ADVANCES IN VETERINARY BIOMECHANICS

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ABSTRACT


Biomechanics studies the relation between mechanics and biosystems. A short account is given of research on the biomechanics of the locomotory apparatus at the Institute of Veterinary Anatomy of Utrecht University, and of cognate work elsewhere. Topics of primary interest in veterinary biomechanics comprise: (a) kinematical analysis of articular movement, (b) the relation between strain and degenerative changes in joints, (c) the mechanics of tissues in relation to wound healing, (d) the relation between electromyographic data and muscular force, and (e) in vivo determination of stress and strain in animals.

INTRODUCTION

Biomechanics studies the relation between mechanics and biosystems such as locomotory and cardiovascular systems; it can be subdivided into biostatics and biodynamics. The former studies biosystems under a balanced set of forces; the latter examines the effect of an unbalanced system of forces upon living creatures. The study of mechanical properties of biomaterials (connective tissue, cartilage, bone) is the domain of biostatics, studies on forces and their effects on the bone-muscle-joint system during locomotion are a subject of biodynamics.

In a strict sense, veterinary biomechanics forms a new area of applied science which has gone under this name for only a few decades. This is by no means surprising, since many anatomists and clinicians, both in veterinary and human medicine, not only are not acquainted with simple engineering principles but indeed are somewhat irrationally afraid of them.
Veterinary biomechanics derives its basis from various sources. There is information derived from functional anatomy of the locomotory system of vertebrates in general (see, for instance, Kummer, 1959); on the other hand, veterinary biomechanics received an impetus from human functional anatomy (see, for instance, Pauwels, 1965) and from the incidental and scattered application of mechanics to various veterinary clinical problems (see, for instance, Rooney, 1969). Apart from that, there is "intuitive" biomechanics, which has been developed during long years of experience in corrective trimming and shoeing of horses: this empirical knowledge needs experimental verification.

The integration of these scattered bits of knowledge, augmented by results from recent and more specific veterinary biomechanical studies, made it apparent and generally understood that many disorders and traumatic affections have a mechanical basis, so that basic knowledge of the mechanical processes in the living animal is of great advantage to the veterinarian.

The following is a short account of research in the Institute of Veterinary Anatomy at Utrecht University and of cognate work elsewhere. Initial housing, staff and technical facilities forced us to confine research to theoretical and practical biostatistical problems of the locomotory apparatus; more recently, a promising start has been made on the study of biodynamical problems.

PRESENT STATE OF KNOWLEDGE

Skull and head

From a functional standpoint, the structure of the head serves a twofold task. The cerebral skull and orbits provide room and protection for the brain and the eyes, the facial skull accommodates the masticatory apparatus. Masticatory forces are impressive; their deforming effects are counteracted by solid structures, especially in regions which provide origin to the masticatory muscles. These considerations lead to a model in which the skull is interpreted as a compromise structure between two sorts of three-dimensional body: the sphere which has the smallest surface area of all bodies of equal volume, and the tetrahedron, which ensures maximum resistance against the deforming strains. Both structures satisfy the minimum-maximum law of skeletal architecture. The shape of the skull is the result of a combination of both structures, on which the effect of an