EUROPEAN COMMUNITY PREVIEW ARTICLE

MALIGNANT HYPERTHEMIA IN THE PIG: AETIOLOGY, THERAPY AND IMPLICATIONS

J.V. MCLoughlin

Department of Pre-Clinical Veterinary Sciences, Trinity College, Dublin (Ireland)

ABSTRACT


The malignant hyperthermic syndrome occurs in man and the pig, usually following administration of the anaesthetic halothane or the myorelaxant succinylcholine. Mechanisms in skeletal muscle and in the central nervous system appear to be involved in its development. The primary intracellular event may be a loss of energy phosphates from muscle and other tissues while manifestations of sympathetic activation such as tachycardia and hyperthermia develop subsequently. Myorelaxants, adrenergic blocking agents and neuroleptic drugs have been reported to prevent the onset of acute malignant hyperthermia in susceptible animals.

INTRODUCTION

The malignant hyperthermic syndrome (MHS) is characterised by an elevated body temperature and extreme rigidity of the skeletal muscles and occurs in man and pig following the administration to susceptible individuals of certain drugs, notably the inhalant anaesthetic halothane and the depolarising myorelaxant succinylcholine. The syndrome is recognised in human medicine as a serious complication of general anaesthesia, with a mortality rate of 70 per cent, and in veterinary medicine as an aspect of the susceptibility to stress which is associated with the improvement of the pig as a meat-producing animal. MHS occurs most frequently in breeds of pig such as the Piétrain and Poland China and in certain strains of Landrace. These breeds are also known to have a high incidence of the acute stress syndrome and pale soft exudative (PSE) muscle. The former condition develops in vivo, the latter post-mortem and both together with MHS are associated with
high body temperature, rapid loss from skeletal muscle of the high-energy phosphates adenosine triphosphate (ATP) and creatine phosphate (CP) and a high rate of anaerobic glycolysis.

The results of studies in vitro suggest that the trigger site for MHS may be located in the skeletal musculature and may involve defects, either inherent or drug-induced, in the ability of the sarcoplasmic reticulum (SR) to sequester calcium ions or abnormalities in mitochondrial function. Studies on experimentally-attenuated forms of the syndrome are providing information on the sequence of haemodynamic and physiological changes associated with MHS. Less attention has been paid to neural and neuroendocrine factors in MHS, in particular to the relationship that may exist between susceptibility to the syndrome and central mechanisms involved in behavioural responses and the reaction to normal physiological stress. Procedures to detect MHS-susceptibility in man and animals are a continuing subject of research.

An extensive literature on human and porcine malignant hyperthermia now exists. The most comprehensive review of the syndrome in both species consists of the proceedings of a conference held in Toronto and published by Gordon et al. (1973). More recent reviews deal with MHS in the context of animal physiology and the properties of meat (Campion and Topell, 1975; Cassens et al., 1975) and the various treatments used to prevent or alleviate the syndrome (Hall et al., 1975).

PRESENT KNOWLEDGE OF MALIGNANT HYPERThERsMIA

Symptomatology

Malignant hyperthermia appears to have the same symptoms irrespective of whether it is initiated by halothane or succinylcholine. The first sign of an adverse reaction is an extension of the limbs which progresses to rigidity and a rise in body temperature. The acute syndrome develops rapidly following the administration of a triggering agent to Piétrain pigs (Hall et al., 1975; Mcloughlin and Mothersill, 1976). A typical example of acute MHS, taken from our laboratory records, is that of Piétrain given 5% halothane in oxygen. The body temperature was $39^\circ C$ initially. The limbs extended one minute after the commencement of anaesthesia; after two minutes the muscles of the limbs and back were completely rigid and the body temperature had risen to $40.9^\circ C$. Halothane was discontinued but the temperature continued to rise and reached $41.7^\circ C$ after eleven minutes. The animal was then immersed in