A NOVEL ISO-ELASTIC CERCLAGE CABLE FOR TREATMENT OF FRACTURES

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Introduction: Wire cerclage is one of the oldest forms of internal fixation. Cerclage has numerous applications in orthopaedics as a primary method of fracture fixation and as a supplement to other forms of fixation. Traditional wire cerclage, however, has several disadvantages. Monofilament wire is prone to breakage.[1] Multifilament braided cables tend to undergo fatigue failure and fray, releasing metallic particulate debris into the body.[2, 4, 6] Both have a limited ability to maintain compression.[3]

A clinical need exists for a cerclage cable that can maintain compression across a fracture without the inherent mechanical problems associated with metal wire. In this paper, we present performance data on a novel flexible, high strength, high fatigue life polymer cable that addresses the inherent problems associated with traditional metal wire cerclage.

Methods: The iso-elastic cerclage cable consists of a nylon core encased in a jacket of UHMWPE braided fibers. This combination results in a cable having pre-determined elastic properties with the ability to store strain energy and provide continuous compression across a fracture construct. A tensioning instrument tightens the assembly with a metal clasp.

Cable assemblies were tested under in vitro static and dynamic loading conditions in both dry and wet environments. Wear behavior and viscoelastic responses under in vitro loading conditions were characterized.

Results: The dry polymer cerclage cable displayed an ultimate tensile strength of approximately 600 MPa. After soaking for 8 weeks, ultimate strength decreased by 6% and elongation to failure increased by 19%. The largest changes occurred after 1 week, and changes after 4 weeks of soaking were negligible.

Wet cable was tested under simulated physiologic conditions by wrapping the cable around a bone plate and cyclically loading it. The cable withstood one million cycles of load (Amplitude = 445 N) without breakage or visible damage. Sections of the fatigued specimens in direct contact with the bone plate were examined by scanning electron microscopy and displayed no fiber fraying, breakage or gross damage (Figures 1 and 2).

Stress relaxation tests showed that initial cable tension decreased by approximately 40% after 8 weeks of static loading. The majority of loss occurred after the first day, and only 1% of the total loss occurred during the final 30 days of the test.

Discussion: This study shows that the ultimate strength of the iso-elastic polymer cable is comparable to that of traditional metal cerclage cable. The iso-elastic cable maintained compression during the time period associated with primary bone healing[5] and showed a substantially superior fatigue endurance limit compared to metal cerclage. The cable easily survived one million cycles of load, which is expected to be beyond the physiologic requirement for patients recovering from a bony fracture. The wear behavior of the iso-elastic cable was clearly superior to that of multifilament metal cerclage. After initial relaxation, the iso-elastic cable maintained compressive forces that are typical of the initial compression held by traditional metal cerclage wires.

The defining characteristic of this polymer cerclage cable is its ability to store strain energy and provide continuous compression across a fracture. The elastic modulus of this polymer cable allows it to maintain compression across a fracture even in the presence of moderate bone compliance or resorption. Metal cable, which is two orders of magnitude stiffer than the polymer cable, suffers a complete loss of compression even after a minimal amount of bone resorption.

An iso-elastic cable has been developed to compensate for micro-movement within the bone fracture construct while maintaining a continuous compressive force across the fracture.

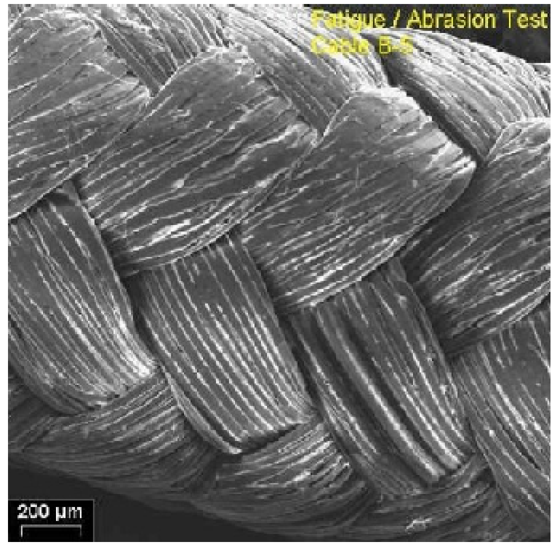

Figure 1. Iso-elastic polymer cable after one million loading cycles. The section shown was not in direct contact with the bone plate. A braided jacket of UHMWPE fibers is evident.

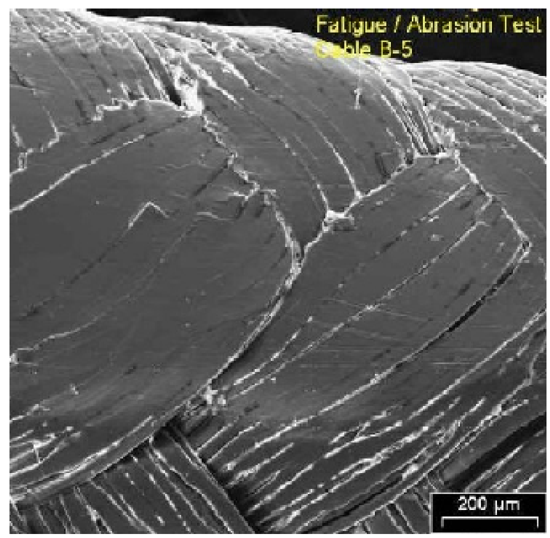

Figure 2. Iso-elastic polymer cable after one million loading cycles. The section shown was in direct contact with the sharp edge of a bone plate. UHMWPE fibers have fused together, but show no evidence of fraying or breakage.

References: **1)** Bostrom et al (1994) J Orthop Trauma 8(5):422-428. **2)** Dahl et al (2004) Annual Meeting of the Mid-America Orthopaedic Society. **3)** Haddad et al (2004) AAOS Scientific Exhibit. **4)** Hop et al (1997) Clin Orthop 344:20-32. **5)** Pilitsis et al (2002) Bone Healing and Spinal Fusion. **6)** Silverton et al (1996) J Arthroplasty 11(4): 400-404.

Acknowledgments: The authors thank Clyde Pratt for helpful discussion.

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