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Osteoarthritis of the temporo-mandibular joint in free-living Soay sheep on St Kilda



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ABSTRACT

Osteoarthritis (OA) is a common degenerative disease of synovial joints with the potential to cause pathology and welfare issues in both domestic and wild ruminants. Previous work has identified OA of the elbow joint in domestic sheep, but the prevalence of OA of the jaw and in particular the temporomandibular joint (TMJ) has not been previously reported. Following up a previous report of a single case of TMJ OA in a free-living population of Soay sheep on St Kilda in the Outer Hebrides, an archive of 2736 jaw bones collected from this population between 1985 and 2010 was surveyed.

Evidence of TMJ OA was found in 35 sheep. Of these, 15 cases were unilateral (11 right side, 4 left side) and the remaining 20 were bilateral. TMJ pathology was much more common in females than males: only 3/35 cases were in males, with overall prevalence at 2.3% for females and 0.2% in males. Radiographic examination of TMJ with OA revealed extensive bone re-modelling with osteophytosis, particularly of the condyle of the mandible. There was a highly significant age-dependence in TMJ OA incidence among age classes: 30/35 cases occurred in geriatric sheep (aged 7 years or more; 11.1% prevalence within this age class), four in adults (2–6 years old; 0.9% prevalence), one in yearlings (0.3% prevalence) and none in lambs. The low incidence in males was confounded by sex differences in longevity: while 18% of females sampled died in the geriatric age class, only 2% of males did so.

Although the low prevalence of the pathology limited the ability to test its association with other traits, it was possible to examine relationships with reproductive performance measures amongst geriatric females with and without TMJ OA. Although there were trends towards lower fecundity and lower lamb birth weight in the breeding season prior to death, these were not statistically significant.

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Introduction

Osteoarthritis (OA) is a common degenerative disease of synovial joints characterised by the destruction of articular cartilage, osteophyte development at the peri-articular margins, bone remodelling and low-grade synovial inflammation. Primary OA is commonly defined as an idiopathic condition developing in previously undamaged joints in the absence of an obvious causative mechanism (Herrero-Beaumont et al., 2009). Historically, primary OA has been perceived to be an outcome of physiological wear and tear of articular cartilage or the accumulation of molecular events which form part of the normal biological aging process

(senescence), although it is now recognised that genetic susceptibility and hormonal factors play major roles in its development (Bijlsma et al., 2011).

Secondary OA is defined as being caused by an underlying condition, such as anatomical abnormalities, trauma, infectious disease, inflammatory and metabolic disorders. Secondary OA of the ovine elbow joint has been reported in association with presumed traumatic rupture of the lateral co-lateral ligament (Scott, 2001) and is characterised by extensive enthesophyte formation and bridging ankylosis in advanced cases. Secondary OA resulting from bacterial infection has also been identified as a major cause of ovine lameness (Scott and Sargison, 2012).

The temporo-mandibular joint (TMJ) is formed by the upper zygomatic process of the temporal bone which is part of the cranium and the condyle of the vertical part (ramus) of the lower jaw bone or mandible (Dyce et al., 2010). A meniscus separates the articular surfaces which allows a greater range and variety of movement. The

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joint capsule is strong and tight and is reinforced by the lateral ligament. As sheep spend up to 10 h/day ruminating (Fujihara et al., 1994), so pain arising from OA of the TMJ would be expected to cause greatly reduced mastication and fibre digestion leading to weight loss and eventual emaciation.

Unilateral infectious OA of the TMJ has been reported in a single sheep (Warmerdam and van Weeren, 1996) and two horses (Warmerdam et al., 1997). Weller et al. (1999) reported a case in a horse which was thought to have an infectious cause but no bacteria were cultured from the TMJ after necropsy, probably because of extended courses of antibiotic therapy before euthanasia.

Following up on the previous single observation of TMJ OA in the St Kilda population of Soay sheep (Clutton-Brock et al., 1990), the objective of our study was to survey a very large archive of 2736 mandibles collected as part of a long-term study of free-living Soay sheep on the St Kilda archipelago between 1985 and 2010 for evidence of OA of the TMJ.

Materials and methods

Animals

The Soay sheep population has fluctuated between 200 and 650 in the Village Bay area of Hirta since the project began in 1985 (Clutton-Brock and Pemberton, 2004). For every year since 1985 a similar fieldwork protocol has been followed with reproduction and survival of all sheep monitored across the year. There is no management of the Soay sheep population and skeletal samples were taken from carcasses where the sheep had died of natural causes.

Samples

Typically a third metacarpal bone and the lower jaw were taken from carcasses but in most cases the entire skull was preserved. This survey involved 2736 individual jaws, excluding any animals of unknown year of birth and lambs that died before 6 months of age, collected on St Kilda and preserved in the research

collections of the National Museums Scotland, Edinburgh (accession number NMS.Z.2003.160).

Examination of skeletal material

OA of the TMJ was based upon gross erosion and pitting of subchondral bone particularly of the articular condyle of the mandible and extensive osteophytosis. The range of pathology affecting the TMJ was very limited in that the joint surfaces either appeared normal or had extensive bony pathology. It was not possible to examine the articular cartilage of the surfaces comprising the TMJ because the skeletal material had been collected from carcasses which may have lain for several months before collection, therefore only bony changes that survived autolysis were recorded.

The pathology comprised widening of the articular space of the TMJ was most reliably identified in those skulls with unilateral lesions (Figs. 1A, B). Gross bony changes typical of OA were readily identifiable as illustrated by the samples in Figs. 1C, D. The widths of the normal and affected articular condyles of the mandible were measured with calipers and compared in 15 sheep with unilateral TMJ lesions. We also measured condyle widths in both mandibles for a further 12 sheep aged 8 years or more with bilateral lesions, taking the average across the two mandibles. We combined the data on widths from pathological condyles for both unilateral and bilateral cases amongst females age 8 years or more ($n = 27$) and tested whether there was any evidence that condyle width associated with pathology was greater in older individuals.

Radiography

Radiographs were taken of 10/35 skulls which showed evidence of OA of the TMJs. For each skull, oblique views were taken with the TMJ reassembled in its normal articulation, together with separate lateral views of the zygomatic process of the temporal bone, and lateral and ventro-dorsal views of the condyle of the mandible. Bone mineral density of each skull and mandible was measured subjectively by one of the authors (PRS) who is experienced in the radiographic evaluation of the ovine skeleton.

Statistical analysis

We compared the distributions of individuals with and without TMJ OA among age and sex groups using Fisher's exact tests, and calculated odds ratios (OR) and

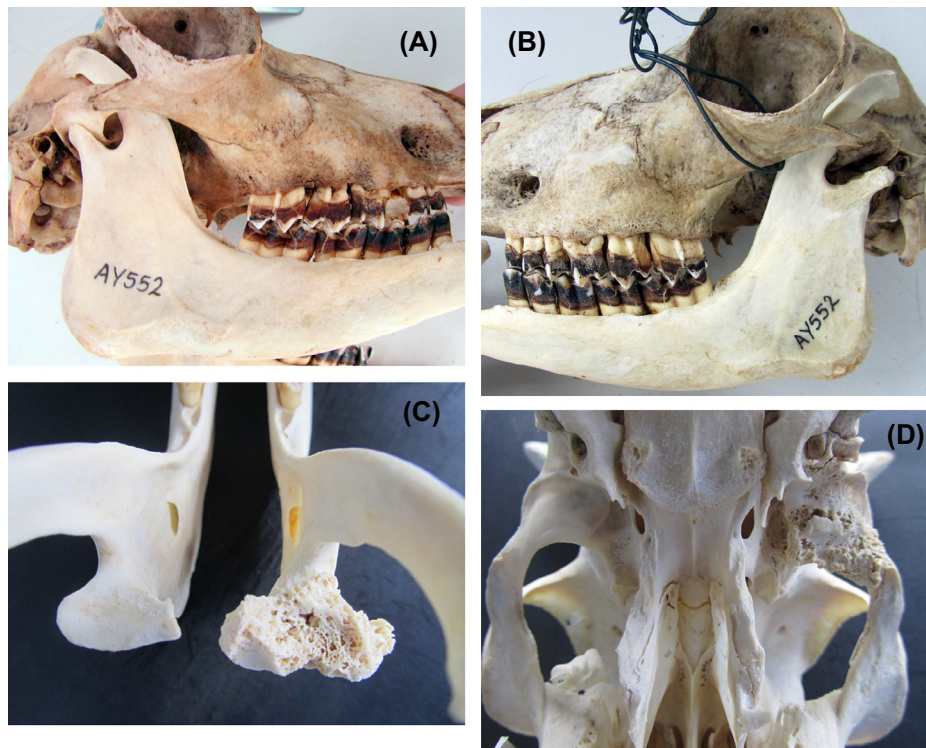


Fig. 1. Photographs illustrate a case of unilateral osteoarthritis (OA) at the temporomandibular joints (TMJs) in Soay sheep from St Kilda. (A) Normal right TMJ and (B) OA of the left TMJ, showing an increased gap between the articular surfaces of the TMJ, from a 10-year-old ewe with unilateral TMJ OA. (C) OA of the right TMJ of a Soay sheep showing erosion of the condyle of the right lower jaw bone or mandible. (D) OA of the right TMJ of a Soay sheep showing erosion of the upper zygomatic process of the temporal bone.

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