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Anatomical Variations of the Attachment Type of the Long Head of Biceps Brachii Tendon at the Glenoid Labrum in Thais

Variaciones Anatómicas del Tipo de Inserción del Tendón de la Cabeza Larga del Músculo Bíceps Braquial en el Labrum Glenoideo en Tailandeses

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SUMMARY: The long head of the biceps tendon (LHBT) originates from both the supraglenoid tubercle and the superior glenoid labrum. Variations in its attachment are clinically significant, as they influence the pathogenesis of superior labrum anterior posterior (SLAP) lesions and affect outcomes of arthroscopic shoulder procedures. The aim of the study was to identify the anatomical variations of LHBT attachment to the glenoid labrum in Thai cadavers and compare the findings with previous reports. A total of 156 shoulders from 78 embalmed Thai cadavers (43 males, 35 females; mean age 69.41 years) were dissected at the Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University. The type of LHBT attachment was classified according to the system of Vangsness Jr. *et al*. (1994). In cases where macroscopic identification was unclear, histological sections were examined. Type I (entirely posterior attachment) was the most common, observed in 148 shoulders (94.87 %). Type II (posterior-dominant) occurred in 6 shoulders (3.85 %), while Type III (equal anterior and posterior) and Type IV (anterior-dominant) were each found in one shoulder (0.64 %). The majority of attachments were oriented posteriorly at the 1 o'clock position in left shoulders and the 11 o'clock position in right shoulders. The LHBT in Thai cadavers demonstrates a predominantly posterior attachment pattern to the glenoid labrum, differing from earlier consensus studies. This knowledge may improve arthroscopic diagnosis, surgical planning, and postoperative outcomes in SLAP and Bankart repairs.

KEY WORDS: Biceps Brachii; Glenoid Labrum; Shoulder Joint; Cadaver; Anatomy.

INTRODUCTION

The long head of the biceps tendon (LHBT) originates from both the supraglenoid tubercle and the superior glenoid labrum, where its fibers blend variably into the labrum (Bain *et al*., 2013; Zappia *et al*., 2013). This attachment has been classified into four types by Vangsness Jr. *et al*. (1994): entirely posterior (Type I), posterior-dominant (Type II), equal anterior and posterior (Type III), and anterior-dominant (Type IV). Subsequent cadaveric studies across different populations confirmed these patterns with varying proportions, suggesting possible ethnic or geographic differences (Tuoheti *et al*., 2005; Reis *et al*., 2009; Chauhan *et al*., 2013; Alashkham *et al*., 2018).

The glenoid labrum increases the depth of the glenoid cavity and stabilizes the shoulder joint, while the LHBT contributes to stability and joint motion (Benninger, 2016; Mehl, 2018). Because of its intra-articular course, the LHBT is subjected to compressive and shear stresses, predisposing it to shoulder pathologies including tendonitis, rupture, and superior labrum anterior posterior (SLAP) lesions. SLAP tears, particularly Type II, are common in overhead athletes and represent a major cause of pain and dysfunction (Pal *et al*., 1991; LeVasseur *et al*., 2021; Varacallo *et al*., 2023). Their diagnosis remains challenging, as MRI findings may overlap with normal anatomical variants, and arthroscopy is often required for confirmation (LeVasseur *et al*., 2021).

Surgical repair of SLAP lesions and Bankart tears is influenced by the vascular supply of the labrum and the biomechanical significance of LHBT attachment types. The anterosuperior region is known to be relatively hypovascular, raising concern for healing potential after repair (Prodromos *et al*., 1990; Cooper *et al*., 1992; Abrassart *et al*., 2006; Alashkham *et al*., 2017). Moreover, tension on the anterosuperior labrum may alter the rotator interval and lead to postoperative stiffness (Arai *et al*., 2012). Patient factors

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such as age and metabolic disorders also influence healing outcomes (Della Rotonda *et al*., 2024).

Given these anatomical and clinical implications, further studies across different populations are valuable. The objective of this study was to investigate the attachment type of the LHBT to the glenoid labrum in Thai cadavers, determine the distribution of the four types, and compare the results with previous studies. Such data provide important baseline knowledge to guide diagnosis, arthroscopic procedures, and postoperative management.

MATERIAL AND METHOD

A total of 78 embalmed Thai cadavers (43 males and 35 females; mean age 69.41 years, range 23–98 years) were dissected at the Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. This yielded 156 shoulders (78 right and 78 left) for examination. All cadavers had been preserved in 10 % formalin solution. Included specimens were donated human cadavers preserved in 10 % formalin, available at the Department of Anatomy, Faculty of Medicine Siriraj Hospital, with an intact shoulder girdle permitting macroscopic assessment of the superior glenoid labrum and the proximal long head of the biceps tendon. Each shoulder (left and right) was treated as an individual sample when both were available. The exclusion criteria comprised shoulders with evidence of prior surgery, gross traumatic damage or severe deformity precluding reliable assessment, poor preservation or extensive postmortem degradation of the superior labrum or LHBT, and cases with advanced pathological changes that obscured native labral morphology. Should histological confirmation have been required but tissue blocks could not be obtained, the shoulder was excluded from analysis.

The attachment type of the long head of the biceps tendon (LHBT) to the superior glenoid labrum was classified according to the system of Vangsness Jr. *et al*. (1994): Type I: entirely posterior, Type II: posterior-dominant, Type III: equal anterior and posterior, Type IV: anterior-dominant.

Classification was performed independently by three observers (Sani Baimai, Sitha Piyaselakul, and Phattarapong Predapramote) in accordance with institutional review board approval. As this process can be subjective, the possibility of inter-observer variability should be acknowledged; however, formal assessment of inter-observer reliability was not undertaken in this study.

Dissection procedure: The skin of the upper limb was removed to expose the shoulder musculature. The deltoid, pectoralis major and minor, biceps brachii (short and long heads), triceps brachii, and teres major and minor muscles were reflected to visualize the glenohumeral joint. The superior labrum was then examined to determine the LHBT attachment type.

Histological analysis: In cases where macroscopic identification was uncertain, tissue blocks including the LHBT and superior labrum were excised. Samples were dehydrated in ethanol, cleared with xylene, embedded in paraffin, sectioned at 5 µm, and stained with hematoxylin and eosin for microscopic confirmation.

Ethical approval: This cadaveric study was conducted in accordance with institutional ethical standards and approved by the Siriraj Institutional Review Board (Certificate of Exemption No. 059/2561). The use of donated human cadavers was carried out with utmost respect, and the authors gratefully acknowledge the individuals and families who contributed their bodies for the advancement of medical education and research (Iwanaga *et al*., 2021).

RESULTS

A total of 156 shoulders were examined from 78 Thai cadavers (43 males and 35 females; mean age 69.41 years). Except for one cadaver aged 23 years, all were above 40 years at the time of death. The age distribution is summarized in Table I.

Using the classification of Vangsness Jr. *et al*. (1994), Type I (entirely posterior) was the most common attachment pattern, observed in 148 shoulders (94.87 %), followed by Type II in 6 shoulders (3.85 %), and Types III and IV in one shoulder each (0.64 %). The distribution by sex and side is presented in Table II. Representative examples of each type are shown in Figures 1 to 4.

Clock-face analysis revealed a predominant posterior orientation. On the left shoulder, attachment occurred at the 1 o'clock position in 93.59 % of cases and at 12 o'clock in 6.41 %. On the right shoulders, attachment was observed at the 11 o'clock position in 97.44 % and at 12 o'clock in 2.56 % (Table III).

Comparison with previous cadaveric studies from other populations is shown in Table IV, which demonstrates that the Thai population has a markedly higher prevalence of Type I attachments than reported in earlier American and Japanese studies, but similar to findings in Brazilian and Indian populations.

Histological analysis confirmed that LHBT fibers intermingle with the posterior labrum fibers at the attachment site, consistent with a strong posterior orientation (Fig. 5).

Table I. Demographic data of Thai cadavers in the present study.

	Age range (years)	Mean (years)	Maximum (years)	Minimum (years)
Male (n = 43)	23-92	70.91	92	23
Female (n = 35)	40-98	67.91	98	40
Total (n = 78)	23-98	69.41	98	23

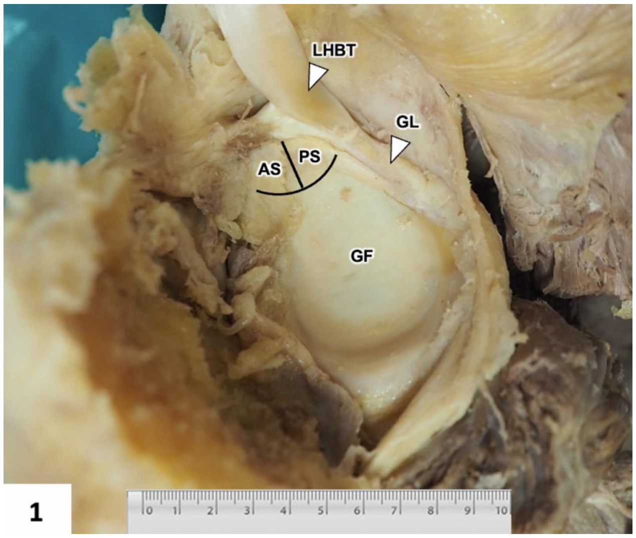

Fig. 1. This figure represents type I (entirely posterior) from the left shoulder of a female cadaver aged 83 years old. LHBT: long head of biceps brachii tendon, GL: glenoid labrum, GF: glenoid fossa, AS: anterior superior, PS: posterior superior.

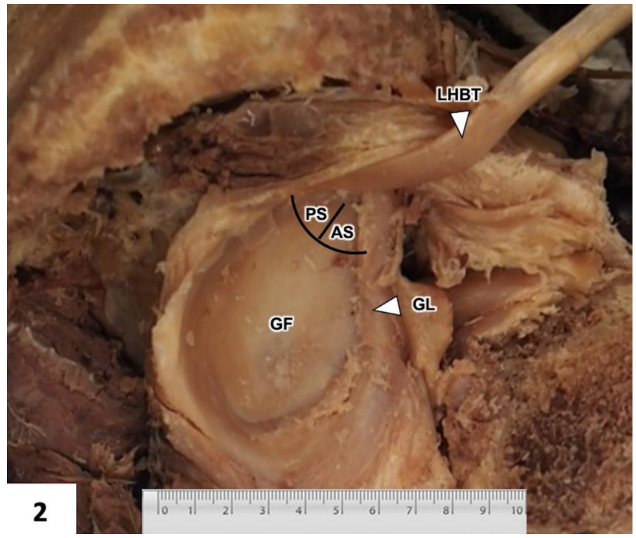

Fig. 2. This figure represents type II (posterior-dominant with some contributions from the anterior) from the right shoulder of a male cadaver aged 81 years old. LHBT: long head of biceps brachii tendon, GL: glenoid labrum, GF: glenoid fossa, AS: anterior superior, PS: posterior superior.

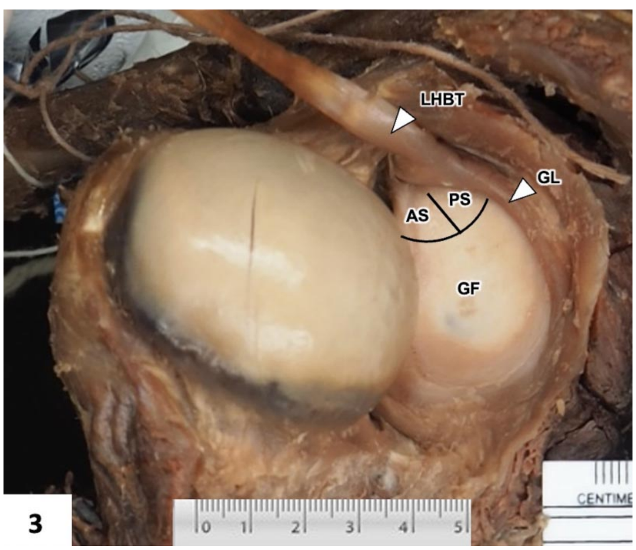

Fig. 3. This figure represents type III (equal contributions from posterior and anterior labrum) from the right shoulder of a male cadaver aged 23 years old. LHBT: long head of biceps brachii tendon, GL: glenoid labrum, GF: glenoid fossa, AS: anterior superior, PS: posterior superior.

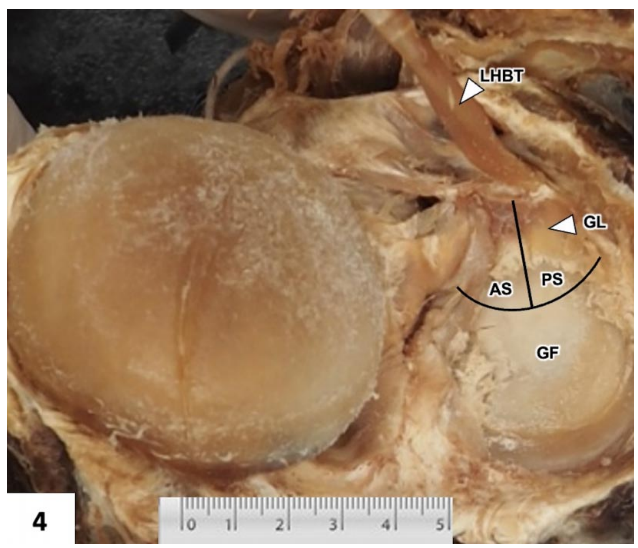

Fig. 4. This figure represents type IV (anterior-dominant with some contributions from the posterior labrum) from the left shoulder of a female cadaver aged 87 years old. LHBT: long head of biceps brachii tendon, GL: glenoid labrum, GF: glenoid fossa, AS: anterior superior, PS: posterior superior.

Table II. Long head of biceps tendon labral attachment type.

	Left shoulder (n = 78)				Right shoulder (n = 78)			
	Type I (%)	**Type II (%)**	**Type III (%)**	**Type IV (%)**	**Type I (%)**	**Type II (%)**	**Type III (%)**	**Type IV (%)**
Males (n = 86)	40 (93.02 %)	2 (4.66 %)	1 (2.32 %)	0 (0 %)	42 (97.67 %)	1 (2.33 %)	0 (0 %)	0 (0 %)
Females (n=70)	32 (91.43 %)	2 (5.71 %)	0 (0 %)	1 (2.86 %)	34 (97.14 %)	1 (2.86 %)	0 (0 %)	0 (0 %)
Total (n=156)	72 (92.31 %)	4 (5.13 %)	1 (1.28%)	1 (1.28 %)	76 (97.44 %)	2 (2.56 %)	0 (0 %)	0 (0 %)

Table III. Clock attachment of the long head of biceps tendon.

	Left shoulder (n = 78)			Right shoulder (n = 78)		
	11 o'clock (%)	**12 o'clock (%)**	**1 o'clock (%)**	**11 o'clock (%)**	**12 o'clock (%)**	**1 o'clock (%)**
Males (n = 86)	0 (0 %)	2 (4.65 %)	41 (95.35 %)	43 (100 %)	0 (0 %)	0 (0 %)
Females (n=70)	0 (0 %)	3 (8.57 %)	32 (91.43 %)	33 (94.29 %)	2 (5.71 %)	0 (0 %)
Total (n=156)	0 (0 %)	5 (6.41 %)	73 (93.59 %)	76 (97.44 %)	2 (2.56 %)	0 (0 %)

Table IV. Comparison of type percentage patterns across past studies.

Study	Number of shoulders	Country	Type I (%)	Type II (%)	Type III (%)	Type IV (%)
Present study	156	Thailand	94.87	3.85	0.64	0.64
Vangsness *et al*. (1994)	100	USA	22	33	37	8
Tuoheti *et al*. (2005)	101	Japan	27.7	55.4	16.8	0
Reis *et al*. (2009)	20	Brazil	95	0	0	0
Chauhan *et al*. (2013)	50	India	74	20	6	-
Alashkahm *et al*. (2018)	140	UK	47.7	31.5	16.2	4.6
N *et al*. (2019)	60	India	51.7	26.7	3.3	0

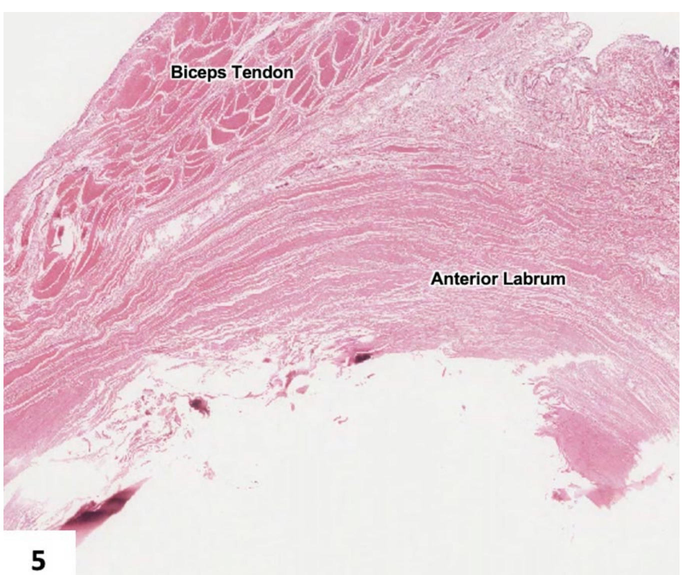

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Fig. 5. The histological result of type I (right side).

DISCUSSION

In this study of 156 shoulders from 78 Thai cadavers, the overwhelmingly predominant type of LHBT attachment was Type I (entirely posterior), observed in 94.87 % of specimens, while Types II, III, and IV together accounted for only ~5.13 %. This contrasts with several studies in other populations. For instance, Alashkham *et al*. (2018), examined 140 shoulders from Libyan/UK cadavers and reported Type I in 47.7 %, Type II in 31.5 %, Type III in 16.2 %, and Type IV in 4.6 %. Similarly, Lu *et al*. (2023), reported a more mixed distribution of attachment types in patients with rotator cuff tears, suggesting that clinical populations may reveal different patterns compared with cadaveric anatomy. Clinical studies such as Kim *et al*. (2013), further emphasized that variations in the biceps-labrum footprint can influence SLAP repair outcomes, underscoring the importance of population-specific anatomical knowledge.

Comparison with global data shows that in Japan, Tuoheti *et al*. (2005), reported a much more mixed distribution, with Types II and III more prominent and Type I representing only ~28 %. Histological examination, however, confirmed a posterior orientation even when anterior fibers were present. In Brazil, Reis *et al*. (2009), studied fetal specimens and found a higher proportion of mixed and posterior-dominant attachments. Similarly, in India, Chauhan *et al*. (2013), described variations where anterior and mixed attachments were more frequent than in our Thai sample. None of these reports demonstrated the extreme predominance of Type I seen in Thais. Recent scoping reviews (Diplock *et al*., 2023) have highlighted both the variability of labral attachment and the lack of standardized definitions across studies, complicating cross-population comparisons.

These differences may reflect ethnic or population-specific variation, but also methodological factors, such as differences in defining "anterior contribution," the application of histology, and specimen preservation. In Alashkham *et al*. (2018), although Type I was most common, nearly half of the shoulders still showed some anterior component (Types II–IV). In our Thai series, macroscopic attachments classified as Type I or posterior-dominant lacked detectable anterior contributions, aligning more with the posterior bias noted in some cadaveric cohorts.

Clinically, the posteriorly biased attachment pattern in Thais has several implications. Imaging (MRI or MR arthrography) may overestimate anterior labral contributions, leading to misclassification of mixed or anterior-dominant SLAP variants. Surgical planning for SLAP or Bankart repairs should therefore anticipate predominantly posterior attachment, with anchor placement and suture tensioning adjusted to adequately address posterior loading. Vascular considerations also remain critical, as highlighted by Prodromos *et al*. (1990), and others, who demonstrated regional variability in labrum blood supply that can affect healing.

Our findings of consistent clock-face orientation (~1 o'clock in left shoulders and ~11 o'clock in right shoulders) provide further practical guidance. This consistency supports more precise surgical planning in Thai patients, contrasting with more variable orientation patterns reported in mixed-attachment populations such as those described by Lu *et al*. (2023). Overall, these results highlight the need to consider both population-specific anatomy and methodological differences when interpreting and applying data on LHBT attachment.

LIMITATIONS

This study has several limitations that should be acknowledged. First, the majority of cadavers were elderly (mean age 69.41 years), and both age-related changes and the embalming process may alter tissue architecture, potentially reducing the visibility of delicate anterior fiber contributions. Second, histological analysis was only performed in specimens where macroscopic identification was unclear; therefore, subtle anterior fibers might have been overlooked when gross inspection alone was used. Third, while the classification of LHBT attachment was conducted independently by three observers, inter-observer reliability was not formally assessed, and some degree of subjectivity remains inherent in this process. Finally, the cadaveric nature of the study limits direct clinical correlation, as anatomical findings do not necessarily reflect the incidence of SLAP lesions, surgical repair outcomes, or functional consequences in living patients.

CONCLUSION

Given the dominance of Type I in Thai anatomy, clinicians should anticipate predominantly posterior attachments in interpreting imaging and operative findings. When planning arthroscopic SLAP or labral repairs, anchors and sutures placement should favor posterior labral regions even when anterior involvement seems present macroscopically. Rehabilitation programs should also consider posterior labral tissues bearing more load, especially in overhead or rotational elbow-extension activities. Preoperative counseling should reflect anatomical variation to set realistic expectations.

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BAIMAI, S.; KAENSA, C.; KOEDPUECH, K.; KITTIWANGCHAI, M. & SUBMANEEANANT, P. Variaciones anatómicas del tipo de inserción del tendón de la cabeza larga del músculo bíceps braquial en el labrum glenoideo en tailandeses. *Int. J. Morphol., 44(2)*:393-398, 2026.

RESUMEN: El tendón de la cabeza larga del músculo bíceps braquial (TCLMBB) se origina tanto en el tubérculo supraglenoideo como en la parte superior del labrum glenoideo. Las variaciones en su inserción son clínicamente significativas, ya que influyen en la patogenia de las lesiones SLAP (lesiones del labrum superior anterior y posterior) y afectan los resultados de los procedimientos artroscópicos de hombro. El objetivo del estudio fue identificar las variaciones anatómicas de la inserción del TCLMBB en el labrum glenoideo en cadáveres tailandeses y comparar los hallazgos con informes previos. Se disecaron un total de 156 hombros de 78 cadáveres tailandeses embalsamados (43 hombres, 35 mujeres; edad media 69,41 años) en el Departamento de Anatomía de la Facultad de Medicina del Hospital Siriraj de la Universidad Mahidol. El tipo de inserción delTCLMBB se clasificó según el sistema de Vangsness Jr. *et al*. (1994). En los casos en que la identificación macroscópica no fue clara, se examinaron secciones histológicas. El tipo I (inserción completamente posterior) fue el más común, observado en 148 hombros (94,87 %). El tipo II (predominante posterior) se presentó en 6 hombros (3,85 %), mientras que el tipo III (anterior y posterior iguales) y el tipo IV (predominante anterior) se encontraron en un hombro cada uno (0,64 %). La mayoría de las inserciones se orientaron posteriormente, en la posición de la 1 en punto en los hombros izquierdos y en la de las 11 en punto en los hombros derechos. El tendón TCLMBB en cadáveres tailandeses muestra un patrón de inserción predominantemente posterior al labrum glenoideo, a diferencia de estudios previos consensuados. Este conocimiento puede mejorar el diagnóstico artroscópico, la planificación quirúrgica y los resultados postoperatorios en las reparaciones de lesiones SLAP y Bankart.

PALABRAS CLAVE: Bíceps braquial; Labrum glenoideo; Articulación del hombro; Cadáver; Anatomía.

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