Spinal Fusion Animal Models

Spine fusion is a frequent surgical procedure consisting in fusionning 2 vertebrae to stabilize the spine through intertransverse or vertebral body fusion. It is indicated in several pathological cases such as:
- Vertebral fractures
- Degenerative disc diseases and herniation
- Scoliosis or kyphosis
- Spinal tumors

The success of spinal fusion depends on the capacity of the bone graft to form new bone. The use of auto graft, the "gold standard", has limitation due to limited availability and problem at the donor site. Thus, the development of alternatives to auto graft can improve the quality and the rate of success of bone fusion. Additionally, the use of fixation devices such as screws, plates or cages improve the fusion by stabilizing the vertebrae.

Novel bone graft substitutes, including tissue-engineering constructs, growth factors and gene therapies, aim to improve vertebrae fusion. Establishment of feasibility, efficacy and proof of concept of these novel technologies require validation in an animal model.

Validated small and large animal models are available to study spinal fusion at the cervical, thoracic and lumbar levels using anterior or posterior approaches.

Although animal studies may be necessary to address specific questions prior to human use, the FDA recognize that choosing and validating an animal model is difficult because there is no perfect animal model. In choosing an animal model, the sponsor should consider the morphology, histology, biomechanics, and kinetics as compared to the human situation.

Species Available:

- Rabbit
- Rat
- Dog
- Goat and Sheep
- Pig

The following are some examples of questions that animal studies might be used to address:

- For an intervertebral body fusion device used in conjunction with a biological component (e.g., bone morphogenic protein), animal studies may provide information as to whether bony fusion occurred or is progressing and the quantity and quality of bone formed inside the device (a stress protected environment) as compared to an appropriate control group. Animal studies are used to evaluate dilution, dose, and concentration factors for certain systems.

Spine Preclinical Research Services

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Animal studies may be used to evaluate a novel system design in earlier development stages (e.g., different design concepts of vertebral disc replacement devices).

- Animal studies may be used to support the biocompatibility of a totally new material, a new material for use in orthopedics, or a new material for spinal exposure.

- Additionally, these studies may be used to address the probability of generating abrasion or wear particles of the new materials.

Types of Model:

Procedures are usually performed at one level but multilevel fusion are also possible:

- Anterior cervical fusion
- Anterior cervical discectomy (Sheep, Goat)
- Posterolateral lumbar fusion (Rabbit, Primates)
- Posterior lumbar fusion (Rat)
- Posterior thoracic fusion (Rat)
- Posterolateral muscle splitting intertransverse fusion (Dog**)**

Outcome Measures:

The success of fusion can be assessed following established procedures:

- Radiography: intervertebral angle
- CT MicroCT,
- DXA: bone mineral density
- Histology and histomorphometry: bone quality
- Mechanical testing
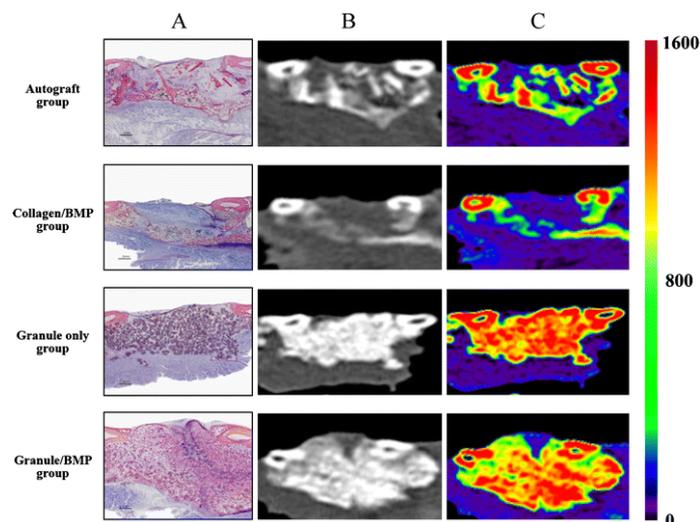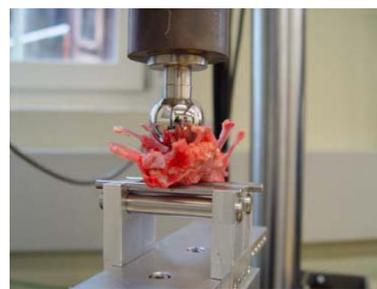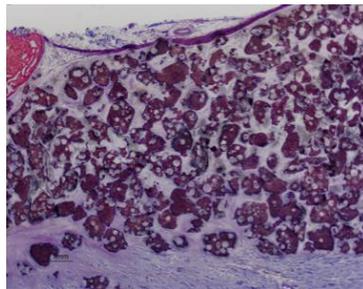
Representative **A)** histology, **B)** CT images, and **C)** CT color-mapped images. For all images, the upper region is the ventral side and the lower region is the dorsal side. The left side is the cranial region and the right side is the caudal region.

From: Evaluation of early tissue reactions after lumbar intertransverse process fusion using CT in a rabbit. Shinbo J, Mainil-Varlet P, Watanabe A, Pippig S, Koener J, Anderson SE. Skeletal Radiol. 2010 Apr;39(4):369-73. Epub 2009 Jun 25.