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CASE REPORT

RARE ORIGIN OF THE THIRD HEAD OF BICEPS BRACHII MUSCLE, ITS CLINICAL SIGNIFICANCE, REVIEW ON INCIDENCE AND CLINICAL APPLICATION

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ABSTRACT

The anatomical variations of the biceps brachii muscle are well-known and well-documented. Awareness of these variations is necessary to avoid complications during radio diagnostic procedures or surgeries in the arm. The biceps brachii muscle is one of the most variable muscles in the human body, in terms of the number and morphology of its heads.

Thus, the anatomical variations and gross innervations pattern of the biceps brachii muscle were studied in the present work by using 62 arms from 31 adult cadavers. Among 62 studied arms, 26 arms (41.9%) were males, and 36 arms (58.1%) were females.

During the study, the third head was found in seven out of 62 arms (11.3%). It was found that four out of 26 studied male biceps muscles (15.4%) revealed third heads while three out of 36 studied female biceps muscles (8.3%) revealed third heads. Also, third head prevalence among male subjects was found to be nearly doubled than those of female subjects. It was found that three out of 31 left-sided biceps muscles (9.3%) included third heads while four out of 31 right-sided biceps muscles (12.9%) included third heads. So, the third head prevalence on the right side was found to be higher than that of the left side. Bilateral third heads were found in two out of 31 cadavers (6.4%) and three out of 31 studied cadavers (9.6%) had unilateral third heads.

There were three types of variations encountered in the origin of the third head. They could be categorized as (1) infero-medial humeral origin was found in five arms (71.4%), (2) infero-lateral humeral origin was found in one arm (14.3%), (3) coracoid origin was found in one arm (14.3%). The third head originated from the coracoid process of scapula together with the short head of biceps brachii was a rare variant found by Macalister in 1875. In the present study, it was found in one out of seven third heads (14.3%). Based on the current literature review, it was the first time to find this rare origin of the third head since the day of the Macalister. Understanding of such variations is helpful in preoperative diagnosis and surgery of the upper limb.

Keywords: **Biceps brachii, Anatomical variations**
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INTRODUCTION

Biceps brachii derives its name from its two proximally attached parts or heads. The short head arises by a thick flattened tendon from the coracoid apex together with coracobrachialis. The long head starts within the capsule of the shoulder joint as a long narrow tendon, running from the supraglenoid tubercle of the scapula at the apex of the glenoid cavity, where it is continuous with the glenoidal labrum. The two tendons lead into elongated bellies that although closely applied, can be separated to within the 7 cm or so of the elbow joint. At this joint they end in a flattened tendon, which is attached to the rough posterior area of the radial tuberosity; a bursa separates the tendon from the smooth anterior area of the tuberosity. Biceps brachii is innervated by musculocutaneous nerve, C5 and C6 with separate branches passing to each belly. It is a powerful supinator, that flexes the elbow, most effectively with the forearm supinated

[Standring S 2008].The biceps brachii was one of the most variable muscles in the human body, in terms of the number and morphology of its heads (Testut and Latarjet, 1944; Khaledpour, 1985; Kosugi et al 1992; Tountas and Bergman, 1993; Neto et al 1998). One of the most common variations of biceps brachii is the existence of the third head (Greig, et al, 1952; Swieter and Carmichal, 1980; Asvat et al., 1993; Sargon et al, 1996; Nakatani et al, 1998 and Szewczyk et al 2022).The accessory heads of the biceps brachii had been described to have three, four and five heads (Testut, 1883; Herve, 1889; Le Double, 1897; Stolowsky, 1899; Pires de Lima, 1923; Swieter and Carmichael, 1980; Bergman et al, 1988; Kosugi et al, 1992; Asvat et al, 1993; Nakatani et al, 1997; El-Naggar and Zahir, 2001; Rodríguez-Niedenführ *et al* 2003; Vazquez T et al 2003; Schoenleber, 2006; Nayak S.R et al 2008).

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CASE REPORT AND OBSERVATIONS

During the dissection of the upper limb for the research study of the variations of biceps brachii muscle in human adults, this is the rare origin of the third head of biceps brachii muscle originated from the coracoid process (duplication of short head) and inserted into the common muscle belly in the right arm. (Fig.1). In this case report, the third head of biceps brachii originated from the coracoid process, it might be considered as a duplication of the normal short head, it was a rare variant found by Stolowsky (1899) and Macalister (1875). Based on the current literature review, it was the first time to find this rare origin of the third head since the day of the Macalister.

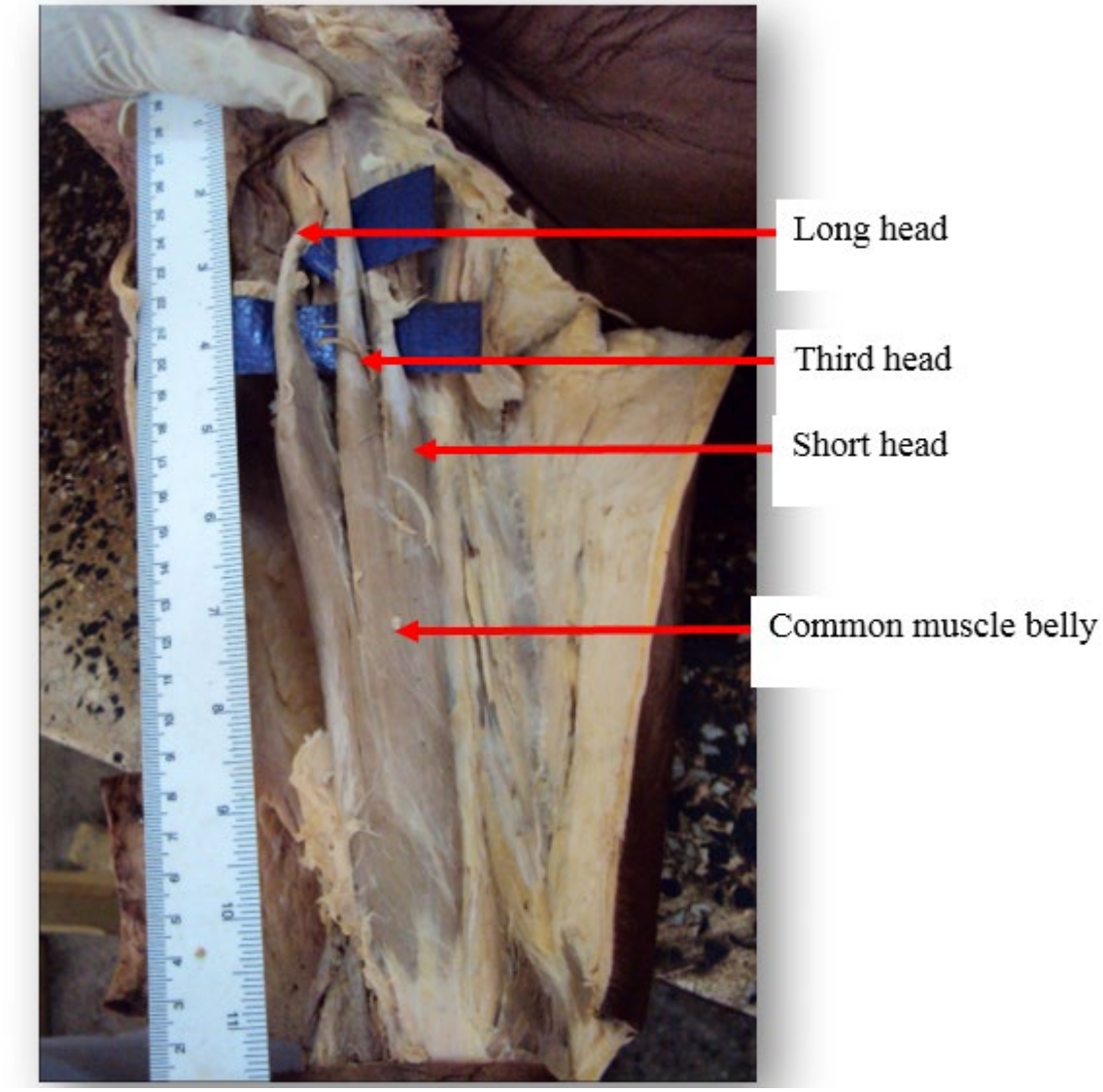

Figure 1: Photograph showing third head of biceps brachii muscle originated from the coracoid process (duplication of short head) and inserted to common muscle belly in right arm. (Cadaver No 7, female).

DISCUSSION

The incidence of the accessory head of the biceps brachii muscle in different races together with the names of the authors were listed in the table 1. The overall incidence ranged from 0.65%-3%. The incidence of the third head of the biceps brachii muscle varied greatly among the different populations and was described by many authors, (Table 1). Biceps brachii has been stated as one of the muscles that show frequent anatomical variations (Testut & Latarjet, 1981; Asvat et al., 1993; Nakatani et al., 1998; Nayak et al., 2008). Some of its reported anomalies have been manifested as accessory fascicles that originate from the coracoid process, tendon of the pectoralis major, articular capsule, and head of the humerus or from the humerus itself (Sargon et al., 1996). Among those variations, the presence of an accessory fascicle arising from the shaft of the humerus, which is known as the humeral head of biceps brachii,

is known to be the most common anomaly (Khaledpour; 1985; Asvat et al.; Kopuz et al., 1999). Multiple accessory heads of four to seven have also been reported to a lesser extent (Asvat et al.1993; Nakatani et al.1998; Williams et al.2000; Nayak et al.2008). The study of Kosugi et al (1992) found that a third head was more common in females, but Asvat et al, (1993) observed that a third head was more common in males and Greig et al (1952) reported no difference between sex. Rodríguez-Niedenführ *et al* (2003)., classifies the origin of the accessory heads of the biceps brachii muscle according to their location, as a (1) superior humeral head, (2) inferomedial and (3) inferolateral and (4) other supernumerary heads. The superior humeral head presents a proximal attachment on the surface of the humerus, between the lesser tubercle, the brachial, and the coracobrachialis muscles. Then it continues inferiorly, deep to the short head of the biceps brachii muscle and superficial to the anterior humeral circumflex artery, and merges with muscle fibers of the short head of the biceps brachii muscle in its join with the long head. The inferomedial head has a proximal attachment in the anteromedial surface of the humerus, continues with the insertion of the coracobrachialis muscle, and is closely related to the medial intermuscular septum and brachial muscle; then continues inferiorly, deep to the biceps brachii muscle and superficial to the brachial muscle, inserting in the medial border of the biceps brachii tendon.

The inferolateral head originates in the lateral intermuscular septum, between the insertion of the deltoid and the origin of the brachioradialis muscle, and joins to the long head of the biceps brachii muscle at the level of the lower third of the arm.The most frequently reported cases were a combination of normal long or short heads with either an infero-medial, a superior, or an infero-lateral humeral head. Cases reported previously, including a biceps brachii muscle with up to seven heads, might be considered as combinations of the superior, infero-medial, and infero-lateral humeral heads together with duplication of the long or short head (Rodriguez-Vazquez et al, 1999). Other supernumerary heads (a) the supernumerary head originated from the coracoids process or pectoralis minor, it might be considered as duplication of the normal short head (Macalister, 1875; Stolowsky, 1899), (ii) the supernumerary head originating with the long head of the biceps brachii, might consider as duplication or segmentation of the long head (Macalister, 1875; Stolowsky, 1899). In this case report the third head of biceps brachii originated from the coracoid process, it might be considered as a duplication of the normal short head, it was a rare variant found by Stolowsky (1899) and Macalister (1875). As the anatomical variations of the biceps brachii were well known and well documented, awareness of these variations was necessary to avoid complications during radio-diagnostic procedures and surgery of the arm (Kosugi et al, 1986; Bergman et al, 1988; Nakatani et al, 1997 and Neto et al, 1998).

Author	**Population**	**Incidence**	**Sample size**
Rincon et al, 2020	Colombian	37.5%	32 arms
Szewczyk et al, 2022	Poland (European)	26%	100 limbs
Greig et al, 1952	North American	22%	130limbs
Asvat et al, 1993	South African blacks	20.5%	73 cadavers
Santo Neto et al 1998	Brazilian white	20%	100 limbs
Rodríguez et	Spain	15.4%	175 cadavers

al., 2003			
Kopuz et al., 1999	Turkish	15%	120limbs (neonate), 40limbs (adults)
Kosugi et al, 1992	Japanese	13.7%	546 limbs
Poudel PP 2009	Nepalese population	12.5%	32 limbs
Bergman et al, 1988	African Black	12%	
Bergman et al, 1988	European white	10%	
Mya Thein Shin (2011)	Myanmar	11.3%	62 arms
Santo Neto et al 1998	Brazilian black	9%	100 limbs
Silva, 1926	Portuguese	8.6%	
Asvat et al, 1993	South African whites	8.3%	12 cadavers
Bergman et al, 1988	Chinese	8%	
Rai et al (2007)	Indian	7.1%	84limbs
Ilayperuma, 2011	Sri Lankan	3.7%	270limbs
Kumar et al., 2008	India	3.33%	96 limbs
Khaledpour, 1985	Iranian/European white	0.65%	552 limbs

Table 1: Incidence of the supernumerary head of biceps brachii.

Clinical application

The third head may provide additional strength to the biceps during supination of the forearm and elbow flexion irrespective of shoulder position (Swieter and Carmichal, 1980). The presence of the third head may cause unusual bone displacement, after fracture; such variations have relevance in surgical procedures (Greig et al, 1952; Swieter and Carmichael, 1980). Knowledge of the existence of the third head of the biceps brachii may become significant in preoperative diagnosis and during surgery of the upper limbs (Kopuz et al., 1999).Biceps brachii has a very important role in plastic surgeries and an additional head has added value in flap surgeries according to unilateral variations in the biceps brachii can cause asymmetry between two arms and hence, can be confused with pathological conditions such as tumors (Mustafa et al, 1996, Nayak et al, 2006).The anatomic variation of biceps brachii would be beneficial, especially to orthopedic surgeons who might be aware of it and discovered it during the routine elevation of the deltoid insertion, as part of humeral fracture fixation or shoulder arthroscopy (Mariani et al, 1997; Yeh et al, 1999). The accessory bellies of the biceps brachii muscle usually lay deep or lateral to the median nerve or brachial artery, but superficial to them might produce clinical entrapment syndrome (Khaledpour, 1985; Asvat et al, 1993 and Nakatani et al, 1998). The clinical symptoms were very similar to pronator and carpal tunnel syndrome, which were entrapment neuropathy of the median nerve (Sunderland, 1978; Khaledpour, 1985; Asvat et al, 1993; Nakatani et al, 1997). The awareness of these variations and their CT and MRI (Magnetic Resonance Imaging) presentations would increase the accuracy of the CT and MRI diagnosis, and this potentially helped to avoid unnecessary

surgery. (Gaskin et al, 2007 and Vollala et al, 2008).Rodriguez-Niedenfuhr et al (2003) described concomitant variations of the musculocutaneous nerve, which ran behind, in front, or even through the accessory muscle bundle of the biceps brachii. This intramuscular course of a nerve was a potential compression site.

Conclusion: There are numerous variations seen in biceps brachii which can put a surgeon in dilemma, and it may result in iatrogenic injuries. It may become significant in preoperative diagnosis and during surgery of the upper limb in diagnosing the nerve impairments as the bulky additional heads may compress the musculocutaneous nerve. Hence, it is important to have some knowledge about its variations so that such injuries can be prevented.

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I want to thank those who donated their bodies to science so that anatomical research could be performed. The results from such research can potentially increase mankind's overall knowledge which can then improve patient care. Therefore, these donors and their families deserve our highest gratitude.

Ethical Approval

The cadavers belonged to the Department of Anatomical Dissection and Donation, University of Medicine, Yangon, Myanmar.

Conflicts of Interest

I declare that we have no competing interests.

REFERENCES

1. Asvat R, Candler P, Sarmiento EE. 1993. High incidence of the third head of biceps brachii in South African populations. J. Anat 182: 01-4
2. Bergman R A, Thompson SA, Afifi AK and Saadeh F.A. 1988. Compendium of human anatomic variation. 1st ed. Urban and Urban & Schwarzenberg, Baltimore-Munich. 11
3. Bergman R A, A. K. Afifi, and R. Miyauchi, Illustrated encyclopedia of human anatomic variations, Anatomy Atlas, 2017.
4. El-Naggar MM, Zahir FI. 2001. Two bellies of the coracobrachialis muscle are associated with a third head of the biceps brachii muscle. Clin Anat 14:379–382.
5. Dobson, G.E. (1881) Notes on the anatomy of Cercopithecus callithichus. *Proc Zool Soc*, London; p 812-8.
6. Gaskin, E., Golish, S.R., Blount, K.J. (2007) Anomalies of the long head of biceps brachii tendon: clinical significance, MRI findings, and arthroscopic correlation. *Skeletal Radiol*: 36: 785-9.
7. Greig HW, Anson BJ and Budinger JM. Variations in the form and attachments of the biceps brachii muscle. Q Bull Northwest Univ Med Sch 1952; 26:241-243.
8. Ilayperuma I, Nanayakkara G, Palahepitiya N. 2011. Incidence of the humeral head of biceps brachii muscle – Anatomical insight. Int. J. Morphol 29:221-225
9. J. Wood, "On human muscular variations and their relation to comparative anatomy," Journal of Anatomy and Physiology, vol. 1, no. 1, pp. 44–59, 1867.
10. Kervancioglu, P. & Orhan, M. An anatomical study on the three-headed biceps brachii in human fetuses, and clinical relevance. *Folia Morphol., (Warsz.), 70(2)*:116-20, 2011.
11. Khaledpour C. Anomalies of the biceps muscle of the arm. *Ant Anz.* 1985; 158:79–
12. 85. [PubMed] [Google Scholar]
13. Kopuz C, Sancak B, Ozbenli S. 1999. On the incidence of the third head of biceps brachii in Turkish neonates and adults. Kaibogaku Zasshi 74: 301-5
14. Kosugi K, Shibata S and Yamashita H. 1992. Supernumerary head of biceps brachii and
15. branching pattern of the musculocutaneous nerve in Japanese. Surg and Radiol: anatomy 14:175-185.

16. Kumar H, Das S, Rath G. 2008. An anatomical insight into the third head of the biceps brachii muscle. Bratisl Lek Listy 109: 76-8
17. Macalister, "Observations on the muscular variations in the human anatomy. Third series with a catalog of the principal muscular variations hitherto published," Macalister, vol. 25, pp. 1–134, 1875.
18. Mariani, P.P., Bellelli, A., Battieela, C. (1997) Arthroscopic absence of the long head of biceps tendon. Arthroscopy; 13: 499 – 501.
19. Mooney EK Loh C. Hand Embryology Gross Morphologic Overview of Upper Limb Development. Source – http://emedicine.medscape.com/article/1287982-overview)
20. Mustafa, F., Sargon, D., Tucali, D. (1996) An unusual origin of the accessory head of biceps brachii muscle. *Clinical Anatomy*. 9: 160-162.
21. Nakatani T, Tanaka S, Mizukami S. 1998. Bilateral four-headed biceps brachii muscles: the median nerve and brachial artery passing through a tunnel formed by a muscle slip from the accessory head. Clin. Anat 11: 209-12
22. Nayak, S.R., Prabhu, L.V., Sinvanandan, R, (2006) Third head of biceps brachii; A rare occurrence in the Indian population. *Ann Anat* : 188 (2): 159- 161.
23. Nayak SR, Krishnamurthy A, Ramanathan LA. Multiple muscular anomalies of the upper extremity: a cadaveric study. *Rom J Morphol Embryol.* 2008;49(3):411–415. [PubMed] [Google Scholar]
24. Nayak S. R., Krishnamurthy Ashwin, S.J Kumar Madhan, V. Prabhu Latha, Saralaya
25. Vasudha and M. Thomas Merin. 2008. Four-headed biceps and triceps brachii muscles with neurovascular variation. Anat Sci International 83: 107-111
26. Neto, H.S., Camilli, J.A., Andrade, J.C.T. (1998) On the incidence of the third head of biceps brachii in Brazilian whites and blacks. *Ann Anat:* 180:69-71.
27. Pires de Lima, J. A. (1923) Sur La frequence de quelques anomalies muscularies chez les portugais.*C R Hebdomadaries Seanc Mem Soc Biol.* 88: 1329-1330. (Cited from Rodriguez et al,2003).
28. Poudel PP, C Bha Harai 2009. Study on the supernumerary heads of biceps brachii muscle in Nepalese. Nepal Med Coll J.2009 Jun;11(2):96-8
29. Primrose, A, (1899) *The anatomy of organg-outang (Sima Satyrus).* Transcrips of the Royal Society, Canadian Institute .6:507-598.
30. Rai, R.; Ranade, A. V.; Prabhu, L. V. & Prakash, M. M. P. Third head of Biceps brachii: A study in Indian population. Singapore Med. J., 48:929-31, 2007.
31. Rincon F, Rodriquez IZ, Sanchez A, Leon A, González L. The anatomic characteristics of the third head of the biceps brachii muscle in the Columbian population. *Rev Chil Anat.* 2002;20(2):197–200.
32. Rodríguez-Niedenführ M, Vazquez T, Choi D, Parkin I, Sanudo JR. 2003. Supernumerary humeral heads of the biceps brachii muscle revisited. Clin Anat 16:197–203
33. Rodriguez – Niedenfuhr, M; Parkin, I; Sanudo, J.R (2003). A rare case of the four-headed biceps brachii muscle with a double piercing musculocutaneous nerve*. Surg Radiol Anat;* 25,462-4.
34. Rodríguez-Vázquez JF, Mérida-Velasco JR, Jiménez-Collado J. Unusual variation of a third head of the biceps brachii muscle. Ann Anat 1999; 181:573-5.
35. Swieter, M.G and Carmichael. (1980) Bilateral three-headed biceps brachii muscle. *Anat.Anz.*148:346-349.
36. Schoenleber, S.J., Spinner, R.J. (2006) An unusual variant of biceps brachii. *ClinAnat*.19:702-703.

37. Schwalbe, G., Pftzner, W. (1889) Varietaten, Statistik und Anthropologie, Erste Mitteilung.*Anat Anz* 4: 705-714.
38. Silva, L M (1926). Da bcipite braquial, Tese de Doctoramento, *Portugais.Soc.Biol.*, Comptes Rendus: 95: 309-319.
39. Sonntag, C.F. (1924) Anatomy, physiology, and pathology of the chimpanzee. Proc Zool Soc; 24: 349-449.
40. Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, et al. *Gray's Anatomy*: The Anatomical Basis of Clinical Practice. 40thedition, London: Elsevier Ltd., 2008: 825-826.
41. Stolowsky (1899) Drei Seltene Anomalien des m. biceps brachii. *Anat Hefte*; 12 :300-35).
42. Sunderland, S. (1978) *Nerves and Nerves injuries*. 2nd ed. Edinburgh, London and New York; Churchill Livingstone: p 656-727.
43. Swieter M.G and Carmichael S.W. 1980. Bilateral three–headed biceps brachii muscles. Anat. Anz 148: 346-9
44. Szewczyk B, Jose Ramon Sanudo, Michał Podgórski,Nicol Zielinska, Maria Bettencourt Pires, Paloma Aragonés,[5]and Łukasz Olewnik, a proposal for a New Classification of the Biceps Brachii Muscle, Biomed Research International
Volume 2022 | ArticleID 1510363 | https://doi.org/10.1155/2022/1510363
45. Tamura, H (1971) Case of the brachial biceps with two accessory heads in each. *Acta Anat Nippon* 46:12-16.
46. Testut. L and Latarjet A. 1981. Compendio de anatomia descriptive.22nd ed. Buenos Aires. Salvat.
47. Tountas, C.H.P; Bergman, R.A (1993) *Anatomic Variation of the Upper Extremity*. Churchill Livingstone, New York: p 97-99.
48. Vallois, H.H.V. (1926) Dissection d'un Noir de la Martinique. Revue d' Anthropology, Paris: p 407.
49. Vazquez T, Rodriguez-Niedenfuhr M, Oarkin I and Sanudo JR. 2003. A rare case of a four headed biceps brachii muscle with a double piercing by the musculocutaneous nerve. Surg and Radiol: Anatomy 25: 5-6.
50. Yeh, L.; Pedawitz, R.; Kwak, S. (1999) Intracapsular origin of the long head of biceps tendon. *Skeletal Radiol*; 28: 178-81.)
51. Vijayabhaskar P, Baral P, Vaishya R, Shrestha RN. Supernumerary head of biceps brachii: a
52. rare occurrence in the Nepalese population. Kathmandu Univ Med J 2008; 6:225-7.
53. Vollala, V.R., Bhat, S.M., Potu, B.K., Rodriguez, V. (2008) Multiple accessory structure
54. structures in the upper limb of a single cadaver. *Singpore Med*; 49 (9): e 254.