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## Anatomy of a Blister

By Dr. Gus Benner

I humbly offer a few thoughts and insights on some hikers' nemesis: blisters.

### First, a bit of anatomy.

The skin has three main layers. Starting from the surface they are the epithelium, then the dermis, then the subcutaneous layer. The epithelium has no blood vessels. The cells are produced by a layer adjacent to the dermis which has blood vessels, and those cells migrate toward the surface as they die and are sloughed off. The epithelium itself has 5 layers: starting from the outside they are the stratum corneum, stratum lucidum, stratum granulosum, stratum spinosa, and finally stratum germinativum (or basale).



A typical blister forms between the stratum germinativum and stratum spinosa, all in the epithelium, which, you'll remember, has no vessels. That's why blisters don't bleed. Abrasions go deeper into the dermis, and abrasions bleed. But blisters tend not to. Formation of a blister depends on a couple of factors: a shearing force parallel to the skin surface that splits the layers of the epithelium, and pressure or force perpendicular to the skin surface. To move the superficial epidermal layer over the deeper layer, there has to be a frictional component, but if there is no pressure from the boot, for instance, the shear force of the moving boot cannot develop enough friction on the skin surface to move it over deeper layers, and ultimately develop a blister. So the more pressure, the more friction between the boot (or sock) and skin surface, the more shear force can move the skin surface.

**Try this:** Press your fingers together and move them back and forth - you can feel the friction. The tighter you squeeze them together, the more friction you feel. Now take a rubber balloon - don't blow it up, just put a little oil in it, put it between your fingers, and move them back and forth. They slip pretty easily, right?

### Blister treatment

The exercise above is the theory behind a blister treatment called the Bursatek. Reported in the Summer 2006 issue of Wilderness and Environmental Medicine (by Adrian Polliack and Samuel Scheinberg) it is basically a collapsed rubber balloon or pouch incorporated in an adhesive dressing for a blister that provides a very slippery covering and prevents a shear force from affecting the skin surface. They describe rather elegant ways of measuring the friction of various blister dressings, and find that Bursatek is far the best in reducing friction. Moleskin comes in second. I haven't seen the Bursatek easily available in stores, but it is available via Internet. Hikers should consider keeping some in the first aid kit and applying it as needed.

There are more traditional ways of reducing friction, include breaking in boots well before a major hike, using two pairs of socks, and applying a variety of tape products on the skin, from moleskin, to Second Skin, to duct tape. Each has its enthusiastic advocates, and you can let us know your favorite in the Sierra Club Trails discussion forums.

My own absolute best blister treatment is plain athletic adhesive tape, porous, (not waterproof!) 1-inch wide. Johnson and Johnson makes one product called Zonas Tape. It's cheap, so you can easily use a lot of it to cover your heels and toes before hiking to prevent the problem. The tape is thin, so it doesn't increase pressure, as moleskin does to some degree. The 1-inch width is important: it's wide enough for most coverage, and wider tape has more trouble conforming over curved surfaces. You'll use several pieces of tape over the heel. If you get a red spot, put the tape directly on the red skin. If you get a blister, put the tape directly on the blister. If you get a big blister that's going to break anyway, drain it at the edge carefully with a sterile needle (e.g. passed through a flame), then put the tape directly on the blister. If the blister breaks, and you have raw blister base, put the tape directly on the blister base. Because it is porous and breathes, the tape often stays on easily for days.

One key is to not remove the tape until you get home from your hike -- if it falls off, okay, reapply, but don't pull it off.

Happy Hiking!

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