A pain in the side (stitch) – why stitch can turn a sporting demigod into a ‘DNF’’

*When Haile Gebrselassie dropped out of the 2007 London Marathon, no one was more shocked than the man himself. But why should an athlete of his ability and experience be struck down by something as mundane as a side ‘stitch’?*

The sight of Haile Gebrselassie pulling out of the 2007 London Marathon was almost as shocking to onlookers as Paula Radcliffe’s untimely exit from the Olympic Marathon in Athens. The double Olympic 10,000m champion dropped out of the lead group shortly after the 30km mark, clutching his ribs. ‘I had a stitch here in my chest and could not continue. I’m not injured I just couldn’t breathe,’ he told BBC Sport, with more than a tinge of exasperated disbelief in his voice.

The manner of Gebrselassie’s exit is almost as surprising as his failure to finish; surely succumbing to stitch is not something that we associate with one of the greatest distance runners who has ever lived? Stitch is what ‘fun runners’ get – a ‘rite of passage’ en route to becoming ‘real runners’, isn’t it? However, as Gebrselassie’s exit from London Marathon demonstrates, this is clearly not the case!

The lack of definitive scientific explanation for a stich shouldn’t really surprise us since it’s a very difficult phenomenon to study using normal experimental methods. Experimental scientists generally study a phenomenon by inducing it, or manipulating it, and in doing so they derive a better understanding of its characteristics and the mechanisms that control it.

However, stitch is notoriously unpredictable in its onset, so studying a stitch is very much like trying to study a condition such as acute mountain sickness (AMS); we know AMS occurs in some people when they ascend to altitude, but the symptoms vary between people, AMS doesn’t always affect the same person in the same way, and it doesn’t affect everyone at the same altitude. This means that the only way you can study AMS is to observe a huge number of people, wait for AMS to develop in some of them, and then record the circumstances under which it occurred.

This ‘observational’ or epidemiological research generates information that is analysed by cross-referencing many factors in order to tease out the common denominators within the symptomology and physiology. Associations between these factors then provide pointers to the underlying cause(s). but even when these links are identified, the best that can be achieved with epidemiological research methods is circumstantial evidence of underlying mechanisms.

**What is a ‘stitch’?**

 One theory is that a stitch is caused by the movements of the stomach and liver, which places strain on the diaphragm ligament and/or the ligaments supporting the abdominal organs. Another theory is that a stitch is just plain old diaphragm ischaemia (insufficient blood flow for the metabolic demand), and/or a diaphragm spasm (cramp). A more recent theory is that stitch is a symptom of an irritation of the lining of the abdominal cavity (peritoneum) caused by friction between the abdominal wall and the abdominal organs. However, the injury is still out and any one of these potential mechanisms.

So, it is for the stich. Until 2000, there had been no data published on the phenomenon in the medical literature since 1951. Even those data that now exist are primarily epidemiological and have originated from just one research group in Australia. For example, in one study these researches administrated a questionnaire to 848 people who took part in a 14km run. Twenty-seven per cent who ran in the event than in those who walked. This tells us that a stitch arises frequently, but what are the common denominators in terms of its occurrence?

**Casual factors in stitch**

Studies have also used epidemiological techniques in an attempt to identify casual factors, as well as its prevalence. For example, a survey of almost 1,000 regular sports participants in Australia found that the prevalence of stitch declined with increasing age, and that neither gender, nor training experience appeared to influence stitch.

**Factor about stitch**

Only a few studies have been conducted into the cause of stitch, but here’s what we know so far:

1. Stitch is most common during running (almost 10 times more common than in cycling);
2. The site of stitch varies, but it is most commonly the mid/lateral abdomen;
3. Stitch decreases with increasing age;
4. Stitch may be more common in people who train less regularly;
5. Stitch is sometimes linked to food or fluid intake;
6. Stitch is sometimes also associated with shoulder tip pain;
7. Stitch can lead to difficulty in breathing;
8. Stitch also occurs frequently in horse riding and other sports in which the torso is subjected to movement (team sports and swimming).

In addition, they noted that a stitch was often associated with shoulder tip pain; the shoulder tip is a site for referred diaphragm pain (in much the same way that people get pain in their left arm when they are having a heart attack, pain in the right shoulder is linked to a problem relating to the diaphragm). In another survey from the same research group, 1,000 participants in running, swimming, cycling, aerobics, basketball and horse riding were compared. The authors found that the stitch was most common in sports that involve repetitive movement of the torso, either vertically (*e.g.* running and horse riding), or in longitudinal rotation (*e.g.* swimming).

There have been only two interventional studies of the stitch, *i.e.* studies where the experiments tried to induce a stitch deliberately. In the first of these the experimenters administered a range of different drinks in an attempt to differentiate the influence upon stitch of fluid per se, as well as the effect of the composition of the fluid upon blood flow to the stomach and intestines. After ingesting the fluid (14mls per kg body mass) the subjects were required to perform repeated bouts of hard running on a treadmill. They found that the composition of the fluid had a little or no effect upon the development of ‘stitch’. In separate part of the study the subjects performed a number of manoeuvres after the onset stitch in an attempt to alleviate its intensity. The most effective of these were:

* Bending forwards while contracting the abdominal muscles, or tightening a belt around the waist;
* Breathing through pursed lips with an increased breathing volume.

The second study that attempted to deliberately induce stitch also examined the influence of the composition of different drinks upon the severity and subjective experience of the stitch. The researches selected 40 subjects who were susceptible to stitch and compared their responses to four treadmill running trials (one control and three test drinks). Drinking fruit juice appeared to be more provocative than the other two conditions (water or no drink) was nearly statistically significant and the authors concluded that susceptible individuals should avoid fruit juice and high carbohydrate drinks before, or during exercise.

So, what does all this tell us about the causes of a stitch? The fact that it occurs more often in sports that involve jarring and/or twisting of the torso suggests it’s linked to the movement of the body’s internal organs, and that the factors that are involved in maintaining postural stability may be involved. The shoulder tip pain indicates that the diaphragm muscle may be involved, while the fact that having food or fluid in the stomach increases the prevalence of stitch points to the involvement of organs that are in close proximity to the diaphragm (stomach and liver). Finally, the clincher is the fact that a stitch makes it very, very uncomfortable to breathe. All in all, the evidence adds up to the pain originating from the diaphragm muscle.

**The role of the diaphragm**

It’s well understood by most people that the diaphragm is the main muscle of inhalation, but what is less widely appreciated is that the diaphragm is also a vital part of the group of muscles known as the core stabilisers. The core stabilisers include superficial muscles that form a muscular ‘corsets’, which encapsulates the abdominal compartment of the body, as well as deep muscles that stabilise the spine and pelvis.

These muscles are responsible for keeping the body upright during activities that perturb the centre gravity, such as bending, jumping, running, riding a horse, etc. they also help to provide a stable ‘base’ from which other torso muscles can twist the trunk during actions such as throwing, hitting a ball, or even front crawl and backstroke swimming. Perhaps the most important role for the core stabilisers is to protect the spine and pelvis from damage during lifting and any actions that load or impose stress upon these parts of the skeleton.

In its role as a core stabiliser, the diaphragm is activated subconsciously during the preparatory phase of most limb movements. In doing so it raises the pressure inside the abdomen, which acts to increase spine stability. This function presents no problem when standing still, but when exercising, there’s an additional demand placed on the diaphragm that come from the requirement to breathe more vigorously. Put these two demands together, as occurs during running, and it easy to see how the diaphragm can become ‘overloaded’.

In other words, the diaphragm is subjected to competing demands in its role as a vital stabiliser and the principal muscle of breathing. In addition, because it is surrounded by large, heavy organs (specifically the stomach and the liver below it), there are some situations that make life even more difficult for the diaphragm. If breathing and stride cadence aren’t synchronised, the diaphragm can be ‘buffeted’ by the movements of these large organs as they move up and down under the force of gravity and in synchrony with the foot strike.

Not only does this stretch the diaphragm, but it also means that it must work against the buffering, which adds considerably to the amount of work it must do. This can be a particular problem on uneven terrain when it’s hard to get into a rhythm, and the postural role for the diaphragm and other trunk muscles is also being challenged. Even had rib ache the day after cross-country run. That’s because your ribcage and diaphragm muscle have been fighting hard to keep you from landing on your face in the mud!

**Diaphragm discomfort**

As a scientist, I must resist the temptation to apply my personal experience of a phenomenon to its interpretation. However, I have observed a consistent response across a large number of people, and over many years. These observations (combined with the circumstantial evidence that exists within the literature) suggests, to me at least, that a stitch is almost certainly diaphragm discomfort arising because of an inability to cope with the demands that are being placed upon it.

Most people are inherently poor and inefficient breathers; they just let it happen automatically and pay no attention to the muscles that are used to do it. Of the many muscles involved in breathing, the diaphragm is by far the largest, strongest and most resistant to fatigue. Accordingly, the diaphragm is the muscle that should be employed to undertake the lion’s share of the work of breathing, not the rib cage muscles.

Sadly, in experience, few people use their diaphragm as effectively as they could. In order to do so, they have to re-educate themselves into a way of breathing that was second nature to them as infants. The re-education is possible through a conscious process of focusing inspiratory effort upon the diaphragm and is best practised in the first instance while not exercising.

Unfortunately, the conscious shifting of effort towards the diaphragm during running can have an initial downside, and many people find that they experience the most frequent and severe stitch pains they’ve ever had. However, in my experience, with perseverance over a two- to three- week period, most people also find that pains gradually in frequency and severity.

My interpretation of this phenomenon is that during the initial phase, the diaphragm is subjected to an increased demand to do more of the work of breathing, leading to overload and ultimately, a stitch. However, over a two/three-week period, the diaphragm does what every other muscle in the body does when you ask it to do more than it’s used to – it adapts. This adaption means that the diaphragm becomes better able to cope with the increased demand and the result is that the stitch no longer occurs. But is this the only way to reduce the risk of a stitch?

In the course of my academic research, I have studied the ways in which breathing limits exercise tolerance and performance for over 15years. This research led to the development of a device that trains the diaphragm (an inspiratory muscle trainer) by imposing a resistance to inhalation that is akin to lifting a dumbbell. Our laboratory studies have shown that this training improves performance by making exercise feel easier, and by preventing the inspiratory muscles from diverting blood away from the legs during exercise.

The reason this type of training is relevant to stitch is that one of the anecdotal observations of many people who train their inspiratory muscles using such devices is that they no longer experience stitch pain. In addition, some also reported that if they trained their inspiratory muscles within an hour or so of going for a run, they often got a stitch. These observations are strongly indicative that stitch is a response of the diaphragm in a pre-fatigued state, which predisposed them to getting a stitch. These observations are strongly indicative that stitch is a response of the diaphragm to a situation it can no longer cope with.

**Coping with a stitch**

So, what should you do if you suffer a stitch during a race? One option is to drop out, which is unfortunately what Gebrselassie felt forced to do, but a stitch doesn’t have to spell the end of the race. Stitch pain will subside if you allow the diaphragm to rest, so you can either slow the pace right down, or even walk for a while.

Alternatively, you can give your diaphragm a ‘breather’ by consciously shifting the work of breathing away from your diaphragm for a few minutes, or until the stitch subsides. This tactic has to be a last resort, because your ribcage muscles will also fatigue if you rely on them too heavily.

Other techniques that are supported by the evidence of one study are to:

1.Bend forwards while contracting the abdominal muscles, or tighten a belt around the waist;

2.Breathe deeply through pursed lips. A technique that appears effective for some athletes I’ve worked with is to bend forwards, tighten the abdominal muscles (especially transversus abdominis) and press inwards and upwards (hard!) on the site of the pain with your palm for 10-15 seconds.

Prevention is much better than cure, so let’s consider what can be done to minimise the risk of developing a stitch in the first place. The research suggests that ingesting large volumes of food or drink, especially if it’s high in carbohydrate, should be avoid immediately before, or during exercise.

However, perhaps the best advice is to train your diaphragm so that it’s never faced with a situation that it can’t cope with. As we’ve seen, no amount of ordinary training can do this; if it did, then the likes of Gebrselassie would surely be immune to ‘stitch’, and he patently isn’t. if you don’t want to experience the same fate, then a little heavy breathing will help ensure that your diaphragm can cope with anything you care to throw at it!

**Inspiratory muscle training (IMT)**

IMT requires a specific training device, such as POWER breathe. A typical IMT session consists of inhaling against a moderate training load (around 50% of the maximal voluntary contraction force of the inspiratory muscles) for around 30 repetitions (breathes). This magnitude of load corresponds to the 30-repition maximum (RM) for the inspiratory muscles, *i.e.* the maximum load that can be sustained for 30 repetitions. This is identified by trial and error (just as you would when identifying the 12-RM for a bench press). This ‘foundation training’ is undertaken in the standing position twice daily for 4-6weeks, and a typical session requires just 2-3 minutes. After completing this foundation block, you can move to a more sport-specific training routine. This is achieved by introducing posture specificity to the session in order to challenge both the breathing and postural roles of your inspiratory muscles. If ‘eliminating stitch’ is the main goal, the specificity can be achieved by challenging the postural stabilising role of the diaphragm while undertaking IMT – *e.g.* by standing on a wobble board, air pillow, or Bosu ball while performing IMT.

**Alison McConnell**