

[IMAGE]

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## **Plastic Deformation and Long-Term Support**

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Patients who exhibit postural imbalances resulting from an underlying foot dysfunction often require both appropriate chiropractic adjustments and long-term supportive therapy. For these patients, the "quick fix" is often not a realistic option, and a recommendation of an adjunctive procedure (such as orthotic therapy) frequently raises questions in their minds.

Some concerns typically expressed include: "How long will I need to wear supports?" and "Do I need to use them in all my shoes?" Often, a patient will ask, "Can't I just do some exercises, or have an adjustment, that will fix my foot problems?" Such questions indicate the need for you to spend a little time explaining the concept of plastic deformation (connective tissue overstretch). Taking the time to respond and explain can help prevent many future problems and questions.

The value of discussing the concept of plastic deformation is the carryover into other topics, such as sustained work postures and unrecognized (and unconnected) subluxations. When patients understand that custom-made orthotics have been shown to help reduce fatigue<sup>1</sup> and improve neuromusculoskeletal complaints in the lower extremities, pelvis and spine,<sup>2</sup> they usually accept and value their postural supports. What's important is to keep the terminology as nontechnical as possible (not always easy with this subject), while making sure that certain key concepts are understood.

### **Arch Collapse**

Except for the few people with inherited normal variances or bony anomalies, most of us develop strong, flexible arches in childhood. Our feet and ankles survive the various recreational stresses into adulthood. One problem facing our modern society is the constant walking and standing on flat, rigid man-made surfaces, rather than on soft, variable ground. Over a period of years and decades, the repetitive, abnormal stresses and forces result in a slow breakdown of normal support for the bones and joints of the feet. The connective tissues (collagen and proteoglycans) are exposed to these long-term lengthening forces, resulting in a decrease in elasticity and a sagging of the foot's arch.

This breakdown then allows transmission of abnormal strains into the legs, the pelvis, and ultimately the spine. Since it is usually the spinal symptoms which have brought the patient into the chiropractor's office, the doctor must be able to identify the underlying foot dysfunction.

The tissues which must withstand this strain for years are the connective tissues (ligaments, tendons and fascia), which are composed of woven collagen fibers. This arrangement allows for the combination of flexibility and strength that keeps our joints within close alignment, while still allowing for a wide range of movement. The woven collagen fibers demonstrate a very important physical property: viscoelastic behavior.

### **Viscoelastic Behavior**

Viscoelasticity is the time-dependent response of tissues to a load.<sup>3</sup> If the stress placed on a ligament is within its elastic range, it is able to spring back after loading. The more elastic the collagen is, the better the ligament is at returning to its original length when a load stress is removed. When a ligament is loaded beyond its elastic range, it enters the plastic (viscous) range. Plasticity is the tendency of a material (or tissue) to permanently deform when the load goes beyond the elastic range.

The relative proportion of elasticity and plastic deformation varies with the stretching conditions, especially the amount and duration of applied force. A constant low load applied to soft tissues over a prolonged period demonstrates the phenomenon called creep. This is the steady deformation that occurs over a period of time. One example of this is the loss of an individual's height, which occurs during the day due to temporary deformation of the spinal discs.<sup>4</sup> When creep goes beyond the tissue's elastic capability into its plastic range, permanent plastic deformation is the result.

### **Aging of Collagen**

The physical properties of collagen are closely tied to the number and quality of the cross-links between fibers. During growth and maturation (up to 20 years of age), the cross-links increase, resulting in increased tensile strength of tendons and ligaments.<sup>5</sup> As aging progresses, cross-linking activity plateaus and the collagen content of ligaments begins to decrease. This causes a gradual decline in the elastic capability, facilitating creep and the development of permanent plastic deformation. The process is tremendously variable and occurs throughout a wide range of ages and activity levels.

## **Sports and Recreation**

Another factor to be considered is the greater amount of force applied to the connective tissues during strenuous recreational activities. When running, the forces applied to the ligaments of the foot and ankle are multiplied by at least a factor of three.<sup>6</sup> This means that the elastic range of the connective tissues is much more easily exceeded during any athletic activity that includes running. With more patients trying to increase their activity and fitness levels at the same time the population is aging, it's a safe bet that we'll be seeing more episodes of plastic deformation becoming permanent.

## **Conclusion**

When your patients spend long periods of time on their feet, perform athletic activities which place higher forces on the lower extremities, or are beyond the age of growth, the likelihood of permanent plastic deformation is great. These patients will best respond to chiropractic care for their musculoskeletal systems when supplied with appropriate styles of custom orthotics for all their shoes and levels of activity. When patients understand the concept of permanent plastic deformation, they will realize the importance of wearing their orthotics at least 75-80% of the time, and they will accept this as a permanent form of treatment and support. They will also appreciate your caring, expertise and interest in their long-term health. Such concern and attention helps to build a long-lasting, solid practice.

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