Does the Evidence Support Our Traditional Concepts of Achilles Tendon Rupture Etiology and Repair?

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The approach to evaluation management of acute Achilles tendon repair has undergone a constant evolution over the past 5 decades. Both surgical and non-surgical treatments have been extensively studied and a wealth of new evidence is available that has changed the most basic tenants of management of this common injury. Despite the availability of very good studies that clarify and challenge our traditional thoughts, many traditions and misconceptions persist among foot and ankle surgeons. We will explore several aspects of acute Achilles tendon rupture including; whether repair is needed for good outcomes, current concepts of tendon hemodynamics and ischemia and which steps in the repair algorithm are necessary.

To start the discussion, we will first explore the concept of tendon debridement during repair. This commonly recommended step highlights how historic evidence can create bias in our approach to a common medical problem and how this bias can persist for decades despite new evidence being brought forward. Surgical repair of acute Achilles tendon ruptures commonly includes debridement of damaged tendon fibrils or “mop ends” at the rupture site. Although this step has historically been seen as a necessary step in the repair algorithm, we question whether it is necessary or prudent to resect any portion of the ruptured tendon. Removal of even a small segment of the midportion of the Achilles tendon results in shortening of the muscle-tendon unit and therefore iatrogenic equinus. In order to critically assess the common practice of tendon debridement in Achilles tendon ruptures, we must first answer the following questions: (1) What evidence supports the surgical resection of any portion of the damaged tendon? (2) How do we determine which portion of the tendon is beyond capability for natural biologic repair? (3) Is ischemia the proximate cause of Achilles tendon rupture? (4) Has

this notion of midsubstance ischemia of the Achilles lead to the recommendation of debridement because this section of tendon is thought to be necrotic?

Although the notion of ischemia as the main etiology of Achilles rupture is ubiquitous in the discussion of the condition, there is little to no experimental evidence to support this conclusion. The original study by Lagergren & Lindholm in 1959 used a cadaver model and mapped the blood supply with standard anatomic latex injection technique. The term watershed was ascribed to the vascular anatomy of the tendon because there were vascular components that came from both proximal and distal portions of the tendon similar to the geographic term of a river watershed. They concluded that this anatomic distribution and orientation of blood supply leads to ischemia in the midsubstance of the tendon. This experiment was duplicated by Carr and Norris 1989 with the same conclusion. It is interesting that this notion has persisted for many decades based on mapping of the static arterial anatomy in cadavers alone and not hemodynamic flow studies in live patients. Recent literature questions the concept of avascularity as a significant or sole factor for Achilles tendon tears (Theobald 2005). Astrom 2000 and Astrom and Westlin 1994 found with use of quantitative laser Doppler flowmetry that the mid-section and origin are the areas of the Achilles tendon which are most vascularized uniformly along the tendon and that only the distal insertion has noticeably lower blood flow. Hastad et al. 1959 used Na washout showed there is a decrease in blood flow in all zones as we age, but the blood flow is consistent along the longitudinal course of the tendon. Uniformity of blood flow was confirmed again by Astrom in 2000. Further evidence highlights uniform increase in tendon blood flow to the Achilles tendon throughout its length (Langberg et al. 2001, Langberg et al. 1998, Boushel et al. 2000, Kubo 2008). We wonder if this notion of ischemia, which began with non-hemodynamic cadaver studies, coupled with the visual cues seen during exposure for acute repair including hematoma and tendon fragmentation, has lead us down the path of resection of a portion of the tendon without scientific cause. Let’s face it, the tendon at

the rupture site looks bad when we directly visualize it. And if we are biased by what we were taught about “watershed ischemia”, debridement seems reasonable.

Figure 1: Intraoperative appearance of ATR

Caption: Despite the disorganized visual appearance of the ruptured tendon, available evidence would argue that the tendon is still viable, and that debridement is not necessary

A somewhat less direct approach to answer the question of whether the tendon is ischemic is to examine the results of non-surgical care for ATR. There are a growing number of recent studies indicating that the functional outcomes and re-rupture rates for non-surgical management using early functional rehabilitation are equivalent to surgical repair.

A 2017 Canadian study by Sheth et al. detailed that, although there has been a rise in acute Achilles tendon ruptures in recent years, there has been a significant decrease in incidence of surgical repairs since 2009. They found that the rate of surgical repairs in Ontario, Canada dropped from 20.1% in 2003 to 9.2% in 2013. This drop in surgical repairs in Canada could be contributed to recent literature which supports non-operative treatment. A systematic review and meta-analysis performed by Deng et al. 2017, found that there was no statistically significant difference in the incidence of DVT, functional scores, or ankle ROM between the surgical and non-surgical groups. Deng et al. 2017 also showed that the re-rupture rate for surgical patients 3.7% was statistically lower than the nonsurgical group (9.8%). Prevention of this increased rate of re-rupture in non-surgical patients was previously explained in Twaddle et. al. 2007. Twaddle et al. 2007 observed surgical and nonoperative patients who both partook in early range of motion, he found that there was no significant difference in complications, re-rupture rates, dorsiflexion, plantarflexion, calf size or MFAI between the two groups. Lim and Gwynne-Jones. 2017 also found no significant difference in Achilles tendon total rupture scores between operative and nonoperative treatment groups which followed the same functional bracing protocol. Thus Twaddle et al. 2007 and Lim and Gwynne-Jones 2017 concluded, as did Barfod et al. 2014, that early active rehabilitation is more important for tendon healing than surgery. Suchak found that in surgical patients who were either randomized into early weight bearing or 6 week delayed weight bearing groups, the early weight bearing group had better RAND36 and ROM outcomes at 6 weeks. At 6 months there was no longer this difference between the two groups and the same complication rate was present. Young et al 214, achieved this early active rehabilitation by allowing nonoperative patients to use a weight-bearing casts, which had outcomes equivalent to nonoperative patients who were non-weight-bearing. Hutchison et al. 2015 had low rerupture rates (1.1%) and satisfactory ATRS, AS, and functional outcomes when using the Swansea Morriston Achilles Rupture Treatment programme (SMART) which includes early weight-bearing. A level one study by Willits et al. 2010 “supports

accelerated functional rehabilitation and nonoperative treatment for acute Achilles tendon ruptures" due to the patients having similar clinical outcomes as operative patients, while avoiding the complications associated with surgery. Bergkvist et. al 2012 agreed that nonoperative treatment is the preferred protocol in most patients due to low re-rupture rate (6.6%) in nonsurgical patients and the non-existent chance of infection.

It would stand to reason that if the tendon can heal without surgery, it must not be significantly ischemic and is certainly not dead. In fact, it is just injured and undergoes the normal physiologic reparative process seen with any similar tissue failure. Additionally, limited exposure or percutaneous techniques for repair are now available and provide encouraging results (Chiu et al. Karabinas et al., Hsu et al). These techniques do not include any form of tendon debridement further supporting the concept that the damaged, but not necessarily ischemic, tendon can heal through normal physiologic processes.

While open surgical debridement may have been the standard treatment of acute Achilles tendon ruptures in the past, that does not mean that it is the gold standard of patient care now. Numerous studies have shown that there is sufficient blood flow along the length of the tendon, and therefore there is no ischemia and no need for the tendon to be debrided. This point is further supported by the knowledge that Achilles ruptures may be healed nonoperatively with excellent functional results and low complications. As the research shows, the new standard in care is setting down the blade, taking a break from the OR and having your patients with Achilles tendon ruptures start early weight bearing and ROM.

References:

1. Lagergren C, Lindholm A. Vascular distribution in the Achilles tendon; an angiographic and microangiographic study. *Acta Chir Scand*. 1959;116(5-6):491-495.
2. Carr AJ, Norris SH. The blood supply of the calcaneal tendon. *J Bone Joint Surg Br*. 1989;71(1):100-101.

3. Theobald P, Benjamin M, Nokes L, Pugh N. Review of the vascularisation of the human Achilles tendon. *Injury*. 2005;36(11):1267-1272.
4. Aström M. Laser Doppler flowmetry in the assessment of tendon blood flow. *Scand J Med Sci Sports*. 2000;10(6):365-367.
5. Aström M, Westlin N. Blood flow in chronic Achilles tendinopathy. *Clin Orthop Relat Res*. 1994(308):166-172.
6. Hastad K, Larsson LG, Lindholm A. Clearance of radiosodium after local deposit in the Achilles tendon. *Acta Chir Scand*. 1959;116(3):251-255.
7. Langberg H, Olesen J, Skovgaard D, Kjaer M. Age related blood flow around the Achilles tendon during exercise in humans. *Eur J Appl Physiol*. 2001;84(3):246-248.
8. Langberg H, Bülow J, Kjaer M. Blood flow in the peritendinous space of the human Achilles tendon during exercise. *Acta Physiol Scand*. 1998;163(2):149-153.
9. Boushel R, Langberg H, Green S, Skovgaard D, Bulow J, Kjaer M. Blood flow and oxygenation in peritendinous tissue and calf muscle during dynamic exercise in humans. *J Physiol (Lond)*. 2000;524 Pt 1:305-313.
10. Kubo K, Ikebukuro T, Tsunoda N, Kanehisa H. Changes in oxygen consumption of human muscle and tendon following repeat muscle contractions. *Eur J Appl Physiol*. 2008;104(5):859-866.
11. Sheth U, Wasserstein D, Jenkinson R, Moineddin R, Kreder H, Jaglal SB. The epidemiology and trends in management of acute Achilles tendon ruptures in Ontario, Canada: a population-based study of 27 607 patients. *Bone Joint J*. 2017;99-B(1):78-86.
12. Deng S, Sun Z, Zhang C, Chen G, Li J. Surgical Treatment Versus Conservative Management for Acute Achilles Tendon Rupture: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J Foot Ankle Surg*. 2017;56(6):1236-1243.
13. Twaddle BC, Poon P. Early motion for Achilles tendon ruptures: is surgery important? A randomized, prospective study. *Am J Sports Med*. 2007;35(12):2033-2038.

14. Lim CS, Lees D, Gwynne-Jones DP. Functional Outcome of Acute Achilles Tendon Rupture With and Without Operative Treatment Using Identical Functional Bracing Protocol. *Foot Ankle Int*. 2017;38(12):1331-1336.
15. Barfod KW, Bencke J, Lauridsen HB, Ban I, Ebskov L, Troelsen A. Nonoperative dynamic treatment of acute achilles tendon rupture: the influence of early weight-bearing on clinical outcome: a blinded, randomized controlled trial. *J Bone Joint Surg Am*. 2014;96(18):1497-1503.
16. Young SW, Patel A, Zhu M, et al. Weight-Bearing in the Nonoperative Treatment of Acute Achilles Tendon Ruptures: A Randomized Controlled Trial. *J Bone Joint Surg Am*. 2014;96(13):1073-1079. Accessed Feb 11, 2018.
17. Hutchison AM, Topliss C, Beard D, Evans RM, Williams P. The treatment of a rupture of the Achilles tendon using a dedicated management programme. *Bone Joint J*. 2015;97-B(4):510-515.
18. Willits K, Amendola A, Bryant D, et al. Operative versus nonoperative treatment of acute Achilles tendon ruptures: a multicenter randomized trial using accelerated functional rehabilitation. *J Bone Joint Surg Am*. 2010;92(17):2767-2775.
19. Chiu C, Yeh W, Tsai M, Chang S, Hsu K, Chan Y. Endoscopy-assisted percutaneous repair of acute Achilles tendon tears. *Foot Ankle Int*. 2013;34(8):1168-1176.
20. Karabinas PK, Benetos IS, Lampropoulou-Adamidou K, Romoudis P, Mavrogenis AF, Vlamis J. Percutaneous versus open repair of acute Achilles tendon ruptures. *Eur J Orthop Surg Traumatol*. 2014;24(4):607-613.
21. Hsu AR, Jones CP, Cohen BE, Davis WH, Ellington JK, Anderson RB. Clinical Outcomes and Complications of Percutaneous Achilles Repair System Versus Open Technique for Acute Achilles Tendon Ruptures. *Foot Ankle Int*. 2015;36(11):1279-1286.