

# POSTURAL BALANCE AND BIOMECHANICAL PROBLEMS FOR THE KNEE

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The increased emphasis of jogging and running and for the special few, the marathon, has increased with exploding emphasis in the past few years. If any person wished to follow the "circuit," a 10K race (6 miles), 5 miler, or any other combination of distances, they could take part in competition in any section of the country on a daily and weekly basis providing transportation and funds were available. By and large the runner/jogger pretty much confines their activity to the local scene, running at the track, on the streets or hike and bike trails such as are found in Austin.

Initial training for jogging-running takes many forms. One such being to run a little, walk a little, and gradually increasing the running distance and speed. By this approach the individual builds a certain amount of conditioning. This develops an increased degree of cardio-respiratory efficiency which produces a feeling of exhilaration - once the initial phases of muscular soreness and joint stress subside. If any of these factors continue to persist, especially stresses in the ankles, knees, hips, or low back, the person will either stop the activity, seek help from other runners (as to how they cured their stress problems), and/or look for professional help to alleviate such: usually such may include the family physician, local orthopaedist, osteopath, podiatrist, or some other professional in the community who has helped other runners "get back on the track," running free of stress.

The jogger/runner who has reached the stage of "getting hooked" on the activity and just doesn't feel good without the three times per week or daily run will make every effort to seek professional advice. For example, a young lady stated "while growing up sports was not the thing for girls, at least in my family. Now in college, jogging is an exciting experience but the knee stress has caused me to stop, and I don't feel 'as alive' as when I was running." Another lady who developed some stress problems after running for a few months stated, "I have four children and love them dearly. However, running has enabled me to maintain my sanity as well as calm my nerves and relate more positively to my children, but running and hurting is not enjoyable."

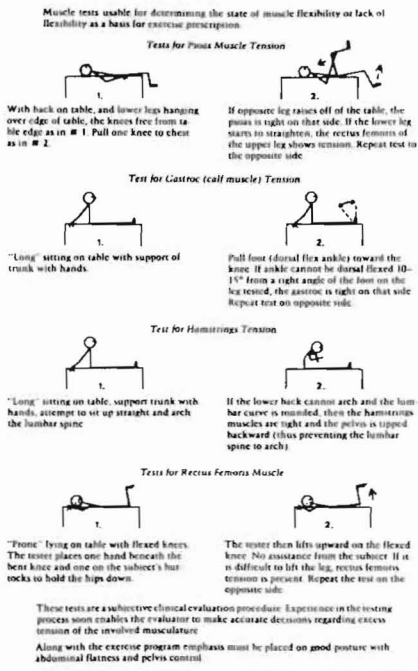
From 1969 through 1985 over 1500 joggers/runners have visited the Rehabilitation Laboratory seeking aid in solution of their stress problems. Each case is an individual problem. It all started in 1969 with a call from one of the professors from the U.T. Engineering Department, a runner, who was experiencing some low back stress while running. By the process of postural

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evaluation, muscular flexibility testing, postural balancing (shims to create lateral postural balance) and a prescribed set of flexibility exercises, to be done daily as well as before and after running, he was able to get back to running free of the problems. That was the beginning and development of my specific research into the problems of mechanical malfunctions of joggers and runners. A standard procedure of evaluation has been set up for two purposes: 1) to determine the mechanical malfunction that caused the problem and 2) to identify distribution of mechanical faults that lead to stress. Table I illustrates data collected from 1472 cases and shows that lateral postural asymmetries (short leg syndrome), bilateral ankle pronation (ankles turning inward), and muscular tension imbalance between the antagonistic muscles (i.e., anterior tibialis and gastroc groups) are shown to be major areas responsible for the development of stress symptoms. In addition to these factors, many people do not know proper running techniques. "Pigeon-toed, or toes inward movement, is the way "leg bone is attached to the thigh bone," so the toe inward position is the proper way to run.

FIGURE 1



Ryan<sup>15</sup> points to the many failures observed in the evaluation of low back pain (a runner problem) in athletes. In the evaluation of this problem he lists, "a variety of treatment approaches that were of questionable value and emphasized that mechanical inefficiencies were the chief cause of stress."

Running is primarily a function of the hip joint flexors (movement of the leg forward) and extensors (movement of the leg backward) as well as the musculature of the lower leg (the calf muscle that pushes the foot down and anterior tibialis that pulls the foot upward as the leg comes forward).

TABLE 1 : 1472 Cases

## JOGGERS/RUNNERS STRESS PROBLEMS -- EVALUATION FINDINGS

Postural Asymmetries		Ankle Pronation			Knee Stress			Muscle Tension	Hip Pain	Low Back	Shin Splints									
		Right	Bilateral	Left	Right	Bilateral	Left													
Short R 463=34.1%	Short L 884=65.2%	M=2 F=3 5	M=576 F=415 991	M=10 F=5 15	M=135 F=96 231 33.1%	M=138 F=102 240 34.4%	M=134 F=92 226 32.4%	M=731 F=514 1245 84.6%	M=76 F=104 180 12.2%	M=114 F=66 180 12.2%	M=78 F=83 161 10.9%									
Total R-L Short 1347=91.5% of the 1356 cases measured		TOTAL WITH ANKLE PRONATION 1011 of 1472=68.6% of the 1101 cases M=588=58.2% F=423=41.8%			TOTAL WITH KNEE STRESS 697 of 1472=47.4% of the 697 cases M=407=58.4% F=290=41.6%			of 1245 cases M=731=58.7% F=514=41.3%	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td colspan="3" style="text-align: center;">KEY</td></tr> <tr><td colspan="3" style="text-align: center;">M = Male</td></tr> <tr><td colspan="3" style="text-align: center;">F = Female</td></tr> </table>			KEY			M = Male			F = Female		
KEY																				
M = Male																				
F = Female																				
SACRAL BASE LEVEL 9=.0066% of the 1356 cases measured					TOTAL WITH CHONDROMALCIA 235 of 697 knee stress cases=33.7% of the 235 cases M=109=46.4% F=126=53.6%															
NOT MEASURED 116=7.88%																				

The major hip flexor is the ilio-psoas muscle. It attaches to the lower five vertebrae of the spine and the inside rim of the pelvis (hips) coming down inside the pelvis and is attached to the inside of the upper leg. This is a strong muscle and if short when standing pulls the pelvis and low back forward, causing a "sway" back. According to Michele<sup>2</sup>, this is a major muscle that causes low back pain in today's society. The quadriceps muscle, on the front of the leg, has one section (the rectus femoris) that attaches to the anterior iliac spine of the pelvis (the point on the front of the hip). When tight it also assists in pulling the hips forward and downward resulting in the "sway-back" position. It also adds stress at the front of the knee especially at the knee cap (patella). When these two muscles are exercised, especially in jogging and running or just prolonged sitting they tend to tighten and shorten. They need to be stretched daily in order to maintain flexibility. The leg is extended at the hip joint by the gluteus maximus (butto muscle) and the hamstrings on the back of the leg. The latter, a primary flexor of the knee, is an active extensor of the knee in walking and especially in running (when the foot is in contact with the ground). So actually, the hamstrings serve two functions: i.e., the movement assisting in extending the hip joint, and flexing the knee as the leg is brought forward. It is weaker than its antagonist, the quadriceps, and also loses measured strength more rapidly, probably due to its dual function. When the hip flexors are tight and the pelvis is dropped forward to produce a "sway-back" position, the hamstrings are also stretched causing it to lose some of the efficiency in function. This is one of the fundamental causes of hamstring injury.

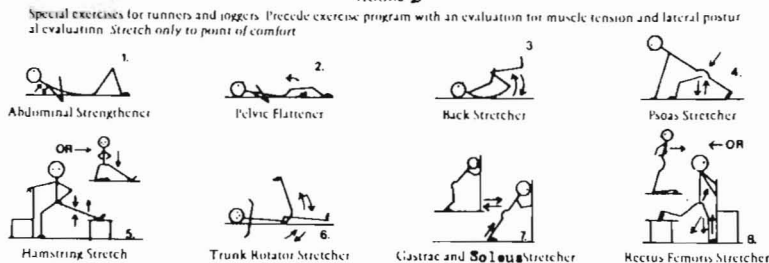
The gastroc-soleus (the calf muscle) is also a major running muscle and its excessive tightness can add to the development of stress. Problems resulting are: anterior "shin splints" on the front of the leg, posterior "shin splints" on the inside of the leg just above the inner ankle bone, ankle pronation (turning in of the ankle), turning outward of the foot (slue footed) in running, knee stress (runner's knee). Low back stress can also develop.

Self evaluation of muscle flexibility can be done but it is advisable to have some assistance, refer to Figure 1. These can be self testing procedures. The lack of flexibility, as determined by these tests, can pinpoint where the tension or short muscles are and the Exercises in Figure 2 will show you how

to correct the problem. The stretching should be done daily only to the point of comfort, 40-50 seconds each<sup>2</sup>. Do not overstretch. (if you do, the muscle will react by tightening); 40-50 second stretch is a good count. Stretch Before and After running.

Lateral tipping of the pelvis (the short leg syndrome - one hip high and one low is a significant part of the total<sup>5</sup> problem and studies have shown it to be highly related to runner's problems<sup>5</sup> as well as low back stress.<sup>1,10,6,11</sup>

FIGURE 2



Abdominal Strengtheners

Roll up head, then neck and shoulders. Keep low back on the floor, hold 8-10 counts. Relax. Repeat.

Pelvic Flatteners

Contract abdominal and gluteal muscles. Force low back to floor, hold 8-10 counts. Relax. Repeat.

Back Stretcher

Pull knees to chest and squeeze 40-50 seconds. Relax. Repeat. On relaxation hold onto knees but extend arms.

Psoas Stretcher

Have foot in front of knee on forward leg, with rear leg straight. Keep hips level. Push hips downward to point of tension in groin area of rear leg. Hold. Release (hips up). Repeat. Do same procedure for other side. 40-50 seconds for each stretch.

Hamstring Stretch

Stand with one leg extended sideward, heel on bench. Press hip downward on elevated leg side to point of mild stretch of hamstrings and leg adductors. Hold 50-60 seconds. Release. Repeat. Do same procedure for other side.

Trunk Rotator Stretcher

On back, arms sideward on mat, legs straight. Swing right leg across toward left leg. Keep knee straight. Roll at hips. The ultimate objective is to reach the foot to the opposite hand but this will take some time to gain the necessary flexibility. Do 20-30 times.

Gastrocnemius and Soleus Stretcher

Stand near wall, toes slightly inward, weight on outer borders of feet. Reach forward to wall, bend arms, lean forward. Keep heels on floor to a mild stretch of calf muscle. Hold 50-60 seconds. Release. Repeat 1-5 times.

Rectus Femoris Stretcher

Top of one foot on low stand, hands grasp back of chair. With trunk erect pull abdominals up, back flat. Push hips forward to stretch rectus. Bend forward knee to increase tension. Mild stretch only. Hold 50-60 seconds. Release. Repeat. Same to opposite side. Repeat 2-3 times each leg.

If there are no medical findings to show cause for the problem then it undoubtedly has been there since early childhood.<sup>7</sup> Correction of this problem can be achieved by a heel lift on the heel of the short side. Some other causes related to this problem may be due to one ankle pronated, and/or one knock knee. The basic approach to the correction of the ankle pronation problem, either unilateral or bilateral, is with the use of some type of orthotic device. Such devices are usually individually designed and fitted by a specialist. Subotnich<sup>14</sup> has reported that about 85 percent of all ankle problems are due to ankle pronation.<sup>4</sup>

The Rehabilitation Laboratory makes use of a podiatry designed Rear Foot Control<sup>13</sup> to aid in solving the ankle pronation problem along with a series of specifically designed exercises to strengthen the muscles that assist in correction of the ankle pronation problem, refer to Figure 3. The exercise description is as follows:<sup>8</sup>

Sit with knees flexed to about 110-115°, place feet 3-4 inches apart, foot-ankle about 90°, toes pressed together, fists between the knees. Lock heels on the floor, press toes together hard and squeeze knees together against the fists with maximum effort. Hold ten seconds - relax. Repeat 4-5 times in series. This exercise strengthens the muscles on the inside of the

ankle (tibialis posterior and flexor hallucis longus) and aids in control of pronation. The knee squeeze strengthens the muscles that turn the lower leg in and aids in development of the "pigeon-toes" foot action.

Early use of the "Rear Foot Controls" is an important first step in the correction of mechanical errors in running. They are especially effective in early training because they immediately promote better foot and leg function. This aids in the development of proprioceptive action for muscle function. "Rear Foot Controls" are also important during phases of muscle fatigue because they continue to maintain proper foot-leg function when the musculature tends to lose its effectiveness in action.<sup>9</sup>



Figure 3—Isometric Exercise.

Sit with knees flexed to about 115°, feet 3-4 inches apart, foot-ankle angle about 90°, toes pressed together, flats between the knees. Lock heels on the floor, press toes together hard, and squeeze the knees together against the flats with maximum effort. Hold ten seconds—relax. Repeat 4-5 times in series, 2-3 times daily. This exercise strengthens the muscles on the inside of the ankle (tibialis posterior and flexor hallucis longus) and aids in controlling pronation. The knee squeeze phase strengthens the muscles that turn the lower leg in.

In conclusion, these techniques have been used successfully to assist runners and joggers who come to the U.T. Rehabilitation Laboratory. The emphasis is on the Muscle Flexibility and Postural Balancing to improve running mechanics. To date the results have been highly successful!

A few case studies: CASE - A young lady runner (Marathon) came in with "Runner's Knee" pain. Postural measurements and a tread mill test for running mechanics indicated correction was needed; a 3/8" heel lift and "Rear Foot Controls." She is running pain free at under three hours at Marathon distance (ranked high in national competition).

CASE - A faculty runner with low back stress. Postural measurements demonstrated lateral imbalance. Daily flexibility exercises and a heel lift of 1/2" was placed on his right heel (refer to Figure 4). He is running 10-15 miles per week free of stress and competing in appropriate age group races.

CASE - A U.T. trackman with knee stress. Postural evaluation showed lateral imbalance and ankle pronation. A heel lift and "Rear Foot Controls" seemed to solve the problem. He stated that he couldn't believe running could be so comfortable with the adjustment.

The above procedures have been helpful to those in need, but one has to recognize that other approaches and procedures have been successful. The use of Flexibility Exercises and Postural Balancing with the use of the Heel Lift

and "Rear Foot Controls" seems to be a basic approach for helping joggers and runners to make their exercise more pleasant. This mechanical approach keeps them coming to my door.

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