

Tendinopathy

Achilles, patellar and proximal hamstring tendinopathies go under the spotlight

FIFA World Cup fever

An interview with the Socceroos Team Doctor

Winter wellness

The latest nutritional info to keep you well through the long, cold months

- Biomechanics of Achilles tendinopathy and its relevance to management
- Patellar tendinopathy and its diagnosis
- Proximal hamstring tendinopathy assessment and management
- Physical activity guidelines...anyone?
- It's not just the size that counts, but how you use it
- Sports medicine and sports science contributions to football

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Editor

John Orchard

Managing Editor

Georgia Brumby

Chief Executive Officer

Nello Marino

Subscription Manager

Brigid Doherty

Advertising Manager

Georgia Brumby

Design/Typesetting

Papercut

SMA STATE BRANCHES

Australian Capital Territory

ACT Sports House
100 Maitland St Hackett ACT 2602
T (02) 6247 5115

New South Wales

PO Box 3176 Rhodes NSW 2138
T (02) 8116 9815

Northern Territory

PO Box 2331 Darwin NT 0801
T (08) 8981 5362

Queensland

Sports House 150 Caxton St Milton QLD 4064
T (07) 3367 2700

South Australia

PO Box 219 Brooklyn Park SA 5025
T (08) 8234 6369

Victoria & Tasmania

Sports House
375 Albert Road Albert Park VIC 3206
T (03) 9674 8777

Western Australia

PO Box 57 Claremont WA 6010
T (08) 9285 8033

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E members@sma.org.au

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Biomechanics of Achilles tendinopathy and its relevance to management



Figure 1: The statue of the warrior Achilles in Hyde Park, London, seen from behind to visualise the tendon or “Achilles’ heel”.

Dr John Orchard examines the biomechanics of Achilles tendinopathy in relation to management.

The Achilles tendon is named after the Greek legend of the warrior Achilles (Figure 1) who was famed to have only one weak spot in his entire body, after his mother tried to make him immortal by dipping him into the river Styx shortly after birth.

“...the therapist and patient need to work together towards the Blackjack hand of 21 without busting, or to cook the soup that is ‘not too hot, not too cold but just right’.”

By legend, the only vulnerable part of his body remained the Achilles tendon by which she held him, and where he was later killed after being struck there by an arrow. Ironically direct contact injuries to the Achilles tendon in humans are quite rare. Most Achilles injuries – whether ruptures or tendinopathies – occur due to the intrinsic load of accelerating the weight of the body. And, when comparing real-world patients to the warrior Achilles (who was immune from injury elsewhere), clinicians are painfully aware that whatever pathologies cause Achilles pain are also able to affect tendons throughout the body.

“So just when we thought that diagnosis of Achilles pain was easy (and it was only management which was complicated) we may be about to enter a new era where Achilles pain needs to be subcategorised into different types, which may all respond to different management.”

In clinical physician practice – and this article is written from a clinical rather than scientific perspective – I like to differentiate between diagnostic problems and management problems. In fact, the ability to work-up diagnostic challenges is a hallmark of physician (“medical”) practice versus surgical practice (where the focus tends to be “can I help this patient with an operation (management)”?) and para-medical practice (“can I help this patient with conservative management, e.g. exercises/stretching/massage/manipulation/orthotics etc.?”). As a general rule for the musculoskeletal world, we more often encounter diagnostic challenges in the central parts of the body (e.g. back pain/groin pain/shoulder pain) and more often encounter pure management challenges with peripheral parts of the body (e.g. plantar fasciitis, tennis elbow, knee medial ligament tear). For the areas where diagnosis is difficult, such as back pain, it actually makes sense to most-often start management with non-specific non-invasive management and advice, rather than obsess about diagnosis¹. But when pain has persisted and failed first line conservative management, diagnostic workup becomes justified.

Achilles tendinopathy is traditionally meant to be completely a “management” problem, which is another way of saying that diagnosis is straightforward. Pain arising from the Achilles tendon usually localises very well and the patient can point to the painful part of the heel with a finger, differentiating plantar fascia heel pain from Achilles tendon heel pain (Figure 2). A rupture can be distinguished from a tendinopathy on history and with a prone calf squeeze test. The nearby diagnosis of ankle posterior impingement can also be distinguished by less localised pain and with a forced plantar flexion test.



Figure 2: Location of Achilles pain usually makes the superficial diagnosis easy.

So Achilles diagnosis is easy and management is difficult: can we move on to management now? Not so fast, as there is one elephant in the room left to deal with. If, Mr Einstein, Achilles diagnosis is so straightforward, why all the fuss about the change in terminology from Achilles tendinitis to Achilles tendinopathy? Good question, concerning a small matter of all of us clever PhD and Professor geeks not actually being able to tell you with any certainty why Achilles tendons get painful! Except that we're pretty certain it isn't just inflammation.

Or that your mother dipped you into the River Styx at birth holding you by the heel. So if you could work out why Achilles tendons get painful, you might have a better chance of working out how to successfully manage them.

“So what lessons are there for treating a painful Achilles tendon from all of this discussion about mechanics? The number one lesson is to understand that the Achilles (like all other tendons in the body) is in a constant struggle to work out whether to become thicker and stronger or not.”

If we want to try to understand how the Achilles tendon stuffs up, it helps to start with understanding how it works when it isn't stuffing up. We know that Achilles tendons make the calf muscle-tendon unit biomechanically much more efficient, particularly when bounding at constant speed, like the way kangaroos and wallabies move² (Figure 3). So, Achilles tendon, you have one job, which is to be a useful spring! We'll keep things simple, when the calf muscle stretches you out, recoil back to your resting length for us. One job, one instruction. OK, two more instructions, don't snap when



Figure 3: A Wallaby with view of the right Achilles tendon.



you're getting stretched and don't complain about it hurting. There are a few hundred tendons in the body and we can't work as a team if every one of you complains every time you get stretched. So please Achilles tendon, just recoil as quickly as you possibly can without snapping or complaining (if possible), as you don't want to leave all of the work accelerating the body to the poor old calf muscle.

So Achilles mechanics is pretty simple if you're the body, but it's quite difficult if you're the tendon. Imagine being a rubber band and being told to recoil as quickly as possible but without snapping. That's like telling a Blackjack player to get as close to 21 as possible without going over it. Which is why playing Blackjack is easy and difficult at the same time. It is easy describing the rules and strategy of Blackjack, but hard knowing whether to sit or draw. The Achilles (and all tendons of the body) spend their entire lives going through this same dilemma. The closer you get to failure, the more spring/recoil you give. Add a few more collagen fibres and you'll insure against rupture, but you won't recoil quite as quickly. So the Achilles tendon keeps looking around for signs of damage and if there are signs the tendon is under stress, lay down a few more fibres to protect against failure. However, if there

isn't much evidence of tendon stress, then don't worry about replacing fibres, as it appears they aren't currently needed (and would possibly just make the tendon less elastic).

“The Achilles tendon is named after the Greek legend of the warrior Achilles who was famed to have only one weak spot in his entire body, after his mother tried to make him immortal by dipping him into the river Styx shortly after birth.”

There are a few good anecdotes that, in combination, illustrate the dilemmas associated with being a good Achilles tendon. The most famous of these in sports medicine circles is the Hakan Alfredson (personal) Achilles story. Hakan Alfredson is the famous Swedish Achilles surgeon and we'll call him Alfredson when talking about him professionally and Hakan for this story, when we are referring to Hakan the recreational jogger in the early 1990s. Hakan hasn't been able to run without Achilles pain for ages and nothing he has tried to relieve the pain has worked. As Alfredson the surgeon, he has cured many cases of chronic Achilles pain with surgery and he's also noted that most patients with chronic Achilles

pain who happen to rupture their tendon seem to be cured of the chronic tendon pain once they have (eventually) recovered from a surgical repair. So Hakan the runner wants Achilles surgery, but he lives in Sweden and must go on a waiting list to have it, as all the hospitals are public and not even surgeons themselves are allowed to jump the queue. The only exception is if you have a ruptured tendon, this qualifies as an emergency case and you get the surgery straight away. So Hakan tries to jump the waiting list by rupturing his own Achilles tendon and he tries to do this by doing repeated heel drops over the edge of a step on the injured side. The exercises cause him a lot of pain, but don't rupture the tendon. In this case what doesn't kill you makes you stronger, and within a few weeks Hakan's Achilles pain is gone. Not content with curing himself, Alfredson tries to cure the world and publishes a moderate quality study (Fifteen recreational joggers in their early 40s compared to similar historical control group with no randomisation or blinding) which becomes of major historical importance³, crediting previous authors who described successful treatment of tendinopathy with eccentric exercise⁴.

The next story is not nearly as interesting, being about me as a runner, but it helps complete the jigsaw puzzle of what the Achilles actually does. For consistency with the Hakan references when talking about myself as a runner I'll call myself John. John has only run one marathon, 23 years ago in the tough days before they had invented gel shots, and is not interested in ever doing another. He can remember being in lots of pain, everywhere in the legs during the event, and everywhere in the lower limb muscles for days after the run. However John distinctly remembers both Achilles tendons swelling up, developing crepitus on movement and getting very sore starting from about a week after the race and lasting about a week. It is an $n=1$ study but a good learning tool. The overload (running a Marathon), followed by everyday living activities only, led to transient Achilles tendon pathology after a delay in time (1 week), rather than immediately.

“Is there a role for interventional management in Achilles tendinopathy? Of course there is, but the lesson that the patient must ‘get’ is that interventional management cannot be used as a substitute to getting the underlying load management decisions correct.”

What else does a propelling a body as far as a Marathon distance do to an Achilles tendon? Well, extrapolating from Tim Noakes Lore of Running⁵, it probably makes Achilles

tendons reform themselves so they are more resistant to stretch. This makes Achilles tendons stronger (more likely to withstand future injury) but slower (giving slightly less recoil on each landing). Noakes has sustained for many years that the best way to win a major Marathon event is to be an excellent distance runner who hasn't done many Marathons⁵. Obviously you need to have excellent aerobic capacity and biomechanical efficiency of your running to finish a marathon in world class time, which is stating the obvious, so an elite marathon runner should have elite 5 km and 10 km times. But the surprising observation from Noakes – which is borne out by the history of the Marathon event – is that if you keep running these events you start to slightly slow down in them. Therefore the Marathon is an event where the world King and Queen are usually rapidly changing. As soon as you run an event fast enough to win an Olympic Marathon Gold or set a new World record, for example, you soon find that no matter how hard you train you have probably lost 1–2% of your pace. This probably relates to changes in all of the major tendons of the lower limb, but particularly the biggest of them all, which is the Achilles.

“Achilles tendinopathy is traditionally meant to be completely a “management” problem, which is another way of saying that diagnosis is straightforward.”

The stress of breaking the world record or winning an Olympic Gold in the 100 m doesn't have the same impact on the Achilles tendon, allowing someone like Usain Bolt to stay as the top ranked sprinter for longer. However if you



Figure 4: An Achilles surgeonfish (Tang), not to be confused with Achilles surgeons like Hakan Alfredson and Nic Maffulli.

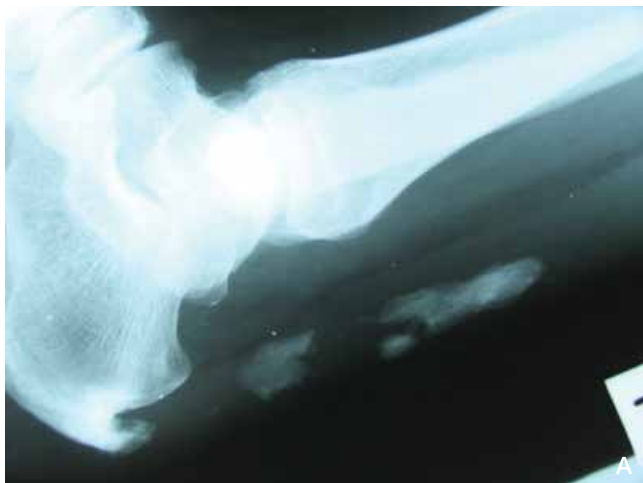


Figure 5A: Achilles ossification (an extreme case both affecting insertion and mid-tendon).



Figure 5B: Insertional calcification/ossification can be demonstrated on MRI as well, but no better than X-ray or US.



Figure 5C: This X-ray pair shows a more established (attached) spur on one side (probably ossification) and possibly more recent calcification within the tendon on the other.

rupture the Achilles tendon and recover from the surgical repair, as a 100 m sprinter you never regain the same pace (it stays approximately 2–3% down for good). Donovan Bailey encountered this after winning the 100 m Gold in Atlanta then rupturing his Achilles (playing social basketball) prior to the next Olympics. In Sydney he was a beaten semi-finalist. Football players can recover from Achilles ruptures and still be very good players, because of the skill element involved, but they almost never can regain blistering pace if they once had it. The surgically-repaired Achilles tendon is actually stronger in one sense than it was before (which is one of the few times that surgeons say this accurately) but it is thicker and stiffer, so it gives less recoil and spring, and contributes less to propulsion. Hakan Alfredson didn't care about this when he was trying to rupture his own tendon – he just wanted the end of his own Achilles pain. But for the elite athlete with Achilles tendinopathy it is a matter of wanting to have your cake and eat it as well. The elite athlete wants a thicker stronger tendon to get over the pain associated with Achilles insufficiency, but not one that is so much stronger that it means the Achilles does not recoil as much, such as a surgically-repaired one.

“The overload (running a Marathon), followed by everyday living activities only, led to transient Achilles tendon pathology after a delay in time (1 week), rather than immediately.”

My final case vignette is about a professional footballer I looked after early in my career but who I won't name as his story is not in the public domain. He had chronic Achilles pain and hadn't been able to play for a month despite treatment, and with his team about to embark on a finals campaign he looked devastated to be about to miss the finals. He asked whether it would be possible to have the Achilles injected with local anaesthetic to play for the finals and after weighing up how important a finals series is to a professional player, I agreed to do it (after warning him of the risk of rupture). We decided to try it out at a training session beforehand and at this session he actually managed to rupture the tendon (whilst under local anaesthetic). Although this is another $n=1$ case study, it goes to show that whatever was making his Achilles tendon painful, it was doing so in a protective fashion because the tendon really was insufficient and prone to rupture if it was fully loaded.



So what lessons are there for treating a painful Achilles tendon from all of this discussion about mechanics?

The number one lesson is to understand that the Achilles (like all other tendons in the body) is in a constant struggle to work out whether to become thicker and stronger or not. A painful tendon basically is one that needs to get stronger but is sending out painful signals to protect itself against rupture. We know from clinical experience – and study – that eccentric strengthening exercises tend to be superior to rest at curing tendinopathy pain. But we also know that ongoing heavy overload can make tendinopathy worse (and highly aggressive strengthening exercises can be in this category). So the therapist and patient need to work together towards the Blackjack hand of 21 without busting, or to cook the soup that is “not too hot, not too cold but just right”. Therapists can classify patients into reckless individuals that are pushing through the pain barrier too much and need to back off, those who have become “pain-averse” who need to strengthen more, or those who oscillate between the two extremes and never hit the magic window of sufficient strengthening without overload. Most of the treatment of the therapist is advice on tactics, since the patient is the one living with the painful tendon 24 hours a day and has to make the right decisions on an ongoing basis. The patient can be warned that he or she might only pay the price for an overload days or even weeks down the track. But on the upside, any load upgrade that can be tolerated can usually be banked and maintained with the expectation of further strengthening. If the patient is a team athlete with a competitive season, he or she can be reassured that continuing a season with an ongoing overload is not going to be catastrophic, but that eventually the proper rehab will be needed in the off-season (and total rest is unlikely to constitute the “proper” rehab).

“There are a few hundred tendons in the body and we can’t work as a team if every one of you complains every time you get stretched. So please Achilles tendon, just recoil as quickly as you possibly can without snapping or complaining (if possible), as you don’t want to leave all of the work accelerating the body to the poor old calf muscle.”

Is there a role for interventional management in Achilles tendinopathy? Of course there is, but the lesson that the patient must “get” is that interventional management cannot be used as a substitute to getting the underlying load management

decisions correct. In a generic sense though, it may be that Achilles injections, so long as they don’t harm the tendon (like cortisone might) could all work equally well. That is, the beneficial effect of an injection may be due to the insult around the tendon which could have the effect of stimulating the laying down of better organisation of more collagen fibres.

Despite my introduction of Achilles tendinopathy as a “management” problem and not a diagnostic one, it is becoming more apparent that there are subtypes of Achilles tendinopathy that may need to be managed differently. The most specific of these is calcific (or more correctly ossific) insertional Achilles tendinopathy. This can be painless in which case it doesn’t need treatment. If the calcification is associated with pain, then shock wave has been shown to be helpful⁶ and surgery may be required for high demand patients.

“Not content with curing himself, Alfredson tries to cure the world and publishes a moderate quality study (Fifteen recreational joggers in their early 40s compared to similar historical control group with no randomisation or blinding) which becomes of major historical importance, crediting previous authors who described successful treatment of tendinopathy with eccentric exercise.”

Another specific subtype is the hypervascular appearance on Colour Doppler ultrasound. This again can be non-painful and doesn’t require treatment. If painful, it may respond to ultrasound-guided polidocanol injection to the anterior (ventral/deep) surface of the tendon. It has been recognised that hypervascularity can be a normal finding in athletes and it also can be associated with rheumatological disease, in which case it is unclear whether it would respond to management of the inflammatory condition.

We are starting to recognise (with more extensive use of routine ultrasound examination in the clinic) that true partial tears of the Achilles tendon do exist and we need to manage these more conservatively (i.e. perhaps these cases need more rest/immobilisation than others).

Alfredson is a big believer that plantaris hypertrophy and tendinopathy can cause the medial Achilles to become painful, possibly through direct impingement, and that an extra-tendinous minor surgical procedure can be used to relieve this source of pain.



Figure 6: There is some evidence that the “average” mid-Achilles tendon with a lump may be associated with elevated cholesterol, but when it is a gross lump and there are cholesterol deposits elsewhere (e.g. around eyelids) it can be labelled Xanthomatous disease.



Figure 7: The average Achilles after surgical repair will be wider/thicker than normal, but across the length of the tendon rather than as a discrete lump in the mid-part of the tendon. Often the tendon will (eventually) become pain free.

The painful Achilles as a by product of systemic disease is also recognised, particularly in the case of hypercholesterolaemia. This is called xanthoma in the extreme cases, but again it is unclear in both these cases and in the milder cases whether lowering of cholesterol with diet or statin drugs is helpful.

The Achilles and calf can also be painful as a side effect of chronic nerve impingement in the low lumbar spine, a condition which is extremely common in middle to old age.

“As soon as you run an event fast enough to win an Olympic Marathon Gold or set a new World record, for example, you soon find that no matter how hard you train you have probably lost 1–2% of your pace. This probably relates to changes in all of the major tendons of the lower limb, but particularly the biggest of them all, which is the Achilles.”

So just when we thought that diagnosis of Achilles pain was easy (and it was only management which was complicated) we may be about to enter a new era where Achilles pain needs to be subcategorised into different types, which may all respond to different management. This justifies practitioners who wish to subspecialise in tendinopathy needing to profess specialist understanding of the tendon. But it is also worth keeping the perspective that most people with Achilles tendon pain get better. The body – eventually – does a good job of curing the pain of Achilles tendinopathy itself in the vast majority of patients, probably with the help of the patient being advised or stumbling upon the formula of moderately loading the tendon just enough to strength it but not enough to overload it.

Further reading:

Peter Malliaras highlights signs and symptoms of common differential diagnoses in Achilles
http://www.completesportscare.com.au/2014/04/achilles-tendon-differential-diagnosis-peter-malliaras-carly-johnson/?doing_wp_cron=1398127110.6306259632110595703125

References, as indicated within the article, are available at sma.org.au/publications/sport-health