Experimental Comparison and Biocompatibility of Readily Available Nylon Cable Ties and Stainless Steel Wire for Fractures in Rabbits
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Disclosures:

Introduction: Correct reduction and adequate fixation are important concepts for fractured bone ends to heal. Fractures are any break in the continuity of bone, and best results are seen with anatomic reductions, and fixation with devices that are stiff to maintain the reduction, but flexible enough to stimulate union. Addition of cerclage to primary fixation devices such as plates and screws or intramedullary nailing, augments stability. There are comparable findings among stainless steel wire, nylon and novel materials used as cerclage in animal and human models; with the strength of NCT documented and may prove to be a substitute for cerclage use in humans. A pilot study in animals was conducted first. In this prospective, randomized controlled trial, our objective was to compare the histologic biocompatibility, radiographic, and clinical characteristics of commercial nylon cable ties (NCT) and stainless steel wire (SSW) for fracture fixation augmentation in rabbits.

Methods: Fourteen rabbits had baseline radiographs taken prior to undergoing bilateral femoral osteotomies, which were fixed with an intramedullary pin and augmented with NCT on the right, and SSW on the left. Subjects receiving nylon cable tie augmentation on the right femur were randomized as to which would be implanted with steam or ethylene oxide-sterilized (etOH) implants. Duration when partial weight-bearing (PWB) was started and when equal weight-bearing (EWB) followed were recorded, and analyzed using t-test for independent samples at 95% level of significance. Specimens were sacrificed at random on days 1, 7, 14, 21, 28, and 42 after surgery with repeat radiographs. Axial and longitudinal sections of callus tissue were harvested and viewed under microscopy for inspection of inflammatory picture.

Results: Histologic slides gathered fit the classic foreign body response. Specimens on day 1 specimens showed predominant picture of hematoma formation, neutrophils on day 7, macrophage in days 14 and 21, fibrosis and granulation on day 28, callus on day 42. Radiographs showed callus at two weeks and union in six weeks. Significant radiographic deformities and shortening were seen on the SSW group (p=0.015202). Rabbits were able to PWB as early as 3 days postop, and bear weight on the other limb at an average of 5 days after. The number of days after surgery when PWB (p=0.802772) and EWB (p=0.191653) were attained were not significant between the two groups. The shortening between the left and right femur was significant with the use of etOH compared to steam-sterilized NCT (p=0.026684). The number of days after surgery when PWB and EWB were attained were not significant between steam and etOH-sterilized NCT.

Discussion: NCT are comparable to SSW in terms of histologic biocompatibility and functional outcome, with SSW having significant radiographic shortening. Within the NCT group, etOH-sterilized implants had significant shortening over steam-sterilized NCT, but with similar microscopy findings and functional limb use.

Significance: Commercial NCT may be used as cerclage for fracture fixation augmentation in humans.

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9. Riansuwan, K; Vroemen, J; Bekler, H; Gardner, T; Rosenwasser, M. Stability of metal and cable tension band constructs for simulated olecranon fractures. JBJS Br 2010 vol. 92-B no. Supp II 355
3. Anesthesia and analgesia in laboratory animals at UCSF. International Animal Care and Use Committee (IACUC) 2010.

<table>
<thead>
<tr>
<th>Expired</th>
<th>Rabbit</th>
<th>AP Deformity(degrees)</th>
<th>Lateral Deformity (degrees)</th>
<th>Shortening (mm)</th>
<th>Days PWB Started</th>
<th>Days EWB Started</th>
<th>Histopathology</th>
<th>Dominant Picture</th>
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<tbody>
<tr>
<td>Day 0</td>
<td>CG</td>
<td>L Varus 10R Valgus 15L Varus 5R Neutral 0</td>
<td>L Neutral 0R Anterior 5L Neutral 0R Neutral 0</td>
<td>5474</td>
<td>**</td>
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<tr>
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<td>AD</td>
<td>L Neutral 0R Valgus 7L Neutral 0R Valgus 10</td>
<td>L Posterior 20R Anterior 5L Neutral 0R Neutral 0</td>
<td>4200</td>
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<td>Day 7</td>
<td>EI</td>
<td>L Varus 5R Valgus 5L Neutral 0R Valgus 10</td>
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<td>Day 14</td>
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<td>KN</td>
<td>Valgus 5</td>
<td>5L Neutral 0R Neutral 0</td>
<td>9354</td>
<td>R7R3</td>
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Radiography. Postoperative pelvis frog leg and AP views of rabbit D (larger image) and postoperative femur AP and lateral radiographs of rabbits D (day 1), H (day 7), K (day 14), N (day 21), J (day 28), L (day 42).

Histopathology. Slide photography (clockwise from upper left): hematoma formation HPO (day 1), neutrophil predominance on cortex-muscle interface LPO (day 7), macrophage predominance HPO (day 14), callus formation LPO (day 42).

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