Correspondence

Case report: bilateral sternalis muscles with a bilateral pectoralis major anomaly

The importance of continuing to record and discuss anatomical anomalies was addressed recently by Hicks & Newell (1997) in the light of technical advances and interventional methods of diagnosis and treatment. Two recent radiological reports (Bradley et al. 1996; Murphy & Nokes, 1996) highlighted the diagnostic dilemma posed by a sternalis muscle in the detection of breast cancer.

The sternalis muscle occurs only in humans, is reportedly found in 3–5% of the population and is classified with the pectoral group of muscles (Bergman et al. 1988). Although sternalis has been well described in the literature, some confusion persists. For example, it is presented in Gray's Anatomy (Bannister et al. 1995) as a variation of pectoralis major and is called rectus sternalis, whereas in the embryology text by Larsen (1997) it is presented as a derivative of the rectus column and called sternalis. In the book on anatomical variation (Bergman et al. 1988) it is termed m. sternalis, classified with pectoralis major but stated only that it is considered by some authors to be a vestige of the panniculus carnosus. We report here an excellent example of bilateral sternalis muscles with an accompanying bilateral pectoralis major anomaly and review briefly the homology and innervation of this muscle.

A well defined sternalis muscle was found bilaterally in an 83-y-old subject during routine dissection (Figs 1, 2). This is the first instance of the muscle we have encountered in dissection room experience of over 200 cadavers over a 20 y period.

The left sternalis was 26 cm long and 4.6 cm wide at its broadest part. The right sternalis was 23 cm long and 2.5 cm at its widest part. Both were well developed muscular bands. In each the proximal end of the muscle was in direct continuity with the sternal tendon of the sternocleidomastoid muscle. The proximal ends of both sternalis muscles were interconnected by a thick band of tendinous fibres continuous with the tendons of sternocleidomastoid superiorly and of sternalis inferiorly. The majority of the fibres in this 3.4 cm wide tendinous band ran diagonally from the right sternocleidomastoid tendon to the left sternalis tendon and the deeper fibres were attached to the manubrium. Both sternalis muscles ran distally almost parallel with the sternum to the costal margin and inserted into the aponeurosis of the external oblique muscle with some fibres attaching to the right 6th and left 7th costal cartilages.

On each side a narrow slip of muscle fibres passed laterally from the sternalis tendon. These pectoral slips lay superficial to pectoralis major at the level of the 1st intercostal space. On the left side this muscle slip (1.2 cm wide) ended in a flat tendon, 3 cm long, which inserted into

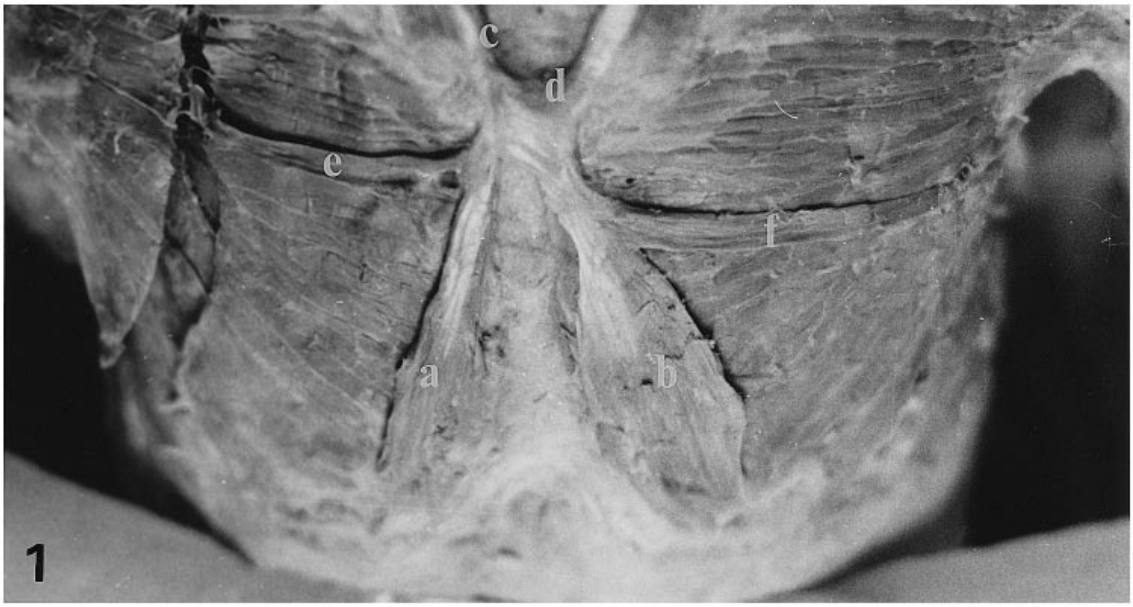

Fig. 1. Bilateral sternalis muscles (a, b) are continuous with the tendons (c, d) of the sternomastoid muscles. The pectoral slips (e, f) radiate laterally.

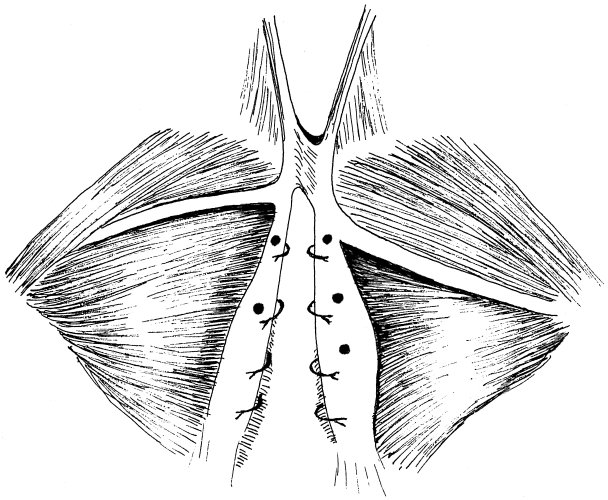

Fig. 2. Drawing of the bilateral sternalis muscles, highlighting the interconnections between these muscles and sternomastoid. Perforating branches of the intercostal nerves which supplied sternalis penetrated at the black dots. The anterior cutaneous branches of the intercostal nerves are depicted curving around the medial border of sternalis.

a thickening of the pectoralis fascia over the lateral border of that muscle. The right muscle slip had no distal tendon but its fibres merged with those of pectoralis major about 3 cm from its lateral border. There was no underlying defect in either of the underlying pectoralis major muscles.

Nerves were traced to the sternalis muscle on each side from the 2nd and 3rd intercostal nerves and a smaller nerve from the left 4th intercostal nerve also passed to the left sternalis. These nerve branches pierced pectoralis major and entered the deep surface of sternalis terminating in the substance of that muscle. These nerves were separate from the anterior cutaneous branches of the intercostal nerves which pierced pectoralis major deep to sternalis but passed medially between pectoralis major and sternalis before looping in a recurrent fashion around the medial border of sternalis to pass laterally on its superficial surface. A small nerve entering the deep aspect of the left pectoral slip was traced medially to the 2nd intercostal nerve. The right pectoral slip of muscle had no discernable innervation. No branch from either the medial pectoral or lateral pectoral nerves were traced to the sternalis muscles. There was no evidence of any other muscle anomalies.

This case illustrates a combination of the classically described sternalis muscle with another anomaly, the bilateral slips of muscle extending laterally from the upper part of sternalis and blending into pectoralis major near the axilla. We have called these 'pectoral slips' and they are infrequently present. Shepherd (1885) showed a drawing of 2 such slips of muscle associated with a unilateral sternalis in an anencephalic fetus. Schultz (1888) provided a drawing of a single sternalis with doubled pectoral slips. The drawing by Calori (1888) most closely approximates the present case although those bilateral sternales did not appear to interconnect with the tendons of the sternomastoid muscles as in the present case. Huntington (1905) showed a unilateral slip on the left side, again in an anencephalic fetus. Both these latter illustrations were included by Bergman et al. (1988) in the textbook on anatomical variations. No separate name has been given to these pectoral slips that we can identify. The slips may represent either high variations of the chondroepitrochlearis which do not reach the axillary arch or the arm but blend into the underlying pectoralis major or variations of the pectoralis quartus which usually arises more inferiorly in the 5th and 6th intercostal spaces and passes laterally towards the axilla (Macalister, 1871; Perrin, 1871; Bryce, 1899).

A debate has ranged since the 17th century particularly about the homology and innervation of sternalis and there is an extensive literature. The homology debate from the literature reviewed (Table 1) shows that sternalis has been classified by various authors under 4 main headings, as being derived (1) from pectoralis major, (2) from rectus abdominis, (3) from sternomastoid and (4) from the panniculus carnosus. An examination of the innervation patterns reported (Table 2) has narrowed the debate. Sternalis is either pectoralis major derived with an innervation from the thoracic/pectoral nerves or rectus derived with an innervation from the intercostal nerves.

Table 1. *Homology of the sternalis muscle from a review of the literature*

Derivation from pectoralis major	Derivation from rectus abdominis	Derivation from sternomastoid	Derivation from panniculus carnosus
Bardeleben, 1876	Early anatomists*	Bourienne, 1773*	Turner, 1867
Abraham, 1883	Bardeleben, 1876	Theile, 1843*	Barlow, 1935
Cunningham, 1884, 1888	Fick, 1917–18	Henle, 1858*	Shen et al. 1992
Shepherd, 1885	Fukuyama, 1940	Bardeleben, 1876	
Bryce, 1899	Rao & Rao, 1954	Rao & Rao, 1954	
Eisler, 1901	Blees, 1968	Blees, 1968	
Ruge, 1905	Larsen, 1997		
Huntington, 1905			
Fick, 1917–18			
Yap, 1921			
Fukuyama, 1940			
Dziallis, 1968			
Kida & Kudoh, 1991			

*Cited by Turner (1867)

Table 2. *Innervation of sternalis based on a review of literature*

	Number of sternalis muscles with innervation noted	External thoracic or internal thoracic nerves	Intercostal nerves	Double innervation from intercostal and thoracic nerves
Hallett, 1848*	1		1	
Bardeleben, 1876	2		2	
Malbranc, 1878*	2	1	1	
Krause, 1880**	1	0	1	
Cunningham, 1884	1	1		
Shepherd, 1885	9	6 & 2?		1
Wallace, 1886	1	1		
Lamont, 1887	6	5		1
Dwight, 1887	4	2?	2	
Bardeleben, 1888	10		10	
Cunningham, 1888	17	17		
LeDouble, 1890	4	1	3	
Fick, 1891	4		4	
LeDouble, 1897		Yes		
Christian, 1898	3	1	2	1
Eisler, 1901	17	17		
Ruge, 1905		Yes		
Fick, 1917–18			Yes	
Yap, 1921	11	9	2	
Locchi, 1930	20	20		
Taniguchi & Tochihara, 1932***			Yes	
Patten, 1933–34*a*, *b*	2	2		
Slobodin, 1934–35	6	3	3	
Barlow, 1935	17	3	13	1
Ura, 1937/8***		Yes		
Morita, 1934***		Yes		
Fukuyama, 1940	32	15	17	
Misra, 1954	6		6	
Rao & Rao, 1954	4		4	
Kacker, 1960	6		6	
Blees, 1968	1		1	
Kitamura et al. 1985***			Yes	
Kida & Kudoh, 1991	2	2		
Shen et al., 1992	2		2	
O'Neill & Folan-Curran, 1998	2		2	
Totals	191	102 & 4?	81	4
Percentage		55	43	2

*Cited by Cunningham (1888); **cited by Barlow (1935); ***cited by Kida & Kudoh (1991).

It is evident that the incidence of sternalis muscles innervated by the intercostal nerves is higher than may have been apparent in the earlier literature. From the literature reviewed in Table 2, 55% of the muscles were innervated by branches of the internal or external thoracic nerves, 43% by branches of the intercostal nerves and 2% both from the intercostal and the thoracic nerves. The question of the double innervation was addressed by Kida & Kudoh (1991) when they stated that the existence of a communication between the pectoral nerve and the anterior branch of the intercostal nerve should be further examined in such cases. This was a suggestion first proposed by Cunningham (1888) when he stated that it is just possible that with the intercostal supply there may have also been a thoracic supply which had been overlooked. The incidence of 43% of sternalis muscles reviewed receiving an intercostal nerve supply would make an inconstant communication unlikely and we consider it would have been detected in the many detailed dissections of the nerves that have been performed. This difficulty in reconciling the presence of the intercostal innervation with a derivation of sternalis from pectoralis major has contributed to the extensive debate on the homology, particularly as to its possible origin from rectus abdominis.

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ACKNOWLEDGEMENTS

We wish to acknowledge the assistance of Mr J. Furey and Mr T. Hogan.

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