



## Hands of a surgeon: Second to fourth digit ratios in the surgical profession



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### ABSTRACT

Second to fourth digit ratio (2D:4D) is a sexually dimorphic trait and a low ratio has been shown to be linked with a heightened visuospatial ability. Surgeons are typically renowned for good visuospatial awareness and this is now a requirement to gain access on to surgical training programmes. We hypothesized that a lower 2D:4D would be found in a cohort of surgeons compared to an age and gender matched control group. Digit ratios were measured in each group and compared. We found that male surgeons had a significantly reduced 2D:4D ratio compared to the controls. There was no difference observed between female surgeons and the female control. We have demonstrated that male surgeons have a significantly lower 2D:4D ratio compared to an age and gender matched control. This would be in keeping with published reports that a low 2D:4D ratio is associated with improved visuospatial ability.

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### 1. Introduction

Exposure to prenatal androgens has an enduring organizing influence on physical development and future behaviours. These androgenic steroids profoundly effect the lateralization of the developing brain and influence its later sensitivity to circulating testosterone (Breedlove & Hampson, 2002, Chap. 3; Coates, Gurnell, & Rustichini, 2009). These effects have been shown in both human and animal studies, to include, increased reaction times (Salminen, Portin, Koskinen, Helenius, & Nurmi, 2004), risk preferences (Coates et al., 2009) and heightened vigilance (Coates et al., 2009).

The second-to-fourth digit ratio (2D:4D) is a well recognized physical marker of intrauterine androgenic steroid exposure (Manning, 2002). It first became evident as a marker of prenatal androgen from the observation that the human male ring finger is longer than the females. This sexually dimorphic trait is the ratio of the length of the index finger (2D) to the length of the ring finger (4D) and has been shown to be smaller in humans, mice and baboons, with a longer ring finger suggestive of higher foetal androgens (Brown, Finn, & Breedlove, 2002; Cohen-Bendahan, van de Beeka, & Berenbaum, 2005; McFadden & Bracht, 2003; McFadden & Shubel, 2002). In humans, the 2D:4D ratio represents

the most powerful human dimorphic digital ratio combination, with the index finger length being a measure of the amount of intrauterine oestrogen exposure and the ring finger length acting as a measure of intrauterine androgen exposure (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Malas, Dogan, Evcil, & Desdicioglu, 2006; Manning, 2002). The complex organization and development of the brain is influenced by the same androgenic steroids that determine the 2D:4D ratio and testosterone has been shown to be the most influential of these hormones impacting on cortical dominance (Bull, Davidson, & Nordmann, 2010). It is postulated that testosterone decelerates left hemisphere development whilst promoting right hemisphere growth. This accounts for males being more likely to be right hemisphere dominant than females and to have a lower 2D:4D ratio (Bailey & Hurd, 2005; Bull et al., 2010; Williams et al., 2000; Wilson & Lewis-Jones, 1998). Digit ratios have been shown to be associated with several physical and psychological traits and can be predictors of assertiveness, increased risk-taking, (Coates et al., 2009), aggression (Joyce et al., 2013), prowess in competitive sports (Manning & Pickup, 1998; Manning & Taylor, 2001) and improved visuospatial awareness (Collaer, Reimers, & Manning, 2007; Geschwind & Galaburda, 1985; Kimura, 1996; Manning & Taylor, 2001).

Fundamental skills in becoming a surgeon include good psychomotor skills, visuospatial ability and stereoscopic depth perception (Gallagher, Leonard, & Traynor, 2009). Several studies

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have demonstrated the existence of an explicit link between visuospatial and surgical ability (Cuschieri, 1995; Gibbons, Baker, & Skinner, 1986; Grace, 1989). Visuospatial ability has been shown to be a key factor in predicting the learning rate and performance for complex surgical tasks.

Individuals without these abilities tend not to pursue a career in surgery as it has been shown that there is a strong and statistically significant relationship between visuospatial ability and surgical performance (Gallagher et al., 2009). Surgeons also require a good deal of confidence in their own ability but a heightened sense of vigilance is needed at all times in theatre along with quick reactions. Concentration levels must be high despite long operations, frequently at unsociable hours, as even minor mistakes can be catastrophic. Risks are frequently taken for the good of the patient yet the surgeon must be accountable for his or her risk preferences. These biological traits may be attributed to foetal androgenic steroid exposure (Coates et al., 2009).

The purpose of this study was to examine the 2D:4D ratios in a group of surgeons and compare these ratios to an age and gender matched control group. As visuospatial performance is influenced by prenatal androgen exposure, we hypothesized that surgeons have a lower 2D:4D than the general population, as surgery may attract individuals who have a heightened visuospatial awareness. Furthermore, visuospatial ability is now formally assessed and utilized as an essential criterion in the selection process for surgical training.

## 2. Materials and methods

Digit ratios were calculated for 148 surgeons at two large surgical conferences held in Ireland in 2013 (Sir Peter Freyer Surgical Symposium, September 6th, Galway and the British Association of Plastic, Reconstructive and Aesthetic Surgery winter meeting, November 27th–29th, Dublin). Photographs were taken of the volar aspect of the subjects' right hands. The hands were placed flat against a table and digits were fully extended. The data recorded included age, surgical specialty and surgical grade. Only consultant surgeons and specialist registrars (SpRs) were included in the surgeons' arm of the study. Using a previously described method, we measured digit length from the metacarpo-phalangeal crease to the distal tip of the finger (Coates et al., 2009). This crease appears around the ninth week of gestation and is one of the primary creases of the hand. It is a permanent crease and develops independently of finger movement (Kimura, Schaumann, Plato, & Kitagawa, 1990). All photographs were exported to Adobe® Photoshop® CS5 (Adobe Systems, Inc., San Jose, Calif.) and digit lengths were measured using the ruler tool to the nearest 0.1 mm. For the control group, photographs of the right hands of patients attending hospital clinics were subsequently taken and the digit ratios were measured in exactly the same manner. This group was matched for age (born in the same decade) and gender to the surgeons group. Any individual who had previously sustained a fracture or had surgery on their ring and index fingers were excluded from this study.

### 2.1. Statistical analysis

The Kruskal–Wallis non-parametric test was used to compare the difference between the groups (Table 1). A *p*-value of <0.05

**Table 1**

The mean ± standard deviation of second to fourth digit ratios in our four groups as well as the number (*n*) of subjects in each group.

	Males	Females
Surgeons	0.933 ± 0.022 ( <i>n</i> = 114)	0.977 ± 0.033 ( <i>n</i> = 34)
Control	0.971 ± 0.021 ( <i>n</i> = 114)	0.982 ± 0.05 ( <i>n</i> = 34)

was considered statistically significant. Dunn's multiple comparisons test was carried out to examine the difference between the individual groups (Table 2).

## 3. Results

There were 114 males and 34 females in each group. In the surgeons group, there were 36 consultants and 112 specialist registrars. The 2D:4D ratios were significantly lower for males compared to females in both groups. Male surgeons have the lowest 2D:4D ratio (0.933 ± 0.022) and this was extremely significant compared to all other groups (*p* < 0.001) (Table 2). Female surgeons (0.977 ± 0.033) have similar 2D:4D ratios to the female control group (0.982 ± 0.05) and there was no statistical difference between these two groups (*p* > 0.05). There was also no significant difference in 2D:4D ratios between the consultant surgeons and the specialist registrars in surgery. Furthermore, no statistical difference was found in the 2D:4D ratios between the different surgical subspecialties.

## 4. Discussion

The aim of our study was to assess whether the digit ratios of a cohort of surgeons differed from an age and gender-matched control group. We hypothesized that because surgeons are regarded as having good visuospatial awareness, the 2D:4D ratio for surgeons would be less than the control group on account of increased prenatal testosterone exposure. A low 2D:4D ratio, a consequence of increased prenatal testosterone, has been shown to correlate with high mental rotation scores (a measure of visuospatial ability) and good spatial judgement (Kimura, 1996; Manning & Taylor, 2001).

The 2D:4D ratio is typically less in men than in women and it is an important sexually dimorphic trait (Manning, 2002; Waters et al., 2013). The dimorphism is apparent from the age of two and thenceforth increases (McIntyre, 2006). It is the most reliable of the digit ratio combinations and has greater consistency on the right hand than the left, and several authors have reported that the right hand is more androgen sensitive than the left (Williams et al., 2000). Furthermore, several other studies that investigated digit ratios found a stronger correlation between certain psychological factors and the right hand only (Brown, Finn, Cooke, & Breedlove, 2002; Csathó et al., 2003).

A previous study by Manning and Taylor looked at the 2D:4D ratios in competitive soccer players and found that low ratios were associated with a more successful soccer career. A good visuospatial ability is necessary for soccer as it requires accurate delivery of the football (Manning & Taylor, 2001). A low 2D:4D ratio has also been associated with high performance in several other sporting disciplines including swimming (Sudhakar, Veena, & Tejaswi, 2013), gymnastics (Peeters & Claessens, 2013), athletics (Giffin, Kennedy, Jones, & Barber, 2012), surfing (Kilduff, Cook, & Manning, 2011) and elite rugby (Bennett, Manning, Cook, & Kilduff, 2010).

**Table 2**

Data from Dunn's multiple comparisons test.

Comparison	<i>p</i> -Value
Male surgeon vs male control	<0.001
Male surgeon vs female surgeon	<0.001
Male surgeon vs female control	<0.001
Male control vs female surgeon	>0.05
Male control vs female control	>0.05
Female surgeon vs female control	>0.05

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