Thicknesses of the Iliac Crest Appropriate for Anterior Cervical Interbody Fusion Grafts

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Autogenous tricortical iliac crest bone graft is the most widely used for the anterior cervical interbody fusion procedure. The authors performed systematic measurements to delineate the thickest areas of the iliac crest, so that surgeons would know where to select the appropriate grafts for cervical interbody fusion. The Department of Anatomy, Faculty of Medicine, Khon Kaen University, supplied 232 iliac crests (116 left; 116 right) dried hip bones donated by 67 Thai males and 49 Thai females. The deceased averaged 59 years of age (range, 26-86). The thickest part of the iliac crest extended from 3 to 5 cm posterior to the ASIS and ranged between 15.59 and 17.02 mm. These regions have an appropriate thickness for harvesting graft material.

Keywords: *Anterior cervical interbody fusion, Iliac crest*

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Anterior Cervical Discectomy and Fusion (ACDF) is a common surgical procedure used to treat cervical spondylotic radiculopathy[1-9] and cervical myelopathy[10,11]. Interbody fusion is a frequently used adjunct treatment: 1) to help minimize post-operative morbidity, 2) to maintain cervical spinal alignment, 3) to eliminate potential instability, and 4) to preserve inter-space height and angulation; thereby reducing *post-operative neural foraminal compromise* following inter-space decompression[2]. Interbody fusion has proved to be safe and effective and has become the treatment of choice for patients with intractable and intolerable pain from cervical disc disease[3].

Utilization of a cortico-spongy bone graft from the iliac crest has been a good option for the reconstruction of the anterior portion of the spine because of its ability to support weight and its rapid integration with adjacent bone tissue[15]. The iliac crest is the most common donor iliac site because of easy access and copious amount of graft material[16], and has been shown to be superior both structurally and in bone turnover[17]. Autogenous iliac crest bone graft is reported as the most successful material, permitting successful fusion and graft stabilization[18].

The *Robinson Anterior Cervical Discectomy* and arthrodesis with tricortical iliac crest graft has proved to be safe and reliable for anterior cervical interbody fusion. Clinical series have demonstrated successful arthrodesis in 92 to 96% of patients after single-level ACDF with satisfactory clinical results[10,13]; good to excellent results can be expected in 89 to 90% of cases[14]. Tricortical iliac crest bone graft has significantly higher load-to-failure values and strength, and therefore is biomechanically preferred[12].

Despite some recent advances in bone substitute technology, autogenous bone grafts remain the gold standard in reconstructive surgery because of their osteo-in/conductive and non-immunogenic properties[19]. Specific data about the use of autogenous iliac crest bone graft will assist surgeons in selecting the proper site for successful arthrodesis. Ebraheim et al[20] reported the iliac crest has a non-uniform thickness; notwithstanding, Robinson et al, who proposed Robinson tricortical bone graft for anterior arthrodesis of cervical spine, made no recommendation for the site of iliac crest graft harvesting.

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Thus, the authors' aim was to determine the variable thicknesses of the iliac crest in Thais so that surgeons doing cervical interbody fusion would have a guide for choosing tricortical graft material of an appropriate thickness.

Material and Method

The Department of Anatomy, Faculty of Medicine, Khon Kaen University, supplied 232 dried hip bones donated from Thai adults; 116 left and 116 right, dried hip bones from the skeletons of 67 Thai males and 49 Thai females. The deceased averaged 59 years of age (range, 26-86).

The thickness of the iliac crest was measured bilaterally in 1-cm increments from the anterior superior iliac spine (ASIS) through the length of the iliac crest using a sliding caliper. Each measurement (Fig. 1) was repeated three times by three examiners to minimize the human error in measurement, then the mean and standard deviations were calculated. The difference between the left and right thicknesses of the iliac crest were analyzed using SPSS 9 for Windows (mean, Standard Deviation and 95% confidence interval). A p-value of less than 0.05 was considered statistical significant. The results are presented in Table 1.

Results

The thickest points of the iliac crest were 15.59 $\pm$ 2.34, 17.02 $\pm$ 2.53 and 16.13 $\pm$ 3.03 mm, at 3, 4 and 5 cm posterior to the ASIS, respectively (Table 1). The thickest part of the iliac crest was 17.02 $\pm$ 2.53 mm at 4 cm posterior to the ASIS, and there was no significant difference in this region between the right and left iliac crest.

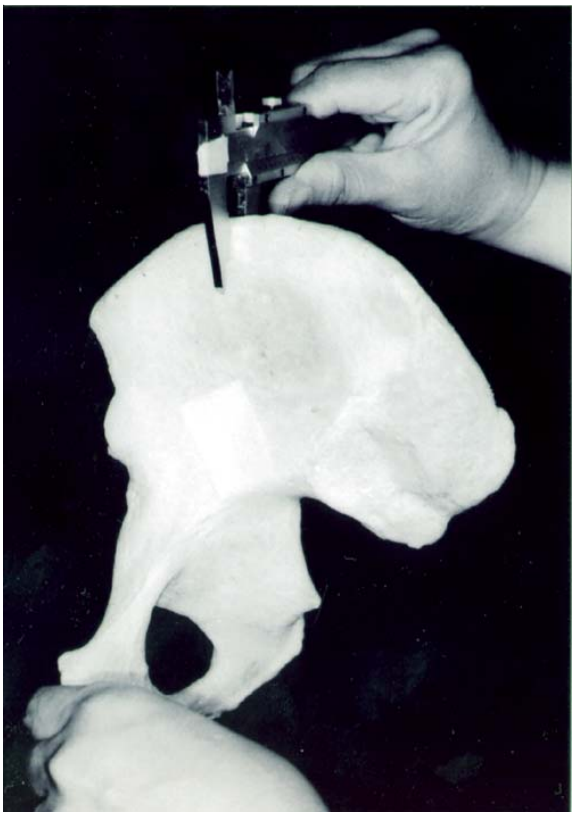

Fig. 1 The measurement of the thickness of the iliac crest

Table 1. Mean values of the thickness of the iliac crest in mm

cm posterior to the ASIS	Right (N=116) Mean	SD	Left (N=116) Mean	SD	Total Mean	SD	Difference Mean	SD	95%CI Lower	Upper	p value
1	14.02	2.02	13.42	2.32	13.72	2.19	0.60	1.83	0.26	0.93	0.001
2	14.12	2.24	14.11	2.26	14.12	2.25	0.01	1.55	-0.27	0.30	0.927
3	15.39	2.34	15.80	2.34	15.59	2.34	-0.41	1.91	-0.76	-0.06	0.023
4	17.04	2.43	17.00	2.63	17.02	2.53	0.04	2.10	-0.35	0.42	0.854
5	16.37	2.81	15.89	3.23	16.13	3.03	0.48	1.83	0.14	0.82	0.006
6	13.04	3.15	12.54	3.31	12.79	3.23	0.51	2.17	0.11	0.91	0.013
7	10.45	2.60	10.22	2.62	10.33	2.61	0.23	1.85	-0.11	0.57	0.183
8	9.13	1.81	9.05	1.86	9.09	1.83	0.07	1.90	-0.28	0.42	0.688
9	9.38	1.60	9.31	1.51	9.35	1.55	0.07	1.23	-0.16	0.29	0.557
10	10.30	1.93	10.52	1.91	10.41	1.92	-0.22	1.41	-0.48	0.04	0.096
11	11.98	2.03	12.50	2.30	12.24	2.18	-0.49	1.92	-0.87	-0.12	0.011
12	13.54	2.46	13.90	2.46	13.72	2.45	-0.39	1.56	-0.84	0.07	0.093
13	13.04	1.24	13.54	1.15	13.29	1.16	-0.50	1.86	-2.81	1.81	0.580

Discussion

Anterior cervical discectomy and fusion is an accepted procedure for patients presenting with cervical myelopathy or persistent radiculopathy, refractory to conservative treatment[11]. Autograft tricortical iliac crest bone was found superior to allograft bone as an interbody fusion substrate, after both single and multiple level anterior cervical decompression procedure with respect to the maintenance of cervical inter-space height and angulation, and the radiographic and clinical fusion success rates[8]. Tricortical bone grafts from the anterior bone part of the iliac crest are often used for anterior cervical spine fusion[20].

A review of the anatomy of iliac crest is essential to avoid any associated morbidity[21]. Kurz et al[22] reported that when approaching the outer table of the anterior ilium, the incision should stop 2 cm posterior to the ASIS to avoid the lateral femoral cutaneous nerve, the sartorius muscle, and the inguinal ligament, which attach there, and to avoid fracture of the ilium.

Hu et al[23] showed that removal of bone 30 mm posterior to the ASIS preserves 2.4 times more strength of the iliac crest compared with harvesting of bone graft 15 mm posterior to the ASIS; thus, they recommended that the anterior *vertical out* should be at least 3 cm posterior to the ASIS, based on their biomechanical analysis.

Ebraheim et al[20] reported that the thickness of the iliac crest was 10.6 ± 1.8, 11.7 ± 1.8 and 16.9 ± 2.3 mm at 2 and 3 cm posterior to the ASIS and at the iliac tubercle, respectively.

The present research showed that the thickness of the iliac crest was 15.59 ± 2.34, 17.02 ± 2.53 and 16.13 ± 3.03 mm at 3, 4 and 5 cm posterior to the ASIS, respectively. Thus, the present study corroborates that of Ebraheim et al that the thickest part of the iliac crest is the region around the iliac tubercle.

In conclusion, to prevent the morbidities associated with iliac crest graft harvesting, the authors recommend the area near the iliac tubercle 3, 4 and 5 cm posterior to the ASIS be used by orthopedists selecting graft material for anterior cervical spine fusion.

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Ethics

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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ความหนาของสันปีกกระดูกสะโพกที่เหมาะสมเพื่อเชื่อมกระดูกสันหลังคอทางด้านหน้า

กิมาพร ขมะณะรงค์, วีระชัย โควสุวรรณ, วินัย ศิริชาติวาปี, สุรชัย แซ่จึง, แก้วใจ เทพธรรมรัตน์

ในการผ่าตัดเชื่อมกระดูกสันหลังคอทางด้านหน้า แพทย์นิยมนำสันปีกกระดูกสะโพกมาทำ เนื้อเยื่อปลูกถ่ายอัตพันธ์ วัตถุประสงค์ของการศึกษานี้ เพื่อหาตำแหน่งความหนาของสันกระดูกปีกสะโพกที่เหมาะสม ในการนำไปใช้เชื่อมกระดูกสันหลังคอทางด้านหน้า โดยทำการวัดความหนาตลอดความยาวของสันปีกกระดูกสะโพก ในตำแหน่งที่ห่างจากยอดแหลมส่วนหน้าของสันปีกกระดูกสะโพกทุก 1 เซนติเมตร ทำการวัด 3 ครั้ง ในแต่ละตำแหน่ง และหาค่าเฉลี่ย ศึกษาจากกระดูกสะโพกแห้งจำนวน 232 ชิ้น ข้างขวา และซ้าย อย่างละ 116 ชิ้น จากเพศชาย 67 ร่าง และเพศหญิง 49 ร่าง อายุเฉลี่ย 59 ปี (ช่วงอายุ 26-86 ปี) จากการศึกษานี้พบว่าความหนาของสันปีกกระดูกสะโพกที่เหมาะสมในการผ่าตัดเชื่อมกระดูกไขสันหลังคอทางด้านหน้า อยู่ในตำแหน่งที่ 3-5 เซนติเมตร หลังต่อยอดแหลมส่วนหน้าของสันกระดูกปีกสะโพก โดยมีค่าความหนาเฉลี่ยอยู่ที่ช่วง 15.59-17.02 มิลลิเมตร