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Topical Review

The Emerging Role of Veterinary Orthotics and Prosthetics (V-OP) in Small Animal Rehabilitation and Pain Management

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In veterinary school, we learn much about how to repair bone fractures, ligament injuries, and neuropathies. The idea, of course, is to return some level of function to a damaged appendage and decrease pain. When a limb cannot be salvaged for medical or financial reasons, we are taught that dogs and cats do “great” on 3 legs. Three legs may mean a less functional limb or outright total amputation. We espouse this doctrine to our clients. Indeed, most of us have countless stories of triped patients acclimating to their disability with aplomb. Although it is true that many patients adapt, learning to ambulate and negotiate their environment, this is functional adaptation—not necessarily the highest quality of life. As a profession, we have come to expect—even accept—that limited mobility, limb breakdown, and chronic neck or back pain are unavoidable consequences. The short- and long-term consequences of limb loss or altered limb function are not benign as once thought. Furthermore, the quality of care demanded by clients is rising and the breadth of knowledge afforded by technology and global communication spawns innovative therapies readily accessible to the computer-savvy pet owner. Recent examples of therapeutic innovations include the following: dentistry, acupuncture, chiropractic, and rehabilitation. Often there is no precedent for these new therapies in animals, and the onus rests with the veterinary community to educate itself to provide best care for patients and clients and to establish evidence-informed best practice. The newest emerging therapeutic modality is veterinary orthotics and prosthetics. Like the previously mentioned modalities, the origin lies in human health care and subsequently leaps to veterinary health care.

This article introduces the practitioner to veterinary orthotics and prosthetics (V-OP) as a therapeutic modality, its role in practice particularly as a pain management and rehabilitation tool, and to the important ethical issues surrounding its use.

Origins of V-OP

Human orthotic and prosthetic (H-OP) practice traces its origins to ancient Egypt and Greece. Earliest assistive devices were made of leather and wood. In the 18th and 19th centuries, these materials were replaced with metal. Not surprisingly, the profession of bracing predates surgery; bone setters and appliance makers were skilled artisans. Modern orthopedic surgery rapidly developed in the 20th century with the advent of implants and safer anesthesia; ultimately, surgery replaced bracing and splinting as the cornerstone of orthopedics. Consequently, bracing became ancillary to surgery. In recent years, improved technology has led to substantial improvements in bracing techniques and a more discriminate parsing of surgical vs. nonsurgical cases. A clear example is the decrease in Achilles tendon surgery in favor of dynamic bracing and rehabilitation for human patients.[1]

Today braces are more accurately termed orthoses. Orthoses are defined as any medical device attached to the body to support, align, position, prevent, or correct deformity; assist weak muscles; or improve function.[2] The term orthosis implies dynamic control, whereas brace more accurately refers to static control. Both are needed in modern therapy, and “orthosis” is preferred as a general term for both types of mechanical devices. They are not a replacement for necessary surgery, but complementary.

Prosthetists were originally black smiths and armor makers. Materials included wood and leather, calling to mind the classical image of the peg-legged pirate. Later, metal was incorporated albeit lending a great deal of weight to these devices. In modern times, a positive consequence of war, if this can be said, includes medical innovation by necessity. The American Civil War resulted in tens of thousands of catastrophic limb injuries. J.E. Hangar is reportedly the first amputee of that war.[3] He subsequently built his own prosthetic leg and ultimately the largest human prosthetic limb fabrication company in the United States, Hanger Inc, publicly traded on the New York Stock Exchange as HGR. In the late 1880s, his devices were available by mail order, typically selling for $75-$150, which is approximately $2000-$4000 in today's dollars. These early devices served an important purpose, but were utilitarian at best and truly uncomfortable at worst.

Once again driven by human conflict, today lightweight materials, microprocessors, and neural integration have resulted in spectacular improvements in function including sensation and lifelike grasping appendages. These devices have allowed amputees to return to and excel in nearly all human endeavors including sport; no longer are these individuals relegated to “getting by” and “making due” with their injury. The goal is to thrive with few or no boundaries. Amputees still face many challenges, and rehabilitation remains critical to successful return to function, but the list of limitations is shrinking.

Over the past decade, there has been a tremendous increase in our understanding of physical fitness for animals coincident with an increased demand for maximizing quality of life for our companion animals. We now know that optimal movement and mobility can significantly affect the physical and mental health of our veterinary patients. Rehabilitation has moved to the forefront of modern veterinary medicine with the debut of the American College of Veterinary Sports Medicine and Rehabilitation.[4] Not surprisingly, innovative human orthotists or prosthetists have

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been tapped to create one-off mechanical appliances to improve the mobility and functionality of the occasional veterinary patient. This seems to mirror the emergence of acupuncture, chiropractic, and rehabilitation therapy for animals in the preceding decades. During this time, human practitioners introduced and, not entirely legally, ministered to veterinary patients owing to a paucity of qualified veterinarians. We are in their debt in terms of introduction; subsequently, veterinary medicine has embraced and advanced these modalities with species-specific scientific vigor. Likewise, many veterinary practice acts have recognized these modalities and redefined the legal use by nonveterinary practitioners. As of this writing, these therapies are emerging as mainstream rather than so-called alternative therapies. Likewise, V-OP is emerging from beneath the wing of H-OP. Recent media productions such as Disney's *A Dolphin's Tale* and PBS's *My Bionic Dog* have recently brought V-OP as a therapeutic option to the public eye. Although these productions still leave the viewer with an impression that such cases are yet novelty, this is far from reality and the current state of the science.

V-OP and the Role of the Veterinarian

Veterinarians have a history of creating assistive devices from items at hand using everything from duct tape to superglue, plywood to low temperature thermoplastics, and aluminum rods to PVC pipe. We have a tradition of a "MacGuyver-like" fortitude driven primarily by economics and a lack of veterinary-specific products in the past. Public demand and the redefined modern role of the companion animal as a family member have provided an opportunity to excel beyond one-off and novelty in veterinary health care. Our clients have recognized there is a gap in veterinary services in terms of managing limb dysfunction and loss, a gap long filled in human medicine.

Scientific rigor and a culture of evidence-informed medicine drive new understanding and ultimately innovative therapies for animals. The structural consequences of a dysfunctional or missing limb or limb segment are now recognized.[5,6] As our understanding of the intricacies of quadruped mobility and biomechanics has grown, so have the variety and sophistication of mechanical assistive devices. Now they incorporate veterinary-specific hinges, composite plastics, titanium, carbon fiber, and specialty foam liners. Biomechanically sound designs improve fit and function. Surgical techniques such as subtotal amputation, intraosseous transcutaneous amputation prosthesis (ITAP), and rotational plasty are providing new opportunities and an expanding patient population. V-OP is evolving into a new subspecialty. Although it is true that techniques and materials used in H-OP can be translated to veterinary patients, specific modifications for quadruped ambulation and the significantly greater magnitude of force generated by these patients must be considered. A thorough understanding of the biomechanics and health issues of animals is essential to avoid injury to the animal, delayed healing, or delayed use of more appropriate therapies. The veterinarian is the key player in this process and must lead the way because of their knowledge of veterinary species and veterinary medicine. H-OP professionals will continue to serve a collaborative albeit secondary role. To do so, veterinarians must begin to educate themselves in this regard to best serve the demands and needs of their clients and patients.

Orthotics Basics

Orthoses provide protected motion within a controlled range, prevent or reduce severity of injury, prevent or relieve contracture, allow lax ligaments and joint capsules to shorten, and provide functional stability for an unstable limb segment.[2] These devices should not be seen as a replacement for surgery, but complementary or adjunctive. They can be designed to restrict, block, enable, or guide range of motion. They can absorb, store, and return energy. They may provide progressive, controlled dynamic return to motion. They can block one plane of motion while allowing another to persist. They may compensate for limb length discrepancy. Importantly, these devices do not create dependency or atrophy unless intended or is an unavoidable consequence of severe injury (Fig 1).

There are many conditions amenable to prescription orthoses (Table). Orthoses can be used as preoperative, postoperative, or "no-operative" solutions. In cases where surgery must be delayed, they can provide interim support, protect the limb, allow more comfortable and mechanically appropriate ambulation, and minimize disuse atrophy. In a postoperative situation, orthoses can provide a safe, effective, and dynamic alternative to traditional casting. Orthoses are also used when surgery is not possible. This might include patients who are poor anesthetic candidates, patients with comorbidities precluding surgery, the aged, injuries for which there is no surgical correction, and families with financial limitations, among others. These "no-operative" patients represent a large and heretofore underserved population.

Paw Orthoses

Injuries and pathology of the paw are often overlooked; yet, they can result in significant discomfort and dysfunction. Thoracic paw injuries are especially problematic because of the normal disproportionate weight distribution compared with the pelvic limbs (Fig 2). Pelvic paw injuries also markedly affect comfort and ambulation because forward drive in faster gaits originates in the pelvic limbs. Additionally, paw injuries ultimately affect the entire mechanical structure regardless of affected limb because compensatory or adaptive gaiting alters function up the kinetic chain (proximal joints, spine, muscles, etc.). Examples common to digital pathology include the following: osteoarthritis of the metacarpal or metatarsal-phalangeal joints; sesamoid bone fractures; flexor tendon laceration, degeneration, or contraction; pathologic supination or pronation; digital luxation; and neuropathy causing loss of dorsiflexion, among others. Orthotic devices can be used to improve comfort, assist in healing, or rehabilitate some injuries. The challenge is affixing such devices to the limb; commonly, the device must include the antebrachium or crus for proper suspension. Device design must take into account pathology, overall

Fig. 1. An example of stifle orthosis for lateral collateral ligament rupture. Orthoses are dynamic allowing joint range of motion.