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Development of a Porcine Model of *Staph. aureus* Implant-associated Orthopedic Infection

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Introduction The purpose of this study was to develop a porcine model of implant-associated orthopedic infection. Pigs offer distinct advantages over traditional lab animals including the ability to place human implants, an immune system similar to man, and the availability of reagents to describe molecular and cellular events.

Materials and methods Four pairs of castrated male sibling domestic 50 kg pigs were used. One sibling was a control (CP) and the other was an infected (IP) pig. Each pig was anesthetized and a 12 cm skin incision made on the medial aspect of the left tibia. A transverse fracture was created by cutting the tibia with a bone saw. After hemorrhage in the fracture site ceased, the fracture in infected pigs (IP) was inoculated with 1.2×10^3 CFU *Staphylococcus aureus* (human orthopedic isolate) in 0.2 ml saline. Control pigs (CP) were inoculated with 0.2 ml saline. Fifteen minutes after inoculation, a 6 hole narrow plate was applied. Soft tissues were closed routinely. The first four pigs were minimally bandaged (MB) over the fracture site. In pigs 5-8, a full-leg bandage (FB) was applied. No antimicrobials were administered. Pigs were anesthetized on days 3, 5, 7, 14, 21, and 28 after surgery, and ultrasound examinations over the plate performed to measured tissue thickness (TTP) and determine fluid accumulation. Radiographs of the tibia were taken on days 7, 14, 21 and 28. Euthanasia and culture was performed on day 28.

Results All pigs used their operated limb but showed lameness for the duration of the study. Pigs 1-4 (MB) developed abscesses or draining tracts associated with the most distal screw. Pigs 5 & 6 (FB) developed draining tracts at the same location. The surgery sites in Pigs 7 & 8 (FB) healed without complications.

Full-limb bandaging reduced the TPP for the first 5 days PO. In IP, TTP increased at all time periods during the study. In CP, TTP did not change between days 3-5, decreased on day 7, then increased on day 14 to a plateau for the duration of the study.

In the first 5 days PO, fluid accumulation was detected in only 1 pig (IP, MB). On day 7, fluid was detected in 2 IP, and 1 CP. On day 14, fluid was detected in 6 pigs, 3 CP and 3 IP. On day 21, fluid was detected in 1 CP. On day 28, no fluid was seen in any pig.

On day 7, radiographs revealed lucency of the marrow cavity in Pig 6 (IP, FB). No other radiographic signs of infection were seen. On day 14, IP showed widening or reaction at the fracture; the fracture was unchanged in CP. Five pigs (2 CP, 3 IP) showed lysis around the distal screw. On day 21, IP had continued lysis and reaction at the fracture. One CP had fracture widening. 3 IP showed lysis of proximal screws. All CP also had lysis and screw loosening of the distal 2 screws. Dystrophic calcification is apparent in the soft tissues of the IP. On day 28, exuberant dystrophic calcification was apparent in IP, and was mild in CP. Lysis was present around affected screws in both IP and CP, and distal screws were loosening.

Culture of the implants at necropsy from 2 IP grew *S. aureus, S. intermedius* and *Streptococcus porcinus*. Cultures from 2 CP grew *S. aureus, S. intermedius* and *Actinobacillus spp.*

Conclusions S. aureus infections were established in all challenged pigs, but contamination with skin flora was common. Full-limb bandaging reduced tissue swelling and infection severity due to contaminants, but did not eliminate infection. Infection of the distal screw was associated with contaminants, whereas infection of screws proximal to the fracture was associated with the inoculated organism. Ultrasound was useful to detect fluid accumulation, but could not be evaluated to detect early infection due to lack of uninfected controls.