

Supplementary Materials

Animal models in spine research: applications, advantages, limitations, and future perspectives

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Supplementary Table 1. Summary of representative animal models used in spine research

Disease	Representative model	Commonly used animals	Main characteristics
IVDD	Needle puncture	Mouse, rat, rabbit, goat, pig	Simple, reproducible and rapid; suitable for degeneration and regenerative therapy studies, but represents acute structural injury
	Lumbar spinal instability	Mouse	Induces degeneration through altered spinal biomechanics without direct disc injury; suitable for mechanobiological studies
	Mechanical loading	Mouse, rat	Reproduces chronic abnormal mechanical stress; useful for studying mechanotransduction and progressive degeneration
	Chemical induction	Rat, rabbit	Rapid induction by enzymes or inflammatory cytokines; suitable for matrix degradation and inflammatory mechanism studies
	Genetic model	Mouse	Useful for gene-function and molecular mechanism studies; relatively costly and

Disease	Representative model	Commonly used animals	Main characteristics
LDH	Spontaneous degeneration	Sand rat, aged mouse/rat	time-consuming Closely resembles age-related natural degeneration, but requires a long observation period
	Autologous NP transplantation	Rat	Reproduces inflammatory effects of exposed NP tissue and is suitable for studying radicular pain
	Nerve root compression	Rat	Reproduces mechanical nerve-root injury and pain-related behavior, but lacks the full inflammatory component
	Melatonin deficiency/bipedal model	Chicken, mouse	Reproduces abnormal spinal growth and curvature; model incidence and stability vary
Scoliosis	Asymmetric tethering/loading	Pig, sheep	Produces progressive three-dimensional spinal deformity and is useful for biomechanical studies
	Genetic model	Mouse, zebrafish	Suitable for investigating scoliosis-associated genes and developmental mechanisms
Vertebral fracture/repair	Osteoporotic compression fracture	Rat, rabbit, large animals	Mimics osteoporotic vertebral collapse; suitable

Disease	Representative model	Commonly used animals	Main characteristics
Spinal fusion	Vertebral bone defect	Rabbit, sheep	for fracture-healing and biomaterial studies Highly standardized and reproducible; useful for evaluating bone regeneration and implants
	Posterolateral fusion	Mouse, rat, rabbit	Simple and widely used for evaluating osteogenesis and bone graft materials
	Interbody fusion	Rat, rabbit, sheep/goat	Higher clinical relevance; suitable for evaluating cages, grafts and osseointegration
	Contusion	Mouse, rat, pig	High clinical relevance to traumatic SCI; suitable for neurological recovery and regeneration studies
SCI	Compression	Mouse, rat	Reproduces sustained spinal cord compression and ischemic injury Suitable for axonal regeneration and neural circuit studies, but less representative of common clinical SCI
	Transection/hemisectomy	Mouse, rat	
Spinal infection	Pyogenic spondylodiscitis	Rabbit, rat	Rapid and reproducible infection model; suitable for antimicrobial and

Disease	Representative model	Commonly used animals	Main characteristics
			inflammatory studies
	Spinal tuberculosis	Rabbit	Reproduces chronic granulomatous infection and vertebral destruction, but has a long modeling cycle
	Implant-associated infection	Rabbit, rat	Reproduces implant-related bacterial biofilm formation; useful for antibacterial implant research