Interlocking Nails and Minimally Invasive Osteosynthesis

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KEYWORDS

• Interlocking nail • Angle-stable interlocking nail • Bone healing • Fracture model
• Traumatology • Minimally invasive osteosynthesis
• Minimally invasive nail osteosynthesis • Small animals

KEY POINTS

- Ongoing reviews of clinical outcomes led to a radical paradigm shift toward further emphasizing the biologic component of fracture healing; this became the foundation of a new philosophic approach known as minimally invasive osteosynthesis.
- With the recent paradigm shift toward biologic osteosynthesis, interlocking nails have emerged as an attractive alternative to bone plating and, to some surgeons, the method of choice for the repair of most comminuted diaphyseal and metaphyseal fractures in human and veterinary patients.
- Interlocking nails have common characteristics: they are solid intramedullary rods featuring transverse holes (cannulations) at both extremities and sometimes along the whole length of the nail. Various locking devices such as screws, bolts or blades are used to lock the nail within the medullary cavity.
- Orthogonal radiographs of the fractured and contralateral intact bone of interest are essential to accurate planning. Imaging of the affected bone is used for evaluation of the fracture location, configuration, and identification of fissures that could extend in the metaphyses.
- As intramedullary devices, interlocking nails can only be used in long bones that provide a non-articular entry point for the nail (which excludes the radius).

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INTRODUCTION

In an effort to improve on the poor functional outcomes associated with external fixation or coaptation and/or long-term patient immobilization, starting in the late 1950s, open reduction and internal fixation (ORIF) became the modus operandi recommended by the Arbeitsgemeinschaft für Osteosynthesefragen (AO) Foundation for the treatment of long bone fractures.[1] Although strict adhesion to ORIF principles of anatomic reduction and rigid fixation allowed the restoration of absolute mechanical stability, it came with a hefty biologic price inherent to extensive iatrogenic surgical trauma, including disturbance of the fracture hematoma and inevitable damage to the local soft tissues and blood supply. As a result, despite improved outcomes compared with earlier techniques, ORIF was accompanied by the rise of new complications, such as delayed or nonunion, implant failure, and osteomyelitis. As an example, humeral and tibial fractures in dogs treated with conventional techniques have a complication rate of up to 40% and 18%, respectively.[2,3] Such observations led to the reiteration of the early AO principles of preservation of blood supply, gentle soft tissue handling, and early mobilization and, in practical terms, to a biologically friendlier "Open But Do Not Touch" (OBDNT) approach to osteosynthesis. Nonetheless, OBDNT techniques, which still favor manipulation of the bone fragments (albeit remotely), continued to put an emphasis on mechanical rigidity of the repaired bone as illustrated by the extensive use of the plate-rod combination (PRC) in the treatment of comminuted fractures.[1]

During the past 2 decades, the ongoing review of clinical outcomes by the AO led to a radical paradigm shift toward further emphasizing the biologic component of fracture healing.[1] This became the foundation of a new philosophic approach known as minimally invasive osteosynthesis (MIO).[4–8] With MIO, the fracture site is not exposed, which in turn preserves the fracture hematoma and promotes earlier fracture healing. Rather, indirect reduction techniques through gentle manipulation of the main bone fragments and small approaches remote to the fracture site are used to introduce the implant in an epiperiosteal (plate) or intramedullary (interlocking nail [ILN]) manner. In addition, quasi-abandonment of interfragmentary screws, cerclage wires, or bone grafts and anatomic reduction became the hallmarks of MIO.[9] This evolution favors the preservation of a biologic environment essential to bone healing. From a mechanical perspective, emphasis is put on restoration of alignment rather than anatomy and on achieving optimal construct stability rather than rigid interfragmentary stability. This is accomplished through several iterations of traditional osteosynthesis techniques such as increased reliance on longer, more compliant bridging implants that bypass the fracture site altogether. Today, biologic osteosynthesis principles and MIO are readily implemented in human orthopedics and are slowly gaining momentum and acceptance in veterinary medicine.[5,6,10] While numerous acronyms have been used to describe specific implant related minimally invasive surgical techniques, adherence to these new principles is collectively known as MIO. This article will address the use of minimally invasive nail osteosynthesis (MINO) in the treatment of long bone fractures in companion animals.

HISTORY OF ILN USE

The ILN concept in the treatment of long bone fractures evolved from the original intramedullary nail and later "detensor" nail designed by Küntscher[11] (Germany) in the 1940s and late 1960s. The first true ILN was developed in the 1970s by Huckstep[12] (Australia) to treat femoral fractures in people. Following the successful experimental and clinical use of modified Huckstep nails in animals by Johnson and Huckstep[13] and