation in teaching strategy at many universities[9] has led to a fundamental paradigm shift, away from the absolute requirement for students to build a systematic knowledge base of anatomy, pathology, and physiology. These foundation skills were traditionally the

basis for constructing a diagnosis, but have been replaced in recent graduates with a common problem-solving framework, the ability to search for online medical information, and a composite learning experience. Whether this problem-based medical curriculum will result in improved quality of medical graduates remains to be seen.

Fundamentals of the diagnostic process

Sir William Osler (1849–1919) insisted that his students learned medicine from seeing and talking to real patients, and this approach was instrumental in the establishment of medical training programs within hospitals. Osler has been quoted as saying, "He who studies medicine without books sails an uncharted sea, whereas he who studies medicine without patients does not go to sea at all".

Osler believed that the best textbooks were the patients themselves, and the application of foundation knowledge of anatomy, physiology, and pathology were crucial in the bedside understanding of patients' conditions.[10] Clinicians draw on their knowledge base to refine a possible diagnosis from triggers in a patient's illness history. Pattern recognition forms a critical part of the diagnostic process, and allows discrimination between a number of diagnostic possibilities, which in turn focuses the physical examination and future investigation.[11] Many esteemed colleagues agree[6, 12] with the need for more anatomical teaching; however, with basic science being out of vogue at present, such skills are in dangerous decline.

The 4-step approach

In order to refocus attention on such a vital area, we outline a 4-step compartmentalization of the diagnostic process[13, 14], which emphasizes history and examination, in an effort to target investigation appropriately in the final step in the process. Dividing the method into a 4-step approach is a means by which the emphasis on traditional skills can be focused by the clinician, teacher or student on the clinical problem at hand.

Step 1: Define and align

The clinician must first ascertain from where the pain emanates. Defining the joint or relevant area affected is the initial task. When the area has been identified, the clinician locates the important anatomical landmarks for that joint or area. For a patient presenting with lateral elbow pain, the obvious "define" is the elbow. We then suggest that the clinician "align" the elbow triangles with the identified landmarks. Clinicians should also focus their examination to include those structures potentially damaged within the area, such as the ulnar nerve, the common extensor origin, the radial head, and the lateral epicondyle.

The text of each chapter will familiarize the reader with the structures encountered in the particular area of interest, presented in a logical manner as they are anticipated, moving along the borders of the triangle. It can be seen that this aligns the questioning and subsequent examination to focus on particular structures which may have been injured, far more than only thinking about the elbow.

Step 2: Listen and localize

Following on from step 1, tables in this section (Fig. 4) direct the reader to targeted questioning, in order to differentiate, if possible, between various diagnoses in the region localized by the triangle. Lateral elbow pain worsened by activity such as playing golf or sweeping the floor requires specific questioning and examination to narrow the diagnosis.

Rather than pose the nebulous question, "What could this diagnosis be?" it is important to pose the question, "What is it not?" Rather than creating an exhaustive list of potential diagnoses, the clinician is better served by eliminating potential diagnoses through discriminative questioning, followed by directed examination.

The patient may have common extensor origin tendinopathy, but the diagnosis could equally well involve the radial head, the radial nerve, the articular surface of the capitellum, or in fact be referred from the cervical spine; so important negatives require attention and training in application. To exclude other sources of pathology, questioning should be targeted at relevant systems or anatomical areas. The consultation must be approached, following step 1, with a list of conditions to be excluded. This requires knowledge of the underlying anatomy and pathology.

We have attempted to package the anatomy in easily digested segments, using the triangle superimposition. By focusing on the functions of those anatomical structures in the relevant sections, it is possible to focus the discriminative questioning.

Step 3: Palpate and re-create

The next step is to focus on the most evidence-based diagnostic tests or maneuvers. The authors conducted extensive, systematic reviews in order to advise on the most evidence-based tests.

The aim of this is to examine with a specific purpose, not just doing such a test for completeness, but in order to identify or dismiss specific pathology. Too often, as students, we attempted to perform a McMurray test or elicit Trendelenberg's sign without thinking about why we were attempting this, other than it being what we were taught to do by our teachers during our training. The adage "see one, do one, teach one" is enshrined in medical teaching; however, in many cases, the reason for doing such tests in the first place is never clearly thought through.

In the example of lateral elbow pain, it is important to connect the test with the potentially damaged structure; resisted extension of the wrist is the examination of choice for extensor tendinopathy, but assessment of resisted supination or extension of the third digit are helpful in excluding radial nerve entrapment. Passive range of movement of the radial head and elbow joint also need to be cleared, in order to exclude articular involvement. Similarly, a thorough examination of the cervical spine and peripheral nervous system of the upper limb is needed in order to assess the possibility of referred pain. Without this basic understanding, an important injury may be missed. In the absence of underpinning anatomical knowledge, such an approach simply cannot be contemplated.

Step 4: Alleviate and investigate

Finally, we direct the reader to the most evidence-based final investigation, where discrimination is not possible by physical examination alone. Often this is of dual function i.e. a diagnostic and potentially pain-alleviating injection, which serves to confirm and treat simultaneously. Injection of local anesthetic into the radial tunnel distal to the lateral epicondyle may abolish symptoms, making a diagnosis of radial tunnel syndrome likely. But, more often, it relies on modern imaging techniques. In the case of ambiguity, an magnetic resonance imaging (MRI) request form with "common extensor tendinopathy" is of far more value to both the patient and the radiologist than "elbow pain". It is critical to emphasize that the most appropriate and cost-effective investigation should be the final step in the diagnostic pathway, rather than the first resort.

Decline of examination skills

Bedside teaching, the mainstay of many generations of clinical education, has been lost in favor of simulated patients, objective examination assessments, and clinical problems designed to fit the curriculum teaching modules and the standardized examination process.[3] Sadly, real-life clinical scenarios rarely fit into neat boxes, an unpalatable truth which poses a fundamental problem for any problem-based learning (PBL) curriculum. There are those who suggest that basic anatomical skills are best abandoned for more modern diagnostic techniques centered on imaging and laboratory tests. They argue that the diagnostic power of history and examination are poor, and that no single symptom or sign is sufficiently discriminative.[15, 16]

The judicious use of modern advances in investigation has improved understanding and diagnostic yield in some situations, but there have also been sharp increases in their use diagnostically, economically, and medico-legally as physicians seek to protect themselves from the threat of litigation. Iglehart looked at the use of imaging services in the US[17] and found a spiraling use of MRI which did not necessarily improve diagnostic yield.

The authors argue that focusing on a thorough clinical history and examination, using the traditional teaching model, not only has the potential to reduce the burden of unnecessary investigation, but it can also target essential investigation more accurately and appropriately.

Indeed, the benefits of improved clinical reasoning and a more refined list of differential diagnoses include not only an increase in the quality and efficacy of referral patterns for radiological investigation. The sensitivity and resolution of modern imaging modalities, particularly MRI, means that clinically insignificant findings can be observed and reported, but are only acted on if not compared with the result of a sound examination.

A chronically painful groin provides many such situations; for example, pathology of the adductor origin could be reported on an MRI of the pelvis in a patient who has pain located and clinically confirmed in and around the iliopsoas muscle. This information may be monitored, but not necessarily acted on, if it is clinically unrelated to the presenting pain.

The tables in each chapter refer to commonly used filtering questions in the history, and then the most evidence-based examination or test available in the current literature, and