Contents

Preface: Minimally Invasive Fracture Repair  xiii
Karl C. Maritato and Matthew D. Barnhart

Biomechanics of Fracture Fixation  1
Simon Roe
This article reviews the biomechanical parameters of fracture repair that influence construct stiffness and strength. The stiffness influences the relative motion between fracture fragments, known as gap strain, and, thus, callus development. Construct strength determines the magnitude and number of load events that the repair can resist before failure. Surgeons must optimize these parameters in order to achieve satisfactory outcomes for the patients.

Pitfalls of Minimally Invasive Fracture Repair  17
Matthew Barnhart
Minimally invasive fracture repair (MIFR) is the ultimate culmination of current osteosynthesis concepts that emphasize the preservation and enhancement of the biologic components of fracture healing. Although the “less is more” approach to tissue dissection and fracture exposure and handling that defines MIFR has numerous reported advantages over more traditional open surgical treatments, it does present some unique challenges and important considerations for the surgeon. This article describes some of the general MIFR challenges a surgeon may encounter.

Minimally Invasive Plate Osteosynthesis Fracture Reduction Techniques in Small Animals  23
Bruno Peirone, Gian Luca Rovesti, Alessandro Boero Baroncelli, and Lisa Adele Piras
Indirect fracture reduction is used to align diaphyseal fractures when using minimally invasive fracture repair. Indirect reduction achieves functional fracture reduction without opening the fracture site. The limb is restored to length and spatial alignment is achieved to ensure proper angular and rotational alignment. Fracture reduction can be accomplished using a variety of techniques and devices, including hanging the limb, manual traction, distraction table, external fixators, and fracture distractors.

Perioperative Imaging in Minimally Invasive Osteosynthesis  49
Laurent P. Guiot and Loïc M. Déjardin
Peri-operative imaging using various appropriate modalities is critical to the successful planning and performance of any orthopedic surgery. The use of intra-operative imaging, while not an absolute prerequisite for long bone fractures, considerably facilitates the smooth and effective execution of minimally invasive osteosynthesis of articular fractures. One
must keep in mind, however, that the risk of overexposure to radiation with fluoroscopy and conventional radiology is real, particularly when considering its insidious effect over time. Strict adherence to the “As Low As Reasonably Achievable” (ALARA) principles is critical to mitigate the deleterious effect of radiation exposure while optimizing surgical outcome.

Interlocking Nails and Minimally Invasive Osteosynthesis

Loïc M. Déjardin, Karen L. Perry, Dirisko J.F. von Pfeil, and Laurent P. Guiot

Reviews of clinical outcomes led to the foundation of a new approach in fracture management known as biological osteosynthesis. As intramedullary rods featuring cannulations and locking devices at both extremities, interlocking nails are well suited for bridging osteosynthesis. Unique biological and mechanical benefits make them ideal for minimally invasive nail osteosynthesis and an attractive, effective alternative to plating, particularly in revisions of failed plate osteosynthesis. Thanks to a new angle-stable locking design, interlocking nailing indications have been expanded to osteosynthesis of epi-metaphyseal fractures, including those with articular involvement and angular deformities such as distal femoral varus and associated patellar luxations.

Percutaneous Pinning for Fracture Repair in Dogs and Cats

Caleb C. Hudson, Stanley E. Kim, and Antonio Pozzi

This article describes the technique of percutaneous pinning in dogs and cats. Only acute fractures evaluated within the first 48 hours after trauma are selected for percutaneous pinning. Reduction is performed with careful manipulation of the fracture to minimize the trauma to the growth plate. After ensuring the fracture is reduced anatomically, smooth pins of appropriate size are inserted through stab incisions or through large-gauge needles. Depending on the anatomic location, the pins are cut flush with the bone or bent over. The main advantages of this technique are the minimal surgical trauma and lower perioperative morbidity.

Minimally Invasive Osteosynthesis Techniques for Humerus Fractures

Karl C. Maritato and Gian Luca Rovesti

A thorough knowledge of humeral anatomy is critical to performing minimally invasive techniques. Fluoroscopy, when available, is invaluable in optimizing fracture repair with minimally invasive techniques. Minimally invasive approaches decrease morbidity and allow an earlier return to function. Minimally invasive fracture repair is performed using implant systems similar to open approaches.

Minimally Invasive Plate Osteosynthesis: Radius and Ulna

Caleb C. Hudson, Daniel D. Lewis, and Antonio Pozzi

Minimally invasive plate osteosynthesis (MIPO) is a biologically friendly approach to fracture reduction and stabilization that is applicable to many radius and ulna fractures in small animals. An appropriate knowledge of the anatomy of the antebrachium and careful preoperative planning are essential. This article describes the MIPO technique, which
entails stabilization of the fractured radius with a bone plate and screws that are applied without performing an extensive open surgical approach. This technique results in good outcomes, including a rapid time to union and return of function.

**Minimally Invasive Osteosynthesis Techniques of the Femur**

Michael P. Kowaleski

A thorough working knowledge of the anatomic landmarks of the femur facilitates anatomic alignment during minimally invasive osteosynthesis (MIO). A variety of fixation techniques, including plate, plate-rod, and interlocking nail, are well suited for stabilization of femoral shaft fractures with MIO techniques. Axis and torsional alignment can be assessed with various intraoperative techniques to ensure that anatomic alignment is obtained.

**Minimally Invasive Fracture Repair of the Tibia and Fibula**

Brian Beale and Ryan McCally

Fractures of the tibia and fibula are common in dogs and cats and occur most commonly as a result of substantial trauma. Tibial fractures are particularly amenable to treatment using minimally invasive fracture repair (MIFR) techniques that preserve blood supply to comminuted fracture fragments, accelerating bone callus production and speeding fracture healing. Treatment of tibial fractures using MIFR techniques has been found to reduce surgical time, reduce the time for fracture healing, and to decrease patient morbidity, while at the same time reducing complications compared with traditional open reduction and internal fixation.

**Meta-bone Fracture Repair via Minimally Invasive Plate Osteosynthesis**

Charles S. McBrien Jr

A concise review of the history of meta-bone fracture repair is provided. The relevant surgical anatomy, available instrumentation, and execution of preoperative, intraoperative, and postoperative surgical care using minimally invasive plate osteosynthesis are discussed in detail. A short discussion that touches on future directions for care of meta-bone fractures follows.

**Minimally Invasive Osteosynthesis Techniques for Articular Fractures**

Grayson Cole and Brian Beale

Articular fractures are common injuries in veterinary medicine. The principles of articular fracture repair are anatomic reduction and rigid fixation in order to optimize joint function. Fluoroscopy and arthroscopy are tools commonly used to allow for anatomic reduction with a minimally invasive approach. Minimally invasive techniques can decrease morbidity and promote an early return to function. Different types of articular fractures and options for minimally invasive repair are reviewed in this article.
Minimally Invasive Repair of Sacroiliac Luxation 231
James Tomlinson

Sacroiliac fracture-luxation is a common injury that is associated with ilial and acetabular fractures of the opposite hemipelvis. Sacroiliac fracture-luxation results in an unstable pelvis and potentially collapse of the pelvic canal. A minimally invasive approach to the reduction and insertion of a screw for fixation of sacroiliac fracture-luxation using fluoroscopic guidance is viable. The advantages of using this technique are that a small incision is made with minimal soft tissue disruption and the surgical time is short. Recent publications have documented that this technique provided superior repair of sacroiliac fracture-luxations.

Percutaneous Plate Arthrodesis 241
Antonio Pozzi, Daniel D. Lewis, Caleb C. Hudson, Stanley E. Kim, and Emanuele Castelli

Arthrodesis is an elective surgical procedure that aims at eliminating pain and dysfunction by promoting deliberate osseous fusion of the involved joint(s). Percutaneous plating can be used to perform carpal and tarsal arthrodeses in dogs and cats. After cartilage debridement is performed, the plate is introduced through separate plate insertion incisions made remote to the arthrodesis site and advanced along an epiperiosteal tunnel, and screws are inserted through the 3 existing skin incisions. The primary advantage of this technique is a decreased risk of soft-tissue complications, including postoperative swelling, ischemia, and wound dehiscence. Preliminary clinical results have been promising.

Unique Differences of Minimally Invasive Fracture Repair in the Feline 263
Karl C. Maritato, Philipp Schmierer, and Antonio Pozzi

As the saying goes, “cats are not small dogs.” Throughout veterinary medicine history, most of the literature focus has been on the canine. Feline patients, however, now constitute a larger proportion of the pet population and are unique in many aspects. They differ anatomically and biomechanically from canines and have specific recovery needs and different pain-related behaviors. It is important that veterinary surgeons understand these differences and improve their knowledge base in the treatment of cats. This article highlights the differences in cats relevant to minimally invasive fracture repair and how they affect a surgeon’s approach to fractures in cats.