



## Case study

# Differential diagnosis of pathologically induced upper and lower limb asymmetry in a burial from late medieval Ireland (CE 1439–1511)



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## ABSTRACT

This paper reports a case study from 15 to 16th century Ireland of a mature adult male with upper and lower limb asymmetry. All of the bones of the right upper and lower extremity were atrophied and demonstrated limb shortening. This individual also had severe scoliosis and accessory facets on the superior aspect of the distal ends of the right metatarsals. These facets were most likely caused by the individual walking predominately on his toes to make up for the height difference between the lower limbs. Based on the patterning of affected bones and associated pathological changes, the individual was diagnosed as suffering from cerebral palsy with right-sided hemiplegia. Few definite cases of cerebral palsy have been identified in the archaeological record and most often only include the shortening of one or two long bones. The case from Ballinderry provides one of the most definitive archaeological cases to date.

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## 1. Introduction

Limb asymmetry in skeletal material is difficult to relate to a specific cause as many non-pathological, pathological, and traumatically-induced episodes can produce asymmetry of one or more long bones. As a result, many studies have focused on attempting to define the amount of variation in limb asymmetry, as this feature, particularly in the upper limbs, can be produced by mechanical loading caused by habitual activity (Blackburn and Knüsel, 2006; Mays et al., 1999; Steele, 2000; Steele and Mays, 1995; Stock and Pfeiffer, 2004). These studies have shown the right upper limb, particularly the humerus, to be more developed than the left, with an average difference in relative length of 1%–3% (Čuk et al., 2001). In comparison, the left lower limb has a tendency to be more robust and longer than its right counterpart, primarily associated to the use of the leg as a weight stabiliser while the right takes on other activities (Kujanová et al., 2008). Limb asymmetry is thus normally a reflection of an individual's handedness and level of activity. Distinguishing between these non-pathological asymmetry patterns and those resulting from a traumatic event or disease is difficult, particularly in the absence of related skeletal lesions (Lieverse et al., 2008). Identified cases due to pathological or traumatic events within the archaeological literature have been few, and primarily include aeti-

ologies congenital (Canci et al., 2002; Hershkovitz et al., 1993; Mann et al., 1998, 1992; Titelbaum et al., 2015) or traumatic in nature (Churchill and Formicola, 1997; Teegen et al., 1997). Due to the high percentage of asymmetry and atrophy observed both in the upper and lower limbs, the individual reported here provides an ideal case study of pathologically-induced bilateral limb asymmetry.

## 2. Burial context

The skeleton (Sk 157) was discovered during excavation of a burial ground on the site of Ballinderry, County Kildare (Fig. 1). Positioned at the top of a low-lying hill, the site included an enclosed burial ground and an associated domestic rural site. The burial ground, which included a total of 240 individuals, was located at the south-eastern area of the site, enclosed by a 45 m radius ditch on the northern and western borders, with a sharp escarpment providing a natural border along the eastern and southern edges. The graves were aligned primarily east-west and were predominately simple, shallow graves ranging from 10 to 35 cm in depth. Many of the graves intersected, with a total of three burial levels identified during excavation. While the most common burial position was supine extended, crouched and flexed burials were also recorded. Two radiocarbon samples from the inhumations dated between CE 1439–1524, while a third was much more recent and likely did not reflect site use. While the two radiocarbon dates place the use of the cemetery in the fifteenth and sixteenth centuries, the high amount

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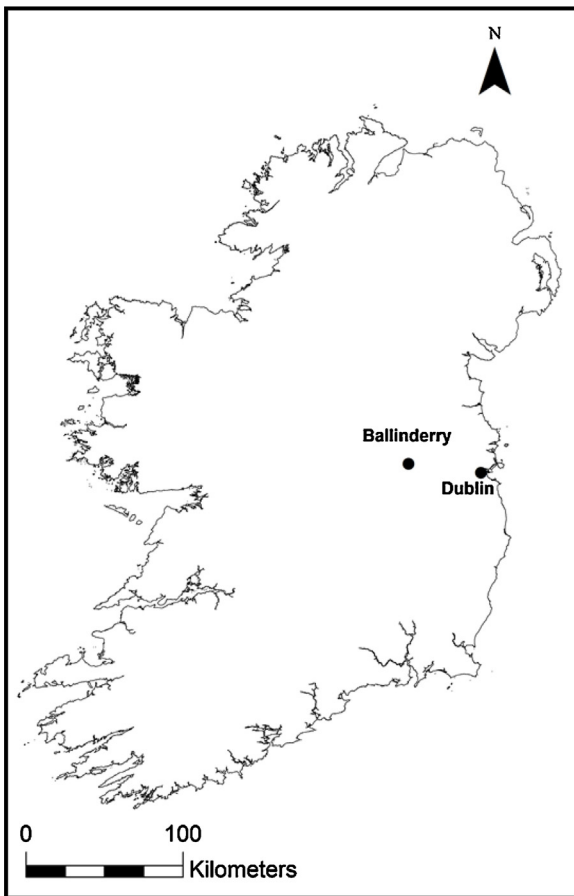


Fig. 1. Location of Ballinderry, Co Kildare.

of intercutting and variation in burial positions suggests a burial ground used over a number of years (Tesorieri, 2012–2013).

Sk 157 was buried in a supine extended position in a shallow grave located well within the cemetery boundaries, with the bones of the skeleton well-preserved but displaying a high degree of fragmentation. Radiocarbon dating places the death of the individual between CE 1439–1511 (Cal Date 2 sigma 95.4%), towards the end of the late medieval period. Severe spinal curvature indicative of scoliosis and the atrophied right arm were observable *in situ* (Fig. 2), and upon closer examination, it was clear that the scoliosis was accompanied by differences of the upper and lower right limb, including the clavicle, scapula, humerus, radius, ulna, carpals, femur, tibia, fibula and slight left-sided rotation of the pelvic girdle (Tesorieri, 2012–2013). Osteological analysis identified the individual as a mature adult male based on cranial and pelvic morphology (Bass, 1995; Brooks and Suchey, 1990; Buckberry and Chamberlain, 2002; Buikstra and Ubelaker, 1994; Krogman and Iscan, 1986).

### 3. Analysis

#### 3.1. Cranium

The occipital protuberance was orientated towards the left with the right occipital condyle positioned slightly lower than the left (Fig. 3). It is likely that *M. trapezius* placed asymmetrical stress on the nuchal musculature, possibly associated with a disproportionate usage of the left upper limb and torso. The mastoid processes displayed irregularities in shape, with the right mastoid wider than its counterpart (Table 1). Similarly, the right attachment for *M. digastricus* was more pronounced on the right side (6.5 mm and



Fig. 2. Image of burial at mid-excavation (arrow points north). The severe curvature of the spine and atrophied right arm are observable.

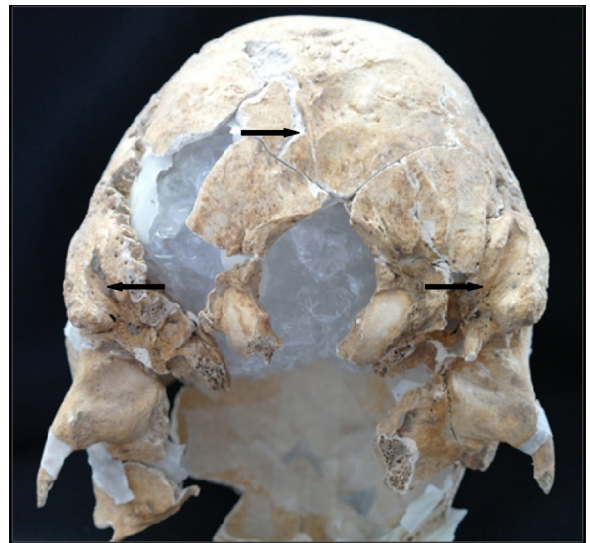


Fig. 3. Posterior view showing midline discrepancy of *M. Trapezius* (superior arrow) and difference in size of digastric notches.

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