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Hybrid Braided Suture Architecture for US0 Equivalent Performance

Executive Summary

This development programme focused on engineering a braided suture construction capable of achieving a US 0 (EP 3.5) diameter equivalent using a hybrid UHMWPE and polyester fibre system, replacing a legacy design dependent on a 217 dtex core component.

The objective was to maintain mechanical performance, diameter control, and handling characteristics while transitioning to a modified material architecture that removed reliance on legacy inputs and improved material flexibility for future design adaptation.

Through controlled braid architecture optimisation and material integration, the programme successfully established a repeatable hybrid construction on standard braiding equipment, delivering equivalent dimensional performance without compromising mechanical integrity.

The Challenge

The existing construction relied on a 217 dtex core element that constrained material flexibility and limited future design scalability. The challenge was to eliminate this dependency while maintaining equivalent US 0 (EP 3.5) diameter performance and preserving key handling and mechanical characteristics.

Key engineering challenges included:

- Eliminating reliance on the 217 dtex core material without loss of structure integrity
- Maintaining strict diameter equivalence despite material substitution
- Managing differences in elastic modulus between UHMWPE and polyester fibres
- Ensuring stable braid formation on a 12-carrier system with hybrid inputs
- Preserving handling characteristics, including flexibility, knot security, and trackability
- Achieving repeatable manufacturing stability under a modified braid architecture

Engineering Objectives

The programme was designed to:

- Develop a US 0 (EP 3.5) equivalent braided suture using a UHMWPE-polyester hybrid system
- Replace legacy 217 dtex core dependency with a scalable architecture
- Maintain dimensional consistency and diameter control
- Preserve mechanical performance including tensile strength and handling behaviour
- Ensure compatibility with standard braiding equipment
- Establish a repeatable and scalable manufacturing process

Development Approach

Hybrid Material Architecture

The development strategy combined material substitution with controlled braid architecture tuning.

Key design features included:

- Replacement of the legacy core structure with a UHMWPE and polyester hybrid system
- Controlled integration of high-strength UHMWPE and compliant polyester fibre phases
- Maintenance of target US 0 (EP 3.5) diameter equivalence
- Structural balancing to preserve flexibility and knot performance
- Compatibility with standard 12-carrier braiding platforms

This approach decouples performance from legacy material dependency, shifting control to architecture-driven design parameters.

Structural Optimization

Structural Design Strategy

Braid geometry was optimised to manage:

- Load distribution between UHMWPE and polyester fibres
- Differential elongation behaviour under tensile load
- Compactness required for precise diameter control
- Structural stability during high-speed braiding conditions

This ensured that mechanical performance was governed by braid architecture rather than single-material dominance.

Validation & Performance Assessment

The hybrid construction was evaluated against dimensional and mechanical performance criteria.

Validation activities included:

- Runnage consistency assessment
- Break load performance testing
- Extension behaviour under load
- Diameter verification (US 0 / EP 3.5 equivalence)
- Picks-per-inch (PPI) structural consistency analysis
- Dye uptake uniformity assessment

Results confirmed that the hybrid architecture achieved target diameter and maintained mechanical performance within acceptable tolerances, while eliminating dependency on the legacy core material system.

Process Control & Repeatability

To ensure scalable production capability, key process parameters were tightly controlled:

- Balanced tension control between UHMWPE and polyester components
- Standardised haul-off speed (45 mm baseline)
- Fixed gear ration configuration (30 x 60) to maintain braid angle consistency
- Picks-per-inch (PPI) monitoring as a structural consistency indicator
- Controlled machine setup conditions across multiple trial batches

These controls enabled stable braid formation and demonstrated repeatability across production runs, confirming process robustness beyond single-batch variations.

Engineering Outcome

The programme successfully demonstrated that a UHMWPE-polyester hybrid braid architecture could replace a legacy 217 dtex-dependent construction while maintaining US 0 diameter equivalence and mechanical performance.

Key engineering outcomes included:

- Successful elimination of 217 dtex core dependency
- Stable achievement of US 0 equivalent diameter using hybrid architecture
- Preservation of mechanical performance, including strength and handling behaviour
- Establishment of a repeatable manufacturing process on standard 12-carrier equipment
- Increased flexibility in material selection and future design adaptation

Application Relevance

Surgical Sutures & Closure Systems

Braided non-absorbable suture architectures requiring consistent diameter control, knot security, and predictable handling performance.

Orthopaedics & Sports Medicine

High-tensile fixation and reinforcement applications in ligament and tendon repair where load retention and creep resistance are critical.

Cardiovascular Surgery

Soft tissue approximation and ligation requiring stable, low-profile braided constructs with controlled elasticity and handling behaviour.

Minimally Invasive & Robotic Surgery

Suture systems optimised for instrument-driven knotting, friction control, and consistent delivery performance.

Advanced Implantable Textile Systems

Reinforcement structures and load-sharing components in textile-based implant constructs requiring dimensional stability and mechanical predictability.

Key Takeaways

- Legacy material dependencies can be replaced through controlled hybrid braid architecture design
- UHMWPE-polyester systems enable effective balance of strength, flexibility, and diameter control
- Structural configuration equipment can support advanced hybrid architectures without process redesign
- Repeatability confirms scalability and production readiness of the hybrid approach
- Performance is governed as much by architecture and process control as by material selection

"By shifting from material dependency to architecture-driven design, a legacy core system was replaced while maintaining US 0 equivalent performance and full manufacturing repeatability."

Contact Corza Medical today

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