Running Injuries — Changing Trends and Demographics

Karl B. Fields, MD

Abstract
Running injuries are common. Recently the demographic has changed, in that most runners in road races are older and injuries now include those more common in master runners. In particular, Achilles/calf injuries, iliotibial band injury, meniscus injury, and muscle injuries to the hamstrings and quadriceps represent higher percentages of the overall injury mix in recent epidemiologic studies compared with earlier ones. Evidence suggests that running mileage and previous injury are important predictors of running injury. Evidence-based research now helps guide the treatment of iliotibial band, patellofemoral syndrome, and Achilles tendinopathy. The use of topical nitroglycerin in tendinopathy and orthotics for the treatment of patellofemoral syndrome has moderate to strong evidence. Thus, more current knowledge about the changing demographics of runners and the application of research to guide treatment and, eventually, prevent running injury offers hope that clinicians can help reduce the high morbidity associated with long-distance running.

Introduction
Long-distance running and recreational road races are a major part of sports activities in communities throughout the United States. Their linkage to charitable fundraising memorial events, weight loss programs, and community celebrations has led to an explosion in the number of road races that occur in towns of all sizes. In 2010, a record 507,000 Americans finished a marathon, with most of them being inexperienced runners. An estimated 20% of Americans run regularly for fitness, but as many as 30% may participate at times in one of these events. The numbers of individuals who take part in recreational running far exceed those who take part in competitive track-and-field competitions.

The trend for wider community participation has changed the demographic of the running community and the pattern of injuries that affect runners. In particular, the average age of runners in road races is 40 yr, including 46% of marathoners. This means that injuries more common to master runners have become prevalent. In addition, individuals who do not have the low body mass index and body habitus of a typical competitive marathon runner have chosen to participate in longer race events like half-marathons and marathons. These runners typically follow training schedules that have a relatively low total mileage and emphasize building up to one long run every other week. Some encourage the participants to walk regularly within the race to complete the event. Not surprisingly, impact injuries that occur in elite runners during high-mileage training now affect heavier runners at a lower mileage.

One consistent feature of running injury research is that injury rates remain high and, in published reports, range from a low rate of 19% to a high rate of 79% of runners injured yearly. Typically, 25% of runners are injured at any given time, and about half experience an injury that takes them out of running for a period during any year. The recovery and rehabilitation of these injuries clearly play a role in the subsequent risk of new running injuries. Only two factors have shown a strong statistical correlation with the prediction of running injuries, and these are previous injury and total running mileage. In the only true prospective study of running injuries, previous injury showed a relative risk of 1.51 in predicting future injury. The other significant risk factor was running mileage, with 40 miles or more per week showing an RR of 2.88 for subsequent injury.

Epidemiology of Running Injury
Older surveys of running injury in general have revealed similar anatomic patterns. The most common injuries are those on the knee, followed by lower leg injuries, Achilles tendon and calf injuries, stress fractures, and foot injuries. Considerable variation exists within these studies related to the demographic of participants, as well as the type of...
running — competitive, recreational, track racing, and shorter distances or longer distances. Compilation of these studies reveals a pattern that suggests approximate injury frequencies per anatomic site as follows (8):

Knee = 25%
Lower leg = 20%
Foot = 16%
Ankle = 15%
Upper leg = 10%
Hip and pelvis = 7%
Lower back = 7%

More recent epidemiologic studies show a changing pattern of injury, consistent with the findings that older runners make up a higher percentage of participants in road races. A 2005 survey study of 2,886 runners of whom 34% were master runners also showed differing patterns between younger and older runners. Knee and shin problems affected more of the younger runners ($P < 0.005$), whereas calf, Achilles, and hamstring injuries were more common in older runners ($P < 0.001$). Speculations about the potential causes of greater muscle injury in older runners include age-related changes in the muscle tendon unit such as decreased strength and increased stiffness. A second possible explanation is that the normal muscle injury that occurs with training seems to take greater time to repair with aging, and older runners continue running at a frequency similar to that of younger runners (24).

This review will focus on the most common injuries in the above areas, with the exclusion of foot problems that are covered in the companion article by Simons in this issue (32). Diagnostic evaluation and specific treatment recommendations are offered. Included are some musculoskeletal images of running injuries because these diagnostic tools have become a valuable adjunct to the diagnosis and subsequent treatment monitoring of running injuries.

Knee Injuries

ITB

ITB syndrome has surpassed PFS as the most common knee problem in runners in recent reports (24). Although lateral knee pain also arises from patellofemoral tendinopathy, vastus lateralis strain, and lateral meniscal pathologic disease, the typical runner with lateral knee pain has ITB syndrome. Even in older epidemiologic studies, ITB syndrome occurred more commonly in more competitive runners than did PFS. One possible reason for an increase in this injury among runners may be the explosion in the number of individuals competing in road races.

Classic treatments for ITB syndrome include many stretches, friction massage to the ITB, correction of the inequality in leg length, training changes including variable-paced running, avoidance of running on cambered surfaces, and correction of biomechanical issues such as excess pronation. None of these interventions have evidence stronger than expert opinion (SOR C in the Strength of Recommendation Taxonomy (SORT)). The strongest evidence for an effective treatment comes from a prospective trial that emphasized correction of weakness in hip abductor strength. In this trial, of the 24 affected runners, 22 resolved symptoms by 3 months and a 23rd by 6 months, using a regimen of lateral leg lifts. (SOR B, moderate evidence) (11).

This finding was supported by subsequent studies showing the association of hip abduction and hip flexion weakness with overall risk of injuries to the lower extremity in runners. The rationale behind this observation is that the gluteus medius is the key stabilizer of the ITB and that it functions in the stance phase of running gait to stabilize foot strike and block dynamic genu valgum (12,27).

PFS

PFS traditionally ranks as the most common running injury. This probably remains true for younger runners and beginners. Moderate evidence links vastus medialis weakness, hip abduction weakness, and cavus feet with PFS (level of evidence (LOE) 2, or moderate evidence, in the SORT system) (4,7,16). Other specific associations such as hamstring tightness, pronation, and Q angles lack strong evidence, and whether to address these in treatment protocols remains controversial (SOR C). Clinical conditions that cause anterior knee pain often are lumped into the PFS category, although the advent of musculoskeletal ultrasound allows clinicians to identify more specific injuries that cause anterior knee pain. These include quadriceps and patellar tendinopathy and partial tears, plica syndrome, and supra- and infrapatellar bursitis. Additional conditions that cause anterior knee pain, such as osteochondral lesions, patellar subluxation or dislocation, patellofemoral arthritis, and systemic medical conditions, require a more extensive workup to make a definitive diagnosis.

Treatment of PFS with orthotics now has relatively strong evidence (SOR A). This comes from recent prospective controlled trials, as well as several case series. One systematic review rated orthotics as likely to provide superior relief in PFS to flat insoles (2). To date, the highest-quality study on PFS evaluated 147 patients randomized to semi-custom heat-molded orthotics, physical therapy (PT), both interventions, and flat insoles (the null intervention). Patients rated their functional assessment and pain at the end of the trial. The study showed a statistically significant improvement in pain in all three intervention groups over the control group (i.e., orthotics and formal PT both led to reductions in pain and to improved function). Results were similar, but the two interventions combined were not better than either alone. The number of patients needed to treat with foot orthoses versus flat inserts was 4 at 6 wk and 9 at 12 wk (based on patient-perceived global success outcomes) (5).

This randomized trial also provided strong evidence that PT can benefit patients with PFS. Presumably, PT addresses both of the associated weakness findings in the vastus medialis and the gluteus medius muscle groups. Although only a small number of strong prospective trials looking at the benefit of PT for PFS exist, of three of these Cochrane reviews, pain reduction was noted in two trials and functional improvements were noted in one trial. Strong evidence that open- and closed-chain rehabilitation programs are equivalent does exist (SOR A) (36). One similar finding in both orthotic and PT intervention trials for PFS is that virtually all trials regardless of type showed some level of benefit from the intervention.

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Meniscus Injuries

Meniscus injuries did not seem significant in earlier epidemiologic studies but now comprise a significant percent of the knee problems noted in recent running injury studies. This parallels the older age of competitors in road races. One study of injured runners in a sports medicine clinic noted a higher risk in male runners and found meniscus injuries to be the fourth most common problem (33). No long-term studies guide the outcome of those individuals who continue to run with a meniscal pathologic abnormality. Orthopedic research demonstrates the poorer ability of the knee to dissipate impact after meniscectomy or significant meniscal cartilage loss. However, patient outcome evidence about whether running after meniscectomy or meniscus injury treated nonoperatively accelerates osteoarthritis of the knee is lacking. Most physicians would caution patients against this type of weight bearing stress, but injury data from a recent race indicate that runners are participating regardless of this advice.

Calf/Achilles Tendinopathy

Calf injuries affect older runners more commonly, and Marti et al. (22) noted these as the most common injury of runners older than 40 yr who participated in a major Swiss road race. Achilles tendinopathy was the most common injury in a recent study of master runners (18). Achilles tendinopathy also occurs more commonly in elite runners — approximately 10% of elite runners annually — and runners with more than 10 years of experience (19). The lifetime risk in former elite male distance runners may be as high as 52% (36). Runners typically attribute this injury to excess speed work, hill running, or overtraining. Cavus feet and inflexible Achilles-calf complexes are suspected of increasing risk. However, these observations about etiology lack any rigorous evidence.

A variety of injuries occur in the calf including the “classic tennis leg,” which represents a tear at the musculotendinous insertion of the medial head of the gastrocnemius muscle. The lateral head of the gastrocnemius experiences less injury perhaps because the toe-off phase of gait occurs with most of the force directed along the medial aspect of the leg. Other soft tissue structures including the intersection of the two heads of the gastrocnemius and the plantaris tendon can tear with excess training.

Pain deep to the gastrocnemius and palpable on squeezing of calf from the medial and lateral aspects suggest soleus syndrome. The soleus is a slow-twitch muscle, and chronic soleus pain may indicate a runner who trains at a mileage too great for his or her fitness.

Achilles tendon injuries occur primarily in two areas. These most commonly occur in what is called the avascular zone, from 2 to 5 cm above the insertion. This is the area in which the fibers of the gastrocnemius and the soleus weave together to form the substance of the tendon. The second area is at the insertion of the Achilles tendon into the heel, representing an enthesopathy — a separation of tendon fibers from their insertion in the bone. These injuries act more like partial tears and pose greater challenges for the runner to heal. Retrocalcaneal bursitis and frank Achilles ruptures occur less commonly in runners. The exceptions to this would be runners wearing shoes with very firm heel counters that may lead to a contusion at the back of the heel and a secondary bursitis. Highly competitive sprinters also have experienced several complete Achilles ruptures presumably from the speed and high tensile stress required in maximal sprinting.

The best evidence for effective treatment of Achilles tendinopathy comes from eccentric exercise protocols studied by Alfredson et al. (1). This type of rehabilitation led to the resolution of tendinopathy in most individuals with noninsertional injuries. Imaging studies with both musculoskeletal ultrasound and magnetic resonance imaging (MRI) that assessed healing of the Achilles tendon of patients using these protocols demonstrated resolution of the pathologic changes of tendinopathy (SOR A) (15,31). Subsequent studies looking at insertional tendinopathy modify the eccentric protocols to make these less stressful and have shown benefit but slower healing times and more treatment failures. Although these studies did not specifically examine the treatment of other calf injuries, most clinicians use this approach for gastrocnemius and soleus problems as well because they are all part of the same musculotendinous complex (18).

Adjunctive treatments using ice massage, heel lifts, and stretching arise from clinical experience and physician opinion (SOR C). Other studies with some evidence include a study of 31 male runners who ran more than 30 miles wk⁻¹. In this trial, 4 wk of PT or wearing custom orthotics reduced pain by 50% compared with an untreated control group (23). Paoloni et al. (28) studied the use of low-dose topical nitroglycerine patches for the treatment of noninsertional Achilles tendinopathy and noted 78% with excellent results when combined with the eccentric rehab protocol of Alfredson et al. (1) versus only 49% on the PT alone. A recent meta-analysis including seven randomized controlled trials found strong evidence that topical nitroglycerine therapy helped relieve pain in chronic tendinopathies (SOR A) (13). To date, studies of platelet-rich plasma injection, prolotherapy, and other modalities yielded mixed results.

Medial Tibial Stress Syndrome/Compartment Syndrome/ Tibial Stress Fracture

Medial shin pain affects young runners as commonly as any type of injury. Particularly, when this is bilateral, this represents the classic “shin splints,” which is a nonspecific type of injury delineated by pain along the posterior medial border of the tibia. Diagnosis primarily comes from physical examination, and advanced imaging, at most, shows linear uptake on a bone scan or nonspecific edema of the periosteum on an MR image. Some evidence supports the use of shock-absorbing insoles because Cochrane cites four medium-quality studies that show some reduction of risk of medial tibial stress syndrome (shin splints)/tibial stress fracture with the use of shock-absorbing insoles (29). A more recent review of newer literature found inconsistent results, with two studies that moderately supported prevention and one that supported shock-absorbing insoles/custom orthotics for treatment (SOR B) (21,26,34).

Compartment syndrome should be considered in runners who have persistent shin or lower leg pain that comes with exertion and has no direct association with a defined
Running Injuries

Evidence suggests that running mileage and previous injury are the strongest predictors of subsequent running injury. Evidence-based research now helps guide the treatment of some of the most common running injuries. Greater focus on hip abduction strength for ITB syndrome and possibly PFS, eccentric strengthening protocols for Achilles tendinopathy, use of topical nitroglycerin in tendinopathy, and orthotics for the treatment of PFS and possibly MTSS all have moderate to strong evidence. A recent study raised

302 Volume 10 • Number 5 • September/October 2011 Running Injuries

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the intriguing possibility that, for heavy physical training, an orthotic intervention also might reduce the risk of overall lower extremity injury (10). Thus, more current knowledge about the changing demographics of runners and the application of evidence-based medical research to guide treatment and eventually prevent running injury offers hope that clinicians can help reduce the high morbidity associated with long-distance running.

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References