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Experimental parapoxvirus infection (contagious ecthyma) in semi-domesticated reindeer (*Rangifer tarandus tarandus*)

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ABSTRACT

Contagious ecthyma (contagious pustular dermatitis, orf) occurs world-wide in sheep and goats and is caused by orf virus (genus *Parapoxvirus*, family *Poxviridae*). Contagious ecthyma outbreaks have been described in semi-domesticated reindeer (*Rangifer tarandus tarandus*) in Sweden, Finland and Norway, occasionally with high mortality. Fourteen one-year-old reindeer were corralled in mid-April. One week after arrival, two animals received a commercial live orf virus vaccine for sheep (Scabivax®) on scarified skin of the medial thigh. Four weeks later, the two vaccinated and six additional animals were inoculated in scarified oral mucosa with parapoxvirus obtained from reindeer with clinical contagious ecthyma. The remaining six reindeer were kept as sentinels, sharing feed and water with the inoculated animals. A small whitish lesion appeared on the inoculation site and the labial skin-mucosa junction of three animals five days post inoculation (p.i.). Twelve days p.i., typical ecthyma lesions were visible on the inoculation site in six of eight animals, including both vaccinees. Four inoculated animals (including both vaccinees) and one sentinel seroconverted 12 days p.i., and five animals (including one sentinel) seroconverted 20 days p.i. No contagious ecthyma-like lesions were detected in the sentinels. All animals were euthanized at 26–29 days p.i. Histological examination of lesions showed proliferative dermatitis with epidermal hyperplasia, hyperkeratosis, intra-epithelial pustules and ulcers. Orf virus DNA was detected in mandibular lymph nodes, tonsils and mucosal lesions of four animals, including one sentinel, which showed that virus transmission took place. The commercial orf virus vaccine may be difficult to administer due to the need for close-cropping and its zoonotic nature, and did not indicate significant protection, although the latter has to be verified with a larger number of animals.

1. Introduction

Contagious ecthyma (contagious pustular dermatitis, orf) is a disease that occurs world-wide in sheep and goats and is caused by orf virus, a member of the genus *Parapoxvirus* in the *Poxviridae* family. The disease is usually not fatal. Lambs and kids, however, can develop severe lesions, with secondary bacterial infections, and may also be prevented from suckling since the udder of the mother

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can be infected and tender. Parapoxvirus has also been isolated from contagious ecthyma-like lesions in other domestic ruminants, as well as in camelids and wildlife species, such as muskoxen (*Ovibos moschatus*), squirrels, and seals (Khalafalla et al., 1994; Nettleton et al., 1995; Sainsbury and Ward, 1996; Tryland et al., 2004; Vikøren et al., 2008). Parapoxviruses causing contagious ecthyma or similar lesions are zoonotic, causing cutaneous infections in fingers and hands of people handling infected animals (Damon, 2007).

Contagious ecthyma has been reported in semi-domesticated reindeer (*Rangifer tarandus tarandus*) in Sweden (Nordkvist, 1973), Norway (experimental animals; Kummeneje and Krogsrud, 1979) and in Finland, starting during the winter 1992–1993 (Büttner et al., 1995). The first serious outbreak of contagious ecthyma under regular reindeer herding conditions in Norway appeared in Nordland County in April 2000, affecting about 30 animals, of which eight died (Tryland et al., 2001). Based on the experience in Finland and Norway, it seems evident, that contagious ecthyma outbreaks in reindeer can be associated to corralling and supplementary feeding of animals (Tryland et al., 2001). Orf virus seems to be able to be sub-clinically present in reindeer, since parapoxvirus DNA was detected in various tissues from six of 48 animals found dead on winter pastures (1999–2000) in Finnmark County, Norway, where contagious ecthyma never has been reported in reindeer (Tryland, 2002).

In Finland, earlier outbreaks were caused by orf virus, whereas more recent virus isolates (since 1999) have mostly been characterized as being pseudocowpoxvirus, another zoonotic parapoxvirus, causing pseudocowpox in cows and milkers' nodules in people (Tikkanen et al., 2004; Hautaniemi et al., 2010). In Norway, however, studies have consistently shown that parapoxvirus obtained from subclinically infected animals and from reindeer with clinical contagious ecthyma has been orf virus (Tryland, 2002; Klein and Tryland, 2005), also being similar to a virus isolated from muskoxen (Vikøren et al., 2008). Thus, we have no reason to believe that reindeer hosts its own specific parapoxvirus, as has been shown for red deer in New Zealand (Robinson and Mercer, 1995). Orf virus is presumably being transferred from sheep and possibly goats through shared pastures via infected organic matter (scabs), in corrals used for both sheep and reindeer, in transport vehicles etc.

Vaccinating sheep against contagious ecthyma, either with commercial vaccine or autovaccine produced from orf virus obtained from the herd to be vaccinated, is not completely protective and the effect is usually short-lived. It has also proved to be challenging, since vaccine strains have also caused regular outbreaks of orf in sheep (Gilray et al., 1998). The humoral immune response has been characterized as relatively poor and short lived in sheep and may thus be of minor importance for the immunity against parapoxvirus infections (Damon, 2007). Further, it seems that passive administration of antibodies (hyper-immune serum) does not protect lambs from infection (Czerny et al., 1997; Haig and McInnes, 2002). The immunological response to parapoxvirus infections in reindeer is virtually unknown.

The aim of this study was to see whether semi-domesticated reindeer and sheep were susceptible to experimental infections with parapoxvirus isolated from reindeer with contagious ecthyma, to establish the incubation period for reindeer, and to look for indications whether a commercial orf virus vaccine for sheep may have the potential to prevent clinical disease in reindeer.

2. Materials and methods

2.1. Animals

Fourteen one-year-old semi-domesticated reindeer (seven males, seven females), were blood sampled (jugular vein), ear-tagged (R1–R14; Table 1) and corralled in mid-April. During a 5-week period, animals were accustomed to people and to commercial pelleted feed for reindeer (Reinsdyrfôr, Felleskjøpet, Trondheim, Norway). In addition, they were fed lichen (*Cladina* spp.) and hay through the experimental period. Four weeks after the arrival of reindeer, two one-year-old male sheep (S1, S2; Table 1) were introduced to a neighbouring pen, having no contact with the reindeer. The sheep were fed hay and commercial pelleted feed for sheep (Formel Favør 10, Felleskjøpet).

2.2. Vaccination

One week after arrival (Day – 28; 4 weeks prior to inoculation of virus), two reindeer (R1 and R4) were vaccinated with a commercial vaccine (Scabivax®, Schering Plough Animal Health Corp., Oslo, Norway), based on live orf virus (strain NZ2) originating from lambs with clinical contagious ecthyma, and expecting to induce immunity in sheep within 3–4 weeks. The medial side of the right thigh was close-cropped with scissors and the vaccine was applied by a cross-scarification of the skin with the vaccine-bottle device, introducing the live virus vaccine suspension in the skin lesion, as recommended for sheep.

2.3. Virus and inoculation

Live parapoxvirus, for inoculation of reindeer and as antigen in ELISA, was purified from scabs obtained from reindeer with contagious ecthyma (Tryland et al., 2001) as described previously (Klein and Tryland, 2005). Four weeks post vaccination (Day 0) the two vaccinated (R1 and R4) and three females (R8, R9, R10) and three males (R2, R12, R13) were inoculated with live parapoxvirus. An area (approximately 2 cm $\times$ 1 cm) of the mucosa of the lower lip was scarified by sandpaper (grade 80), and the suspension of live parapoxvirus was introduced to the scarified mucosa with a cotton stick. The remaining six reindeer received no treatment and were kept as sentinels, sharing feed and water with the inoculated animals. The two sheep were inoculated at the same time as the reindeer (Day 0) by the same procedure. The experimental animal research protocol was approved by the Norwegian Animal Research Authority.