ABOUT JCMR

The Journal of Clinical Medicine and Research (JCMR) is published monthly (one volume per year) by Academic Journals.

Journal of Clinical Medicine and Research (JCMR) is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as cardiology, critical care medicine, Family Medicine, geriatrics, pediatrics etc.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JCMR are peer-reviewed.

Submission of Manuscript

Submit manuscripts as e-mail attachment to the Editorial Office at: jcmr@academicjournals.org. A manuscript number will be mailed to the corresponding author shortly after submission.

For all other correspondence that cannot be sent by e-mail, please contact the editorial office (at jcmr@academicjournals.org).

The Journal of Clinical Medicine and Research will only accept manuscripts submitted as e-mail attachments.

Please read the Instructions for Authors before submitting your manuscript. The manuscript files should be given the last name of the first author.
Editors

Prof. Neveen Helmy Ahmed Aboelsoud,  
Complementary Medicine Researches & Applications (CAM),  
National Research Center,  
Research St (Tahrir),  
Dokki, Cairo,  
Egypt.

Prof. Bodh Raj Panhotra,  
Department of Medical Microbiology,  
Medical Laboratory Technology & Clinical Sciences,  
Sardar Bhagwan Singh Postgraduate Institute of Biomedical Sciences & Research,  
Balawala, Dehradun,  
India.

Editorial Board

Prof. Ahmed BaHammam,  
King Saud University,  
Saudi Arabia.

Dr. Ellen Rosskam,  
Senior Scholar, Woodrow Wilson International Center for Scholars,  
Washington, D.C.,  
Adjunct Professor, University of Massachusetts, Lowell,  
Visiting Senior Fellow, University of Surrey,  
Faculty of Health and Medical Sciences, England,  
Switzerland.

Dr. Philippe Connes,  
National Institute of Health and Medical Research (763),  
Academic Hospital of Pointe a Pitre,  
Guadeloupe (French West Indies),  
Guadeloupe.

Dr. Robert G Bota,  
University of Missouri,  
Kansas City,  
USA.

Dr. Haiyang Zhou,  
Department of General Surgery,  
Changzheng Hospital,  
Second Military Medical University,  
China.

Dr. Jimmy Jose,  
SAC College of Pharmacy, Karnataka,  
India.

Dr. Carlos A. Feldstein,  
Hospital de Clinicas Jose de San Martin,  
Av. Cordoba 2351 Buenos Aires 1120,  
Argentina.

Dr. Fadia Mostafa Attia,  
Faculty of Medicine,  
Suez Canal University,  
Egypt.

Dr. Hamza Mujagic,  
Massachusetts General Hospital,  
USA.

Dr. O.U.J. Umeora,  
Ebonyi State University/Teaching Hospital,  
Nigeria.
Instructions for Author

Electronic submission of manuscripts is strongly encouraged, provided that the text, tables, and figures are included in a single Microsoft Word file (preferably in Arial font).

The cover letter should include the corresponding author’s full address and telephone/fax numbers and should be in an e-mail message sent to the Editor, with the file, whose name should begin with the first author’s surname, as an attachment.

Article Types
Three types of manuscripts may be submitted:

Regular articles: These should describe new and carefully confirmed findings, and experimental procedures should be given in sufficient detail for others to verify the work. The length of a full paper should be the minimum required to describe and interpret the work clearly.

Short Communications: A Short Communication is suitable for recording the results of complete small investigations or giving details of new models or hypotheses, innovative methods, techniques or apparatus. The style of main sections need not conform to that of full-length papers. Short communications are 2 to 4 printed pages (about 6 to 12 manuscript pages) in length.

Reviews: Submissions of reviews and perspectives covering topics of current interest are welcome and encouraged. Reviews should be concise and no longer than 4-6 printed pages (about 12 to 18 manuscript pages). Reviews are also peer-reviewed.

Review Process
All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers. Authors cannot nominate reviewers. Only reviewers randomly selected from our database with specialization in the subject area will be contacted to evaluate the manuscripts. The process will be blind review. Decisions will be made as rapidly as possible, and the journal strives to return reviewers’ comments to authors as fast as possible. The editorial board will re-review manuscripts that are accepted pending revision. It is the goal of the JCMR to publish manuscripts within weeks after submission.

Regular articles
All portions of the manuscript must be typed double-spaced and all pages numbered starting from the title page. The Title should be a brief phrase describing the contents of the paper. The Title Page should include the authors’ full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

The Abstract should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The Abstract should be 100 to 200 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited. Following the abstract, about 3 to 10 key words that will provide indexing references should be listed.

A list of non-standard Abbreviations should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelled out and introduced in parentheses the first time it is used in the text. Only recommended SI units should be used. Authors should use the solidus presentation (mg/ml). Standard abbreviations (such as ATP and DNA) need not be defined.

The Introduction should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and methods should be complete enough to allow experiments to be reproduced. However, only truly new procedures should be described in detail; previously published procedures should be cited, and important modifications of published procedures should be mentioned briefly. Capitalize trade names and include the manufacturer’s name and address. Subheadings should be used. Methods in general use need not be described in detail.
Results should be presented with clarity and precision. The results should be written in the past tense when describing findings in the authors’ experiments. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the Results but should be put into the Discussion section.

The Discussion should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

The Acknowledgments of people, grants, funds, etc should be brief. Tables should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, including headings and footnotes. Each table should be on a separate page, numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text. The details of the methods used in the experiments should preferably be described in the legend instead of in the text. The same data should not be presented in both table and graph form or repeated in the text.

Figure legends should be typed in numerical order on a separate sheet. Graphics should be prepared using applications capable of generating high resolution GIF, TIFF, JPEG or Powerpoint before pasting in the Microsoft Word manuscript file. Tables should be prepared in Microsoft Word. Use Arabic numerals to designate figures and upper case letters for their parts (Figure 1). Begin each legend with a title and include sufficient description so that the figure is understandable without reading the text of the manuscript. Information given in legends should not be repeated in the text.

References: In the text, a reference identified by means of an author’s name should be followed by the date of the reference in parentheses. When there are more than two authors, only the first author’s name should be mentioned, followed by ‘et al’. In the event that an author cited has had two or more works published during the same year, the reference, both in the text and in the reference list, should be identified by a lower case letter like ‘a’ and ‘b’ after the date to distinguish the works.

Examples:

Nishimura (2000), Agindotan et al. (2003), (Kelebeni, 1983), (Usman and Smith, 2001), (Chege, 1998; Stein, 1987a,b; Tijani, 1993,1995), (Kumasi et al., 2001)

References should be listed at the end of the paper in alphabetical order. Articles in preparation or articles submitted for publication, unpublished observations, personal communications, etc. should not be included in the reference list but should only be mentioned in the article text (e.g., A. Kingori, University of Nairobi, Kenya, personal communication). Journal names are abbreviated according to Chemical Abstracts. Authors are fully responsible for the accuracy of the references.

Examples:


Case Studies

Case Studies include original case reports that will deepen the understanding of general medical knowledge.

The Title should be a brief phrase describing the contents of the paper. The Title Page should include the authors' full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

The Abstract should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The Abstract should be 100 to 200 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited.

Following the abstract, about 3 to 10 key words that will provide indexing references should be listed.

A list of non-standard Abbreviations should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelled out and introduced in parentheses the first time it is used in the text. Only recommended SI units should be used. Authors should use the solidus presentation (mg/ml).

The Introduction should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines. The presentation of the case study should include the important information regarding the case. This must include the medical history, demographics, symptoms, tests etc. Kindly note that all information that will lead to the identification of the particular patient(s) must be excluded.

The conclusion should highlight the contribution of the study and its relevance in general medical knowledge.

The Acknowledgments of people, grants, funds, etc should be brief.

References: Same as in regular articles.

Short Communications

Short Communications are limited to a maximum of two figures and one table. They should present a complete study that is more limited in scope than is found in full-length papers. The items of manuscript preparation listed above apply to Short Communications with the following differences: (1) Abstracts are limited to 100 words; (2) instead of a separate Materials and Methods section, experimental procedures may be incorporated into Figure Legends and Table footnotes; (3) Results and Discussion should be combined into a single section.

Proofs and Reprints: Electronic proofs will be sent (e-mail attachment) to the corresponding author as a PDF file. Page proofs are considered to be the final version of the manuscript. With the exception of typographical or minor clerical errors, no changes will be made in the manuscript at the proof stage. Because IJMMS will be published freely online to attract a wide audience, authors will have free electronic access to the full text (in both HTML and PDF) of the article. Authors can freely download the PDF file from which they can print unlimited copies of their articles.
Fees and Charges: Authors are required to pay a $550 handling fee. Publication of an article in the Journal of Clinical Medicine and Research is not contingent upon the author's ability to pay the charges. Neither is acceptance to pay the handling fee a guarantee that the paper will be accepted for publication. Authors may still request (in advance) that the editorial office waive some of the handling fee under special circumstances.

Copyright: © 2013, Academic Journals. All rights Reserved. In accessing this journal, you agree that you will access the contents for your own personal use but not for any commercial use. Any use and or copies of this Journal in whole or in part must include the customary bibliographic citation, including author attribution, date and article title.

Submission of a manuscript implies: that the work described has not been published before (except in the form of an abstract or as part of a published lecture, or thesis) that it is not under consideration for publication elsewhere; that if and when the manuscript is accepted for publication, the authors agree to automatic transfer of the copyright to the publisher.

Disclaimer of Warranties

In no event shall Academic Journals be liable for any special, incidental, indirect, or consequential damages of any kind arising out of or in connection with the use of the articles or other material derived from the JCMR, whether or not advised of the possibility of damage, and on any theory of liability.

This publication is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability, fitness for a particular purpose, or non-infringement. Descriptions of, or references to, products or publications does not imply endorsement of that product or publication.

While every effort is made by Academic Journals to see that no inaccurate or misleading data, opinion or statements appear in this publication, they wish to make it clear that the data and opinions appearing in the articles and advertisements herein are the responsibility of the contributor or advertiser concerned. Academic Journals makes no warranty of any kind, either express or implied, regarding the quality, accuracy, availability, or validity of the data or information in this publication or of any other publication to which it may be linked.
ARTICLES

Research Articles

Anatomical study of the third head of biceps brachii muscle and its innervation by median nerve in human dissection 47
Abdullah G. Al-Kushi

Correlation between clinical and magnetic resonance imaging (MRI) findings in temporomandibular disorder 53
Osama A. Samara, Dina A. Haroun and Soukaina T. Ryalat
Anatomical study of the third head of biceps brachii muscle and its innervation by median nerve in human dissection

Abdullah G. Al-Kushi

Department of Anatomy, College of Medicine, Umm Alqura University, Makkah, Kingdom of Saudi Arabia.

Accepted 14 May, 2013

Several studies have described the biceps brachii muscle as one of the muscles in the upper limb with most frequent anatomical variations. They also reported the presence of this anomaly in varying frequency in different populations. The aim of this study was to assess the anatomical description of the third head of biceps brachii muscle and its abnormal innervation in human autopsies which would be of value for the surgical approach in the arm. Forty arms (20 cadavers) were dissected. The upper arm and axilla region of all cadavers were dissected carefully, then the biceps brachii muscle and surrounding structures were clearly demonstrated to show any muscle variations and abnormalities of its nerve supply, then different photographs were collected. The present study demonstrated the third head of the biceps brachii muscle in 6 out of 40 specimens (15%). The third head of biceps brachii was dominant in the right arm (4 specimens) in contrast to two specimens in the left arms and the muscle was innervated by the median nerve instead of normal innervations by the musculocutaneous nerve. In conclusion, the present study of anatomical variations of the biceps brachii muscle in the arm may contribute to a better developmental understanding and surgical approach.

Key words: Biceps brachii, anatomical variation, median and musculocutaneous nerves, human autopsy.

INTRODUCTION

Biceps brachii muscle is described as a two headed muscle that originates with a short head in combination with coracobrachial muscle from the coracoid process and with a long head from the supraglenoid tubercle of the scapula. The two heads unite distally to form a common tendon that inserts into the posterior aspect of the radial tuberosity, mainly contributing to the flexion and supination of forearm (Williams et al., 1995). Several authors (Ronald et al., 1995; Williams et al., 1995; Asvat et al., 1993; Kopuz et al., 1999; Rodriguez-Vázquez et al., 1999; Kumar et al., 2008; Poudel and Bhattarai, 2009; Kervancioglu and Orhan, 2011) have described the biceps brachii muscle as one of the muscles in the upper limb with the most frequent anatomic variations; variations are in the form of a supernumerary head, third, fourth or fifth heads. The presence of this anomaly varied frequency in different populations (Kopuz et al., 1999; Alberto et al., 2002; Kosugi et al., 1992; Rai et al., 2007; Poudel and Bhattarai, 2009).

The third head of biceps brachii muscle is a thin fascicle that originated at the humeral shaft between the
coracobrachial and brachial muscles. Alternatively between the groove of the radial nerve and the brachial muscle, it descends to join the common distal tendon of the biceps brachii muscle and very rarely joining its muscle body (Rincón et al., 2002).

The biceps brachii muscle is normally innervated by musculocutaneous nerve of the lateral cord of the brachial plexus (Williams et al., 1995). Many investigators (Eglseder and Goldman, 1997; Hooghergen and Kauer, 1992; Kosugi et al., 1992; Uzun and Seelig, 2001) have recorded variations of nerve supply from median nerve in the absence of musculocutaneous nerve. They also observed a communication between median and musculocutaneous nerves. In addition, they described that the lateral cord of the brachial plexus supplies the complete anterior compartment of the arm after piercing the coracobrachial muscle.

The aim of this study was to assess the anatomical description of the third head of biceps brachii muscle and its abnormal innervations in human which would be of value for the surgical approach in the upper limbs.

MATERIALS AND METHODS

Twenty cadavers, 11 males and 9 females at ages 40 to 65 years old were used for this study. Forty Arms (20 right arms and 20 left arms) were dissected in the Department of Anatomy, Faculty of Medicine, at Umm Alqura University. The cadavers were provided from Institute for Plastination, Dr. Angelina Whalley, Im Bosseldorn 17, 69126 Heidelberg, Germany for academic purpose. They were placed in 10% formalin for adequate preservation.

The specimens were dissected through a longitudinal incision at the anterior aspect of the arm extending from the level of the acromion process to the elbow joint. Careful dissection and separation of skin, brachial fascia was carried out. The muscular system was exposed and studied for any variations. The nerves and major vessels were gently and carefully traced. Appropriate photographs were taken.

RESULTS

Six out of forty arms (15%) were observed to have a three headed biceps brachii muscle. All of them were innervated with median instead of the musculocutaneous nerve.

The third head of biceps brachii was found in four right arms (10%) and two left arms (5%). Three male cadavers (7.5%) and one female cadaver (2.5%) have had the third head of biceps brachii. Among these cadavers, one male (two arms) and one female (two arms) had a third headed muscle bilaterally, while the other two males (two arms) were found to have a unilateral third head muscle in their right arms.

The third head of the six cases was observed to arise commonly from the middle third of the humerus shaft near the insertion of the coracobrachial muscle (Figures 1 to 4). This additional head was seen to join the other two heads in the lower third of the arm resulting in a combined tendon inserted into the radial tuberosity (Figure 1). In one specimen, the short head formed a muscle slip adjacent to the brachial muscle forming a tunnel, in which the median nerve and brachial artery passed through (Figures 3 and 4).

The median nerve in the six cases was shown to be formed out of two roots in the upper part (Figure 1) or between the upper and middle third of the arm as shown in Figure 3. The median nerve appeared to provide two muscular branches at upper arm level as shown in Figures 1 to 4. The proximal branch crossed right above the third head of biceps brachii muscle supplying it by a slender branch to its anterior surface, continuing more deeply towards the other two heads, and supplying them also (Figure 2 and Table 1). The proximal branch in the other specimens was seen to arise from the lateral root of the median nerve. It passed underneath the muscle slip, proceeded over the third head without supplying it and ran into more depth towards the other two heads supplying them (Figures 3 and 4 and Table 1).

The distal branch appeared to be smaller and was divided into upper and lower divisions. The upper division supplied exclusively the third head from its deep surface as shown in Figure 2, while the lower ones innervated the brachial muscle (Figures 1 and 2). Another lower muscular division was shown to be rather long, located in the middle third of the arm and split off in the lower third of the arm into two branches supplying the third head and the two main heads of the muscle (Figure 4 and Table 1). The coracobrachial muscle and anterior group muscles are supplied by the median nerve.

DISCUSSION

Knowledge of variations in anatomy is important to anatomists, radiologists and surgeons and has gained more importance due to the wide use and reliance on computer imaging in diagnostic medicine. Also, the presence of anatomic variations of the peripheral nervous system is often used to explain unexpected clinical signs and symptoms (Sud and Shama, 2000). Description of nerve variations are useful in clinical surgical practice since an anatomical variation can be the cause of a nerve palsy syndrome due to uncommon connection between nerve and related muscle (Hoogbergen and Kauer, 1992).

The absence of the musculocutaneous nerve and replacement by the median nerve are in line with Sud and Shama (2000), and is associated with third head of biceps brachii (Abuel-Makarem et al., 2007; Eid et al., 2012; Ongeti et al., 2012). On the other hand, Nakatani and Tanaka (1997a) described the absence of musculocutaneous nerve and that the anterior muscles of
Table 1. Median nerve and its branches supply the third head and other two head of biceps brachii and brachial muscles.

<table>
<thead>
<tr>
<th>Nerve branch</th>
<th>Number of right and left arm</th>
<th>Muscular supply</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proximal branch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximal branch (median nerve)</td>
<td>2 R arms and 2 L arms (one male and female)</td>
<td>Anterior surface of third head and other two head of biceps brachii</td>
</tr>
<tr>
<td>Proximal branch (lateral root of median nerve)</td>
<td>2 R arms (two male)</td>
<td>Supply the two head of biceps brachii only (not third head)</td>
</tr>
<tr>
<td><strong>Distal branch (median nerve)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper division</td>
<td>4 R arm and 2 L arm (three males and one female)</td>
<td>Supply the third head of biceps brachii deep surface</td>
</tr>
<tr>
<td>(a) Lower division</td>
<td>3 R arm and 2 L arm (two males and one female)</td>
<td>Supply brachial muscle</td>
</tr>
<tr>
<td>(b) Lower division</td>
<td>1 R arm (one male)</td>
<td>Supply third head and other two head of biceps brachii</td>
</tr>
</tbody>
</table>

the arm were supplied by the lateral cord of the plexus which pierced the coracobrachial muscle. The formation of the median nerve out of three roots was described by Uzun and Seelig (2001). Two of the roots split off from the lateral cord and the other one splits from the medial cord. The lateral roots were found in close contact cranial to the axillary artery. In our studies, the median nerve was exclusively formed by two roots that united at the level of upper or middle arm thirds. A surgeon must be aware that this kind of variation is more prone to injury during surgical procedures in this region.

Additionally, our studies are in agreement with the results of Sud and Shama (2000), such that the coracobrachial muscle and the other anterior group muscles of the arm were found to be innervated by the median nerve, but not by the musculocutaneous nerve or the lateral cord of the brachial plexus.

Anomalies of the nerves of the upper limb are often accompanied by abnormalities of vessels (Hennesberg and George, 1992). Variations of cord formation in the cranial axilla have been described by many authors (Eglseder and Goldman, 1997; Santo-Neto et al., 1999), and were topographically related to the course of the subclavian and axillary vessels. In our study, the axillary and brachial vessels were normal.

The other anomaly in this study was the presence of the third head of the biceps brachii muscle. It is found three times as often on right than on left arms. This is in agreement with Kosugi et al. (1992), Santo-Neto et al. (1999) and Poudel and Bhattarai (2009).

Male cadavers were found to present a high variance in this study (Asvat et al., 1993). The rate of the third head in this study was different to those from most other published data. While our study elicited a prevalence of 15% white European. Other research groups described a prevalence rate of 8% in Chinese, 10% in white European, 12% in Black Africans, 18% in Japanese, 7.1% in Indian and 12.5% Nepalese population (Kopuz et al., 1999; Alberto et al., 2002; Kosugi et al., 1992; Rai et al., 2007; Poudel and Bhattarai, 2009). The presence of the third head may be a specific functional adaptation of the population characterized by continuous moderate physical activity (Kopus et al., 1999).

The compression of median nerve and vessels by third head has clinical implication that should be considered in patients (Paraskevas et al., 2008). In this study, the median nerve and brachial artery appeared to pass through a tunnel formed by a slip of muscle fiber of the short head of biceps to the brachial muscle. Kosugi et al. (1992) described a case of a Japanese male with bilateral four headed biceps brachii muscle, in which the left third head spread completely into the posterior fascia of the pronator teres muscle, forming a tunnel. The median nerve and brachial artery passed through this tunnel where they appeared compressible against the developing limbs, which lie lateral to the neural tube and cause a bulge in the overlying ectoderm. Spinal nerves are derived from two sources: motor nerves from the neural tube and sensory nerves from neural crest (Williams et al., 1995). Scannes et al. (2000) suggested that the guidance of the developing axons is regulated by expression of chemo-attractants and repulsants in a highly coordinated specified fashion. Any alterations in signaling between mesenchymal cells and neural growth cones can lead to significant variations and cause the median nerve to replace the musculocutaneous nerve in order to supply the anterior group muscles of the arm. Once formed,
Figure 1. A photograph (A) and corresponding scheme drawing (B) of anterior view of the left arm showing the biceps brachii muscle with its long (L), short (S) and third (T) heads. The median (M) nerve gives upper (arrow head) and lower (I) muscular branches. The upper branch gives a long thin branch (double arrows) to the third head. Note the two roots of median nerve (white arrows) united at the upper part of arm.

Figure 2. Higher magnification of the previous Figure 1 (A) and corresponding schematic drawing (B) showing a large upper muscular branch (arrow) supplying the deep surface of both long (L) and short (S) heads. Also, this branch gives a long small branch (arrow head) to the anterior surface of the third head (T). The lower branch (I) splits into two muscular branches: one (i) passes deep into the third head and the other (ii) to the brachial muscle (B). Note ulnar nerve (u), axillary artery (A), brachial artery (b) and long head of triceps brachii muscle (Lt).
Figure 3. A photograph (A) and corresponding schematic drawing (b) of the right arm (anterior view) showing coracobrachial muscle (C) and the two roots of median nerve (upper arrows) united at the junction level between upper and middle third of arm. The upper branch (double arrows) of median nerve arises from the lateral root of the nerve. Note median nerve (M), lower branch (I), third head (T), biceps brachii (Be), ulnar nerve (U) and muscle slip (r).

Figure 4. Higher magnification of the pervious Figure 3 (A) and corresponding schematic drawing (B) showing the median nerve (M) passing through a tunnel formed by a slip of fiber (r) attached to the brachial muscle (B). In the cranial part of arm the lateral root of the median nerve gives a muscular branch (arrow) accompanied with the vascular supply (v), this branch passes over the third head, then runs deep into the long and short heads supplying them from the depth. At the middle of the arm the median nerve gives a large muscular branch (double arrows) which divides into two branches, one (arrow head) to the third head (T) and the other branch (*) to the distal part of the deep surface of the other two heads.
any developmental difference would persist postnatally (Rodríguez-Niedenfohr et al., 1999; Scannes et al., 2000).

Therefore, general surgeons, orthopedic surgeons and medical professionals should have more knowledge about these anatomical variations when dealing with some known clinical syndromes like humeral fracture with unusual bone displacement or shoulder pain syndromes (Brown et al., 1991; Nakatani and Tanaka, 1997b).

Conclusively, this work showed some of the anatomical variations of the biceps brachii muscle and its innervations which is highly important for some developmental understanding and surgical approach.

REFERENCES


Full Length Research Paper

Correlation between clinical and magnetic resonance imaging (MRI) findings in temporomandibular disorders

Osama A. Samara¹, Dina A. Haroun¹ and Soukaina T. Ryalat²*

¹Departments of Radiology, Jordan University Hospital, Amman - Jordan.
²Oral and Maxillofacial Surgery, Oral Medicine, Oral Pathology and Periodontology, Faculty of Dentistry, University of Jordan, P.O.Box no.1669 Tela Al Ali 11953, Amman - Jordan.

Accepted 24 October, 2012

This study was carried out to determine the value of magnetic resonance imaging (MRI) as a diagnostic tool in patients with temporomandibular disorders. The clinical presentation and MRI findings on 88 temporomandibular joints belonging to 44 symptomatic patients were retrospectively studied. The disc position, configuration and signal intensity; mandibular condyle morphology and signal intensity; temporomandibular joint space and surrounding soft tissue abnormality were assessed. The correlation between the clinical and MRI findings was statistically analyzed using Fisher's exact (1-sided) test. Pain in the temporomandibular region was the most common clinical presentation, it accounts for 64% of cases. There was significant correlation between pain, and disc displacement with no reduction (DDWNR) and condylar hyperlaxity (p = 0.04, 0.03, respectively), as well as between clicking and each type of DD (p = 0.00). Statistically significant relationship was also found between tenderness and DDWN, and presence of joint effusion (p = 0.02, 0.03, respectively) as well as between limitation of mouth opening and condylar marrow edema (p = 0.02). Causes of temporomandibular disorders can be well defined by clinical examination. However, MRI can be preserved for patients with pain in whom an initial medical conservative oral treatment failed, in order to exclude other pathological process.

Key words: Temporomandibular joint, magnetic resonance imaging, internal derangement, temporomandibular disorders.

INTRODUCTION

Tempomandibular joint (TMJ) is a synovial joint and the diseases that affect other joints such as disk displacement (DD), degenerative joint disease, inflammatory arthritis, infection and synovitis can affect TMJ. Temporomandibular disorders are the most common causes of facial pain after toothache (Parnes et al., 2006). It had been reported that its etiology is multifactorial and still widely disputed in literature (Emshoff et al., 2003). However, several studies demonstrated that DD (Tallents et al., 2002; Katzberg et al., 1980) and muscular disorders affecting the masticatory system are the most common causes of these disorders (Emshoff et al., 2003; Carlsson, 1999). The initial examination used to image TMJ is usually plain radiograph and conventional tomography, since arthritic changes and congenital bone abnormalities are visualized well on these imaging modalities. Computerized tomography (CT) scan has the advantage in allowing a perfect visualization of the osseous components of the TMJ (Baily et al., 1990). Several authors considered that MRI is the imaging modality of choice in temporomandibular disorders as it provides detailed information regarding the disc, joint space, and adjacent soft tissue structures (Emshoff et al., 2003; Rao, 1995). Therefore, the aims and reasons of this retrospective study determined the correlation between clinical presentation and MRI findings, to identify the most common causes of patients’ symptoms, and clarify the utility of MRI as a diagnostic modality.

*Corresponding author. E-mail: salryalat@yahoo.com.
Table 1. Clinical presentation in 88 TMJ (44 patients).

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>Right TMJ n (%)</th>
<th>Left TMJ n (%)</th>
<th>Bilateral n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>10 (11)</td>
<td>10 (11)</td>
<td>36 (40)</td>
<td>56 (64)</td>
</tr>
<tr>
<td>Tenderness</td>
<td>11 (12.5)</td>
<td>17 (19)</td>
<td>- (-)</td>
<td>28 (32)</td>
</tr>
<tr>
<td>Clicking</td>
<td>12 (14)</td>
<td>8 (9)</td>
<td>18 (20)</td>
<td>38 (43)</td>
</tr>
<tr>
<td>Limitation of mouth opening</td>
<td>- (-)</td>
<td>- (-)</td>
<td>- (-)</td>
<td>34/44 patients</td>
</tr>
</tbody>
</table>

METHODS

Patients

All the MRI changes of the patients who underwent MRI examination in Jordan University Hospital between January 2004 and December 2008 were obtained. Complete medical records were found for 44 patients. Therefore, 88 TMJs in symptomatic patients were studied retrospectively. The clinical data were obtained from patients records. There were 31 female patients aged from 17 to 67 years, with a mean age of 29 ± 11 years, and 13 male patients aged from 18 to 43 years with a mean age of 26 ± 7 years. The patients presented clinically with either one or more of the following symptoms: pain, tenderness, clicking, and limitation of mouth opening. Complete stomatognathic examinations according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were performed for all patients by three consultant Oral and maxillofacial surgeons.

Selection criteria

The criteria for including a patient in the study were the presence of pain in the temporomandibular region and presence of TMJ pain during palpation as well as with jaw function. Patients with ear problems and typical or atypical neuralgic facial pain were excluded. The patients were referred to our MRI unit for the evaluation of presence of DD or adjacent soft tissue anomalies that could be the source of patients’ symptoms.

Imaging technique and interpretation

All MR imaging were obtained with a 1.5 T Magneton vision plus machine (Model of machine: Siemens, Germany) using bilateral TMJ surface coil. Our protocol consisted of oblique sagittal plane proton density and T2 weighted images at closed and then at open mouth. The images were taken for each side in each mouth position (closed and open) at angles perpendicular to the long axis of the mandibular condyle as determined by axial scout view image. A total of nine slices for each side in open and close position were obtained. The parameters used for proton density images were: slice thickness of 3 mm; repetition time, 2500 ms; echo time, 20 ms; field of view, 160 mm; and acquisition matrix size, 202 × 256. For T2-weighted images, the repetition time was 2900 ms, and the echo time was 80 ms.

Both TMJs were examined for disk position, disk configuration, signal intensity; morphology and signal intensity of mandibular condyle, presence or absence of joint effusion in the temporomandibular joint space, and signal intensity of surrounding soft tissues. Disk mobility was not assessed as CINE MRI is not available in our machine. The disk was considered normal if its posterior band was at 12 o’clock position relative to the mandibular condyle on close mouth position according to the criteria proposed by Katzberg and Westesson (1993); dumbbell-like configuration and hypointense homogenous signal. It was considered an abnormal position if the posterior band of the disk was in an anterior position relative to the superior part of the condyle. It was considered displaced anteriorly with reduction (DDWR) when the disk returns back to normal position on opened mouth. However, disk displacement without reduction (DDWNR) was considered when the displaced disk had the same position in close or open position.

Disc configuration was considered abnormal if it was of uniform thickness (biplanar), having a thicker central part (biconvex), or showing an enlargement of its posterior band. Mandibular condyle was considered normal if it was rounded shape; it was considered edematous if its signal was bright on T2 weighted sequence. All MRI examinations were reported by two general radiologists who were unaware of clinical information and working together in consensus with MRI experience of 15 to 18 years.

Statistical analysis

Fisher’s exact (1-sided) test was used to define the relationship between each clinical presentation and MRI findings. It was also used to define the presence of an association among patients’ symptoms as well as among MRI findings. P value < 0.05 was considered statistically significant using SPSS 16 software package for statistical analysis.

RESULTS

Thirty-one out of 44 patients were female with a female to male ratio 2.4:1. Table 1 shows the clinical characteristics of 88 TMJs in 44 patients. Abnormal MRI findings were detected in 70% (62/88 TMJs) of symptomatic joints; of these 45% were seen in female patients. Anterior disk displacement was the most common MRI finding; it was detected in 34% (30/88 TMJs). The MRI findings in 88 joints are demonstrated in Table 2. Pain was the most common symptom (56 TMJs); it was associated with DD in 41% (23/56 TMJs), 29% (16/56 TMJs) were with reduction and 13% (7/56 TMJs) without reduction. Pain with normal disk position was present in 59% (33/56 TMJ). Whereas, in about 22% (7/32 TMJs) where the disk was displaced, the side was painless. Clicking was the second common symptom (38 TMJs); it was associated with DD in 61% (23/38 TMJs); 39% (15/38 TMJs) were with reduction and 21% (8/38 TMJs) without reduction and clicking with mouth opening noticed with normal disc position in 18% (7/38 TMJ). Whereas, at the
side without clicking, DD was present in 30% (15/50 TMJs) of cases. Limitation of mouth opening was observed in 34 patients with 68 TMJ, it was associated with DD in 38% (26/68 TMJs), 20% (14/68 TMJs) were with reduction, and 18% (12/68 TMJs) without reduction. Mouth opening limitation with normal disk position was observed in 62% (42/68 TMJs); whereas DD with normal mouth opening was observed in 85% (17/20 TMJs).

Tenderness at temporomandibular region was found in 28 TMJs; it was associated with DD in 43% (12/28 TMJs), 25% (7/28 TMJs) were with reduction and 18% (5/28 TMJs) without reduction. At the side of tenderness, normal disk position was found in 57% (16/28 TMJs) of cases. At the side without tenderness, DD was present in 30% (18/60 TMJs) of cases.

### Statistical results

On testing the relationship between the clinical presentation and MRI findings, a statistically significant relationship was found between pain and DDWR and condylar hyperlaxity (p = 0.04, 0.03, respectively), as well as between clicking and each type of DD (p = 0.00). Statistically significant relationship was also found between tenderness and DDWN and presence of joint effusion (p = 0.02, 0.03, respectively) as well as between mouth opening limitation and condylar marrow edema (p = 0.02). Detailed statistical relationship and percentage rates of association of each sign and symptom, and MRI findings are shown in Table 3. There was no statistically significant association neither among patients' symptoms (p = 0.3 to 0.6), nor among MRI findings (p = 0.09 to 1). A significant relationship between tenderness and disk morphology was found (p = 0.02)

### DISCUSSION

Dysfunction of the TMJ is a common clinical problem, and imaging of the temporomandibular region has become essential in identifying the origin of patients' symptoms. Seventy percent of our symptomatic patients demonstrated abnormalities in the temporomandibular region on MRI examinations. It had been reported that temporomandibular disorders are more common in female patients; the results of these studies were based on history and clinical examination (Gesch et al., 2004; Nassif and Hilsen, 1992). Although 70% of symptomatic patients in this study were females, abnormal MRI findings were seen in 45% females, and only in 25% male patients, respectively. Several authors described a relationship between psychological status of the patient such as depression and stress and temporomandibular disorders that may explain the difference in the frequency of symptoms and MRI abnormalities (Selaimen et al., 2007; Korszun et al., 1998).

It has been reported that DD can be seen in up to one-third of asymptomatic individuals (Kircos et al., 1987). Haley et al. (2001) demonstrated that 26% of DD were at the side without pain while this rate in our study was 43%. The results of the present study demonstrated that DD was the most common finding in symptomatic patient and that it compares favourably with the results of other studies (Emshoff et al., 2003; Tasaki et al., 1996). Farina et al. (2008) found a significant correlation between TMJ pain and MRI findings of DD, and that was only observed in our patients with DDWR (0.04). The incidence of DD in painful subjects in their study was 82%, and in ours was 54%.

Whyte et al. (2006) reported that DD is usually unilateral and reducible in asymptomatic patients while in symptomatic patients, it is bilateral and reducible in 76% of cases. Our results demonstrated that 83% of bilateral DD were reducible. In general, the reducible displaced disks were more common than the non-reducible disks and that was in agreement with other reports (Tallents et al., 2002). In addition, our results as that of others did not find a statistically significant difference in the frequency of disk involvement of each side (Whyte et al., 2006).

MRI did not reveal any abnormality in 30% of our cases, and absence of DD in 66%; this indicates that DD

---

**Table 2. MRI findings in 88 TMJs.**

<table>
<thead>
<tr>
<th>MRI</th>
<th>Right TMJ</th>
<th>Left TMJ</th>
<th>Bilateral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal disc position</td>
<td>8 (9)</td>
<td>8 (9)</td>
<td>42 (48)</td>
<td>58 (66)</td>
</tr>
<tr>
<td>DDWR</td>
<td>5 (6)</td>
<td>5 (6)</td>
<td>10 (11)</td>
<td>20 (23)</td>
</tr>
<tr>
<td>DDWN</td>
<td>4 (4.5)</td>
<td>4 (4.5)</td>
<td>2 (2)</td>
<td>10 (11)</td>
</tr>
<tr>
<td>Joint effusion</td>
<td>5 (6)</td>
<td>2 (2)</td>
<td>4 (4.5)</td>
<td>11 (12.5)</td>
</tr>
<tr>
<td>Osteoarthrosis</td>
<td>1 (1)</td>
<td>3 (3.5)</td>
<td>0 (0)</td>
<td>4 (4.5)</td>
</tr>
<tr>
<td>Retrodiscal edema</td>
<td>3 (3.5)</td>
<td>1 (1)</td>
<td>4 (4.5)</td>
<td>8 (9)</td>
</tr>
<tr>
<td>Condylar hyperlaxity</td>
<td>1 (1)</td>
<td>2 (2)</td>
<td>10 (11)</td>
<td>13 (15)</td>
</tr>
<tr>
<td>Condylar bone marrow edema</td>
<td>2 (2)</td>
<td>0 (0)</td>
<td>4 (4.5)</td>
<td>12 (13)</td>
</tr>
<tr>
<td>Abnormal disc morphology</td>
<td>4 (4.5)</td>
<td>4 (4.5)</td>
<td>4 (4.5)</td>
<td>12 (13)</td>
</tr>
</tbody>
</table>
is not the main source of patients' symptoms. This finding is in accordance with that of Kobs et al. (2004). Emshoff et al. (2002) reported that MRI was considered as an imperfect standard of reference in TMJ disorders, as some of the DD depicted with high-resolution sonography were missed on MR images. Some authors questioned whether anterior DD is a pathologic finding or just a normal variant (Lieberman et al., 1992). However, in our study, no control subjects had been examined, so we cannot consider the variation normal unless documented as asymptomatic.

Joint effusion is a collection of fluid due to inflammatory changes in the synovial membrane. We did not find a statistically significant relationship between patient's pain and the presence of joint effusion or bone marrow edema, and that was comparable to other reports (Farina et al., 2008; Adame et al., 1998).

Larheim et al. (2001a) reported bone marrow abnormality in 31.4%. In our study, condylar bone marrow edema was found in only 5% of patients with no evidence of osteonecrosis, and that compares favourably with other report (Larheim et al., 2001b). Huh et al. (2003) reported that fluid collection was found more frequently with sub acute disk displacement without reduction, and the high signal intensity within the disk space should be considered a simple matter of fluid collection.

The etiology of this MRI finding in the literature is still under debate. Some authors found that joint effusion and DD are often present even in non-painful TMJ patients (Emshoff et al., 2003; Haley et al., 2001).

Although retrodiscal soft tissue edema was not a common finding in our patients, it was only observed during mouth opening and was not statistically related to patients' symptoms. This can be explained by overstretching of ligaments on mouth opening as mentioned by Sano and Westesson (1995) who attributed that to a functional hyperaemia and peri-vascular inflammation in painful TMJ.

Emshoff et al. (2003) found that osteoarthritic changes were present in 92% of asymptomatic control group subjects. It has been reported also that if osteoarthritic changes occur in young individuals, a longstanding disc displacement without reduction should be ruled out (Helfms et al., 1998). This study did not demonstrate a statistically significant correlation between osteoarthritic changes and DD, neither with nor without reduction. However, local tenderness was associated with alteration in disk morphology (p = 0.02) which is usually related to degenerative changes and that could be attributed to the disrupted normal relationship with the adjacent structures.

Although limitation of mouth opening could be related to either arthrogenous or extra-articular problems, the causes of mouth opening limitation in our patients were unclear. The only statistically significant relationship was found with condylar marrow edema and that was only present in four patients. No significant association was found among patients' symptoms in one hand, and among MRI findings on the other hand. This observation is important as it may indicate that the patients' symptoms and MRI findings are non-specific to a certain pathological process.

Table 3. Relationship between clinical presentation and MRI findings in 88 TMJs.

<table>
<thead>
<tr>
<th>MRI</th>
<th>Pain</th>
<th>Clicking</th>
<th>Mouth opening limitation</th>
<th>Tenderness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal disc position</td>
<td>33 (38)</td>
<td>15 (17)</td>
<td>21 (24)</td>
<td>16 (57)</td>
</tr>
<tr>
<td>DDWR</td>
<td>16 (18)</td>
<td>7 (8)</td>
<td>7 (8)</td>
<td>7 (8) 0.3</td>
</tr>
<tr>
<td>DDWNR</td>
<td>7 (8) 0.04</td>
<td>9 (8) 0.00</td>
<td>7 (8) 0.4</td>
<td>7 (8) 0.00</td>
</tr>
<tr>
<td>Disc morphology</td>
<td>10 (11)</td>
<td>7 (8)</td>
<td>7 (8)</td>
<td>7 (8) 0.02</td>
</tr>
<tr>
<td>Joint effusion</td>
<td>9 (10)</td>
<td>9 (8)</td>
<td>3 (3.4)</td>
<td>4 (4.5) 0.03</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>3 (3.4)</td>
<td>1 (1) 0.7</td>
</tr>
<tr>
<td>Retrodiscal edema</td>
<td>6 (7)</td>
<td>3 (3.4)</td>
<td>3 (3.4)</td>
<td>2 (2.3) 0.6</td>
</tr>
<tr>
<td>Condylar hyperlaxity</td>
<td>13 (15)</td>
<td>6 (7)</td>
<td>3 (3.4)</td>
<td>5 (6) 0.4</td>
</tr>
<tr>
<td>Condylar marrow edema</td>
<td>3 (3.4)</td>
<td>1 (1)</td>
<td>4 (405) 0.02</td>
<td>1 (1) 0.7</td>
</tr>
</tbody>
</table>

P = P-value by Fisher's exact (1-sided) test.
examination, and MRI is not sufficiently useful as a diagnostic modality to determine the cause of mouth opening limitation.

ACKNOWLEDGMENT

This work was supervised by late Dr. Azmi Haroun, a Professor in Department of Radiology, Faculty of Medicine, Jordan University.

REFERENCES


UPCOMING CONFERENCES

8th European Congress on Tropical Medicine and International Health, Copenhagen, Denmark, 10 Sep 2013

13th Congress of the Asia-Pacific Federation for Clinical Biochemistry and Laboratory Medicine (APCCB 2013), Bali, Indonesia, 27 Oct 2013
November 2013
7th International Conference on Communication in Veterinary Medicine (ICCVM), St. Louis, USA, 4 Nov 2013

October 2013
13th Asia Pacific Federation for Clinical Biochemistry and Laboratory Medicine Congress, Bali, Indonesia, 6 Oct 2013
13th Congress of the Asia-Pacific Federation for Clinical Biochemistry and Laboratory Medicine (APCCB 2013), Bali, Indonesia, 27 Oct 2013
Journal of Clinical Medicine and Research

Related Journals Published by Academic Journals

- Journal of Metabolomics and Systems Biology
- Journal of Neuroscience and Behavioral Health
- Journal of Physiology and Pathophysiology
- Journal of Public Health and Epidemiology
- Medical Case Studies
- Medical Practice and Reviews
- Journal of General and Molecular Virology
- Research in Pharmaceutical Biotechnology