

Cases of Hydatid Disease in Medieval Iceland

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ABSTRACT Eight individuals with calcified cysts preserved in the thorax and abdomen, one of which had a maximum diameter of 17–20 cm, were recovered during recent excavations at Skriðuklaustur, a medieval monastic site which also functioned as a hospital during its operation from AD 1493–1554 in Eastern Iceland. Hydatid cysts are the result of parasitic infection by Echinococci commonly in the liver and lungs of the accidental human host. *Echinococcus granulosus* was likely introduced to Iceland soon after the settlement period (9th century AD) and became endemic around AD1200 when dogs were introduced from Germany. It has since been eradicated in Iceland due to an extensive educational literature programme and government controls implemented since the mid-1800s. Reviews of the palaeopathological literature mentioning calcified shell fragments indicated hydatism to be the most logical aetiology. The eight individuals in question were buried in close proximity to one another. This may indicate that this particular ailment (*sullaveiki*) had its own classification during the medieval period in Iceland and perhaps even a distinct treatment if not in life, at least in death. Copyright © 2010 John Wiley & Sons, Ltd.

Key words: *Echinococcus*; medieval Iceland; Skriðuklaustur; hydatism; cyst; monastic hospital; palaeoparasitology

Introduction

During the 2009 excavation season of Skriðuklaustur monastic site, hydatid cysts were recovered from the skeletons of eight individuals, including one cyst measuring 17–20 cm in diameter from the thoracic cavity of an elderly female skeleton. This is the largest cyst ever discovered in archaeological context in Iceland. All of the eight skeletons in question were buried in close proximity to one another in a particular part of the cemetery. Although these remains also presented other signs of pathological change, this area of burial may have been especially designated for those suffering with this particular ailment (*sullaveiki*). Two other skeletons with cysts have been previously reported at Skriðuklaustur (Zoëga, 2007), one diagnosed with tuberculosis and the other with hydatism, but these were found in a different area.

Site description and background

Skriðuklaustur farm is located in the Fljótsdalur valley in east Iceland (Figure 1). An Augustinian monastery operated there (1493–1554 AD), as part of a group of eight other religious communities which existed during the Catholic period in Iceland. All were dissolved during the Lutheran Reformation in the mid-16th century (Guðmundsson, 2000).

None of the monastic sites in Iceland have so far been investigated sufficiently to provide information about their structures and activities, apart from Skriðuklaustur. Since research began at the site in 2000, nearly 160 graves have been excavated at Skriðuklaustur from inside the cloister garden, the church itself, an area south of the church and an area east of the quire. Approximately 110 of the graves belong to the monastic period and the remainder to the period when the sheriffs and their families resided at Skriðuklaustur after the Reformation and dissolution of the monastery. The monastic church was rebuilt in 1670 for their use. However this later church soon fell into disrepair and was finally closed in 1793 after being used as an annex for Valþjófsstaður parish church 2 km away (Kristjánsdóttir, 2008).

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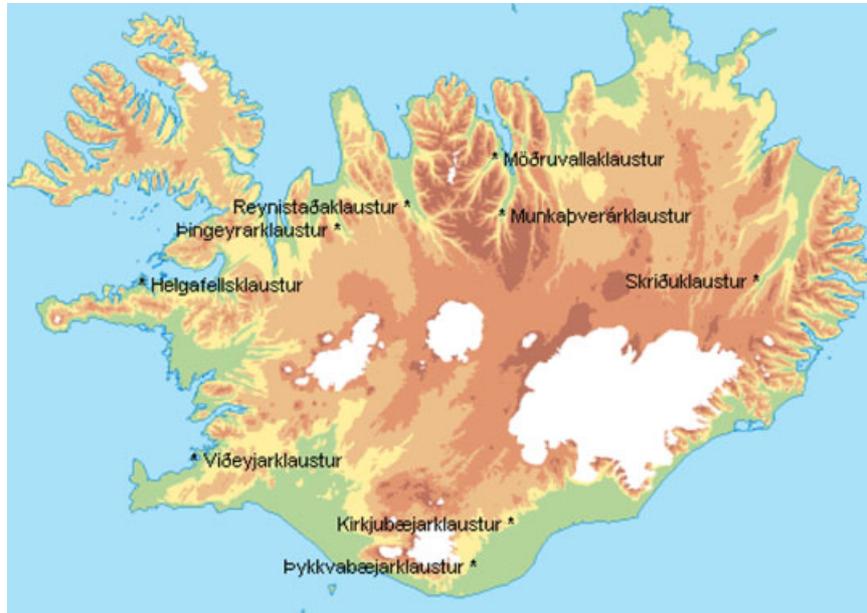


Figure 1. Map showing the location of Skriðuklaustur and the other monastic sites in Iceland. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

Evidence for the existence of a horticultural garden of healing plants at the site and the discovery of surgical equipment together indicate that a hospital was operated in connection to the monastery (Harðarson, 2008; Kristjánsdóttir, 2008; Frölich, in prep.). In addition, 70 of the nearly 160 skeletons exhumed at the site so far bear signs of pathological alteration caused by traumatic injuries and/or chronic/debilitating illnesses. These are symptomatic of treponematosi, non-specific infection, congenital disorders (e.g. cleft palate), periodontal disease, metabolic insult, fractures and traumatic injury and most recently hydatid disease (Pacciani, 2006, 2007; Zoëga, 2007, 2008).

The different burial areas inside the cemetery at Skriðuklaustur seem to have been restricted to specific groups associated with monastic and post-monastic periods of the site (Figure 2). Guests and patients who died in the care of the monastery were largely buried in the cloister garden and in the area closest to it between the church and the monastic houses. These skeletons range across all ages and both sexes but were often arranged in accordance to the deceaseds' diseases or ages. This was not strictly practiced but seems to have been a general trend in the burial patterns. South of the church are the laity, with very young children and mature individuals making up a high percentage of burials here, as is typical of medieval cemeteries in Iceland. East of the quire was an area designated for clerics and perhaps later for the sheriffs and their

families, while inside the church were the monastic benefactors. The area of the cemetery where the skeletons with the hydatid cysts were found is located between the church and the monastic houses (see Figure 2).

Hydatid disease aetiology

The species *Echinococcus granulosus* is responsible for hydatosis which affects humans and animals, creating unilocular cysts. Normally the parasite cycles between dogs and sheep. Humans are accidental hosts in fecal-oral transmission when the eggs of the parasite are ingested, as the life cycle of the parasite will terminate within the human body. Its effects however are chronic and potentially debilitating (Aufderheide & Rodriguez-Martin, 1998; Eckert *et al.*, 2001).

In human infection, the liver and lungs are the most commonly affected areas but the hookworm may infest any tissue. Humans are also apt to carry larger cysts, within which daughter cysts may sometimes form, or they may form outside of the original cyst. These cysts are sometimes asymptomatic for a period of months or years, and may become symptomatic depending on the rate of increase in size and the coincident pressure exerted on other organs and tissue and/or in the case of cyst rupture (Eckert *et al.*, 2001; Craig & Larriou, 2007).

As growth of such cysts progresses slowly, it may take a decade to reach 15–20 cm (Aufderheide &



Figure 2. Skriðuklaustur site plan showing the area where the eight cases of hydatosis were found. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

Rodriguez-Martin, 1998). However, in a modern clinical study nearly half (43%) of sufferers had cysts that grew at 6–15 mm per year, which was classified as ‘moderate growth’ by the World Health Organisation (Eckert *et al.*, 2001). The cyst from the skeleton in Grave 126 (Case 1) at Skriðuklaustur, the largest ever found in archaeological context in Iceland, measured 17–20 cm in diameter.

Other conditions that can result in cysts may be confused with hydatosis, and these ailments are well described elsewhere (cf. Weiss & Møller-Christensen, 1971; Aufderheide & Rodriguez-Martin, 1998; Perry *et al.*, 2008). Cysts have been previously reported (Zoëga, 2007) from two different areas of the site at Skriðuklaustur [SKR 2005-30, SKR 2005-33]. Grave 30, an elderly female, had multiple cysts which were retrieved from the area of the stomach and were likely candidates for hydatism. However Grave 33, a female over 50 years of age, while also found with cysts, was instead identified as a case of tuberculosis as there were characteristic pathological changes to the ribs.

The cases at Skriðuklaustur from the 2009 season

The eight individuals recovered during the 2009 season at Skriðuklaustur were all found together in the area north of the church but still close to the monastic houses. These were buried in a manner typical for this site and of the monastic period. The bodies were buried extended and facing east–west with arms crossed over the body. The skeletons were of individuals of both sexes and happened to be mature and older adults (50+). In addition to the cysts that were retrieved intact from the graves, these individuals suffered from other degenerative and pathological conditions (Table 1).

Case 1

An elderly female skeleton [SKR 2009-126] presented a calcified ovoid object in the posterior right side of the

Table 1. Skeletons from Skriðuklaustur monastic site with hydatid cysts

Grave no.	Sex	Age	Maximum cyst diameter: No. of cysts	Additional pathology
126	F	60+	17 cm: 1	Treponemal infection, osteoarthritis
128	F	60+	Indeterminate	Treponemal infection, osteoarthritis
129	M	50–55	Indeterminate	Non-specific infection
131	M	50–59	4 cm: 5	Osteoporosis
137	F	60+	2 cm: 3	Osteoarthritis, osteomyelitis
143	F	60+	2 cm: 6	Osteoarthritis
147	??	60+	10 cm: 2	Osteoporosis
154	M	60+	4 cm: 4	Osteoarthritis

thorax at the approximate site of the liver. This object was identified as a cyst, hollow with thin calcified walls and perforations throughout. Measuring 17–20 cm at its maximum diameter, it was presumed that it was once filled with liquid, which probably drained through its perforations (Figure 3). This individual also showed evidence of treponemal infection, presenting typical *caries sicca* on the cranial vault, as well as early signs of osteomyelitis on the tibiae as faint striations but with no macroscopically obvious remodelling of the medullary cavity or overlying cortical bone (Figures 4 and 5).



Figure 3. A cyst measuring 17–20 cm was recovered from Grave 126. This figure is available in colour online at www.interscience.wiley.com/journal/oa.



Figure 4. *Caries sicca* are evident on the skull from Grave 126. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

Case 2

This skeleton of an elderly female [SKR 2009-128] was found with multiple small cystic fragments throughout the abdomen, which could not be precisely totalled. Along with osteoarthritis, evidence of *caries sicca* on the skull and osteomyelitis in the tibiae were identified (Figures 6 and 7).



Figure 5. Faint markings of osteomyelitis of the tibia from Grave 126. This figure is available in colour online at www.interscience.wiley.com/journal/oa.



Figure 6. *Caries sicca* on the skull from Grave 128. This figure is available in colour online at www.interscience.wiley.com/journal/oa.



Figure 7. Signs of osteomyelitis on the patellae due to a non-specific infection from Grave 128. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

Case 3

With similar fragmentary cysts to Case 2, this middle adult male skeleton [SKR 2009-129] did not suffer from severe degenerative changes but did present signs of an unidentified infection on the left and right ulna and radius, and throughout the carpal bones. Dental attrition of both maxillary and mandibular teeth was severe. One of the cysts removed had a likely diameter of 5 cm (Figure 8).

Case 4

Five cysts of up to 4 cm in diameter were found in the thoracic cavity and abdominal area of this middle adult male skeleton [SKR 2009-131], which also showed alterations due to osteoporosis in the hands and feet (Figure 9).



Figure 8. Hydatid cysts from Grave 129. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

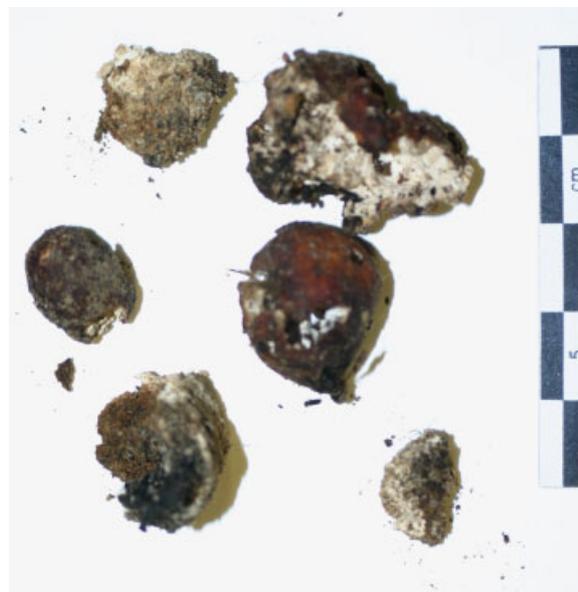


Figure 9. Hydatid cysts from Grave 131. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

Case 5

An elderly female presented multiple daughter cysts [SKR 2009-137] of no more than 2 cm in diameter and an unidentified infection which produced osteomyelitic changes in the scapulae, the long bones of the arms and both tibia.

Case 6

Multiple smaller cysts (2 cm diameter each) were found in the body cavity of the elderly female in Grave 143 [SKR 2009-143] who also suffered from osteoarthritis (Figure 10).



Figure 10. Hydatid cysts of 2 cm diameter from Grave 143. This figure is available in colour online at www.interscience.wiley.com/journal/oa.



Figure 11. Hydatid cysts from Grave 154. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

Case 7

This grave was unfortunately disturbed by later burials at the site and only the upper torso remained *in situ* [SKR 2009-147]. Although sex could not be determined and preservation of this skeleton was extremely poor due to disturbance, two cysts nearly identical in shape and size were positioned bilaterally on either side within the thorax, with the arms crossed over the chest. The site of these cysts (up to 10 cm in diameter each) within the body suggests that they were present in the individual's lungs.

Case 8

Four cysts, one of which was 4 cm in diameter were recovered from the abdomen (Figure 11) and severe osteoporosis plagued this mature adult male individual in life [SKR 2009-154]. An unidentified infection evidenced by lesions on various joint and bone surfaces were also found (Figure 12).

Discussion

Skriðuklaustur was one of eight monasteries and nunneries which operated in Iceland during the medieval period. However, the site is truly unique



Figure 12. A non-specific infection on the individual from Grave 154 caused pathological change to the auricular surfaces of the innominates. This figure is available in colour online at www.interscience.wiley.com/journal/oa.

for its status as a hospital, open to all in need of treatment. Though the monastery operated for a relatively short period of about 60 years, it is clear as excavations continue that those in need of healing travelled and were also laid to rest there. The cemetery in question holds the largest number of burials ever excavated in Iceland thus far.

Echinococcus granulosus is a parasitic zoonosis, which was probably introduced to Iceland sometime after the settlement period in the late 9th century and became endemic in Iceland by AD 1200. Its lifecycle was confirmed through experimentation in Iceland in 1863 and subsequent recommendations for control were implemented through public education and government management. *E. granulosus* has since been eradicated in Iceland with these measures (Beard, 1973; Skírnisson et al., 2003; Ísberg, 2005; Craig & Larrieu, 2007).

There has been very little reporting of hydatid cysts in archaeological material in Iceland. Only one other case is known in a female skeleton, aged 45+ years [VEY-A-007], from a cemetery dated to the 18th century at Viðey in Southern Iceland. In this case the cyst was perhaps as large as 15 cm in diameter but it was broken when investigated (Gestsdóttir, 2004).

Cysts in archaeological material have been reported in Denmark (Weiss & Møller-Christensen, 1971), the Middle East (Zias, 1991; Perry et al., 2008), Egypt (Tapp, 1986), England (Price, 1975; Wells & Dallas, 1976) and North America (Ortner & Putschar, 1985; Williams, 1985). It has been contended that aetiological determination cannot be assumed until assessment of the microstructure of the cyst itself confirms the presence of characteristic hooklets (Aufderheide & Rodriguez-Martin, 1998).

In the case of a young female skeleton from a medieval Danish leprosarium (Weiss & Møller-Chris-

tensen, 1971), histological examination did not reveal the remains of any organic material in the structure of the calcified cyst walls. Thus histological analysis was not considered a feasible route to diagnosis of the cysts recovered from Skriðuklaustur. The cysts found there were typical of *E. granulosus*, having a single chamber which grew by concentric enlargement and contained fluid. All of them were located in the lower thorax and abdominal region, which would again be a typical presentation of this condition as such cysts usually form in the liver or lungs (Eckert *et al.*, 2001).

In the analysis of Grave 33 mentioned above, the vertebrae and lower limbs were unavailable for study due to poor preservation. Considering the similar morphology of this cyst to those diagnosed with hydatosis, and that the lesions of these two ribs could have been caused by inflammation of the viscera in the thorax, the tuberculoid diagnosis may be uncertain. The cysts recovered at Skriðuklaustur in 2009 are not likely to be of tuberculoid origin for two reasons: in size, many of these cysts correspond to the larger dimension expected of cysts caused by echinococcal infection, and many individuals had multiple cysts which is a diagnostic feature of hydatosis. Indications are that though other ailments such as intestinal tuberculosis may cause cysts of a similar morphology, an individual is not likely to present more than one or two (Aufderheide & Rodriguez-Martin, 1998).

Unfortunately, there is no documentary evidence to support any theory that *sullaveiki* was known as a parasitic infection until the government-driven education programs of the 19th and early 20th centuries (Craig & Larrieu, 2007). However, burial patterns at Skriðuklaustur are proving elucidative in their apparent structuring of individuals in death, especially in grouping together those of similar age and those with shared pathological conditions.

Conclusions

Until now there has been little evidence for hydatosis in medieval Iceland. Thus these reported finds are unique indicators of the presence of the disease and its implications. In most cases, and especially that of Grave 126 (Case 1) from Skriðuklaustur, it is possible that the individuals lived with this cyst for some time. Despite the finding of two individuals with cystic conditions outside of this area of the cemetery, the importance of the placement of these eight individuals in question together is still a likely recognition by the medieval caregivers of a specific ailment.

When considering that the remains were found in the burial grounds of a monastic hospital, it is likely that all of the individuals with hydatid cysts were experiencing symptoms and came to Skriðuklaustur for treatment. Some of these eight individuals lived with other conditions, but it is intriguing that according to burial patterns, they seem to have first been buried according to this shared condition and not relative to any of the other identified illnesses or age. It is the recognition of hydatid disease as a primary classifier that takes prevalence here.

Considering the anecdotal and occasionally documented knowledge of this disease (*sullaveiki*) in Iceland (cf. Ísberg, 2005), the striking similarity in morphology to other hydatid cysts reported in the literature, and the shared burial space of these individuals, the indications are that this ailment may have been recognised in medieval Iceland as having its own classification and perhaps requiring distinct treatment if not in life, at least in death. Furthermore, these possible indications that symptoms of echinococcosis were recognised before the 16th century stand *sui generis* in Icelandic medical history.

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