T.C.

FATIH UNIVERSITY

INSTITUTE OF BIOMEDICAL ENGINEERING

ELECTROPHYSIOLOGIC AND PHYSICAL EVALUATION OF HAND AND UPPER EXTREMITY DURING DIFFERENT WORKING CYCLE IN HEALTHY PEOPLE

Gülşah Kınalı

Ph.D. THESIS
BIOMEDICAL ENGINEERING PROGRAMME

ISTANBUL, APRIL, 2016 (DEFENSE)

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PROF. DR. SADIK KARA

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Gülşah KINALI, a Ph.D. student of Fatih University **Institute of Biomedical Engineering** student ID 620112006, successfully defended the **thesis/dissertation** entitled **'ELECTROPHYSIOLOGIC AND PHYSICAL EVALUATION OF HAND AND UPPER EXTREMITY DURING DIFFERENT WORKING CYCLE IN HEALTHY PEOPLE'** ||, which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

Prof. Dr. Sadık KARA
Thesis Supervisor

Examining Commitee Members

Prof. Dr. Sadık KARA ....
Fatih University
Prof. Dr. Ferda DOKUZTUĞ ÜÇSULAR ....
İstanbul Bilgi University
Assoc. Prof. Dr. Rasmi MUAMMER ....
Yeditepe University
Asst. Prof. Dr. Şükrü OKKESİM ....
Fatih University
Asst. Prof. Dr. Saime AKDEMİR AKAR ....
Fatih University

It is approved that this thesis has been written in compliance with the formatting rules laid down by the Institute of Biomedical Engineering..

Director Prof. Dr. Sadık KARA

Date of Submission: 22 March 2016
Date of Defense : 26 April 2016

ACKNOWLEDGEMENTS

Firstly, I would like to express my thanks to Prof. Dr. Sadık Kara for great teaching, insight throughout contrubuting the study, and encouraching me to work about biomedical engineering area.

I give my thanks to my dear family for their great support and also yearning with me, waiting for me during my study.

I would like to give my thanks to Research Asistant Mustafa Selman Yıldırım to support statical and signal analysis of the thesis. I would like to give my thanks all my tutors Assist Prof. Haşim Özgür Tabakoğlu, Assist Prof Şükrü Okkesim and Assist Prof. Saime Akdemir Akar who I attent their lectures during my Phd Study. Also thanks to Asist. Prof. Halil İbrahim Çakar, researchers Nurayım Mamatnazarova and Ali Olamat for their support about writing corrections. Thanks, my close friend physiotherapist Sevim Eryiğit has give great support to me during my phd study.

I also thanks, İstanbul Gelişim University Health Science College management to open university labaratuares to make measurements. Also I would like to give my thanks to my dear students for their great support and understanding during my study.

Gülşah Kınalı

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Prof. Dr. Sadık KARA

Director

Date of Submission: 22 March 2016
Date of Defense : 26 April 2016

To my Family,

TABLE OF CONTENTS

ABBREVIATIONS

Ag-CL : Silver- Cloride
BIOPAC : Biological Pack
CST : Carpal Tunnel Syndromme
EMG : Electromyography
Hz : Hertz
Kg : Kilogram
M. : Muscle
MATLAB : Mathemathical Labratory
Min. : Minutes
MUAP : Motor Unit Action Potantial
MVIC : Maximum Volunter Isometric Contraction
N. : Nerve
RMS : Root Mean Square
Sc : Seconds
SD : Standart Deviation
WRMSD : Work Related Musculo Skeletal Disorder
° : Degree
Σ : Sum

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SUMMARY

ELECTROPHYSIOLOGIC AND PHYSICAL EVALUATION OF HAND AND UPPER EXTREMITY DURING DIFFERENT WORKING CYCLE IN HEALTHY PEOPLE

Gülşah KINALI

Biomedical Engineering Programme

Ph.D. Thesis

Advisor: Prof. Dr. Sadık KARA

It is already known that cumulative exercises of the upper extremities can result in overuse injuries. However, it is very difficult to distinguish which of them cause to the disorders. The primary aim of the project is to determine the effects of different shoulder positions on the gripping capability of the hand and electro-physiologic activity of the upper-extremity muscles. Data from 40 case reports were analysed, in which the patients' ages range between 18 and 30. To measure the gripping ability of hand and do the Electromyography analysis, a BIOPAC® electromyography device and its hand dynamo meter were used. As a result, Electromyography activity of the hand and wrist flexors did not show any significant change depending on the shoulder positions. Depending on the shoulder flexion, the hand gripping efficiency decreased significantly. According to our results, as the shoulder flexion increases, muscular activity and, depending on this, the muscular loading also increases, whereas the functional effect of the hand decreases. The case is both a risk factor for occupational diseases and a situation that decreases skilful functioning of the hands. For the next research, an analysis of the advantages of an weight reducing apparatus and system, which can be used during work requiring overhead work, together with Electromyography results is suggested.

Keywords: Electromyography, signal processing, work related upper extremity disorders, hand grip, overhead, occupational disorders.

ÖZET

SAĞLIKLI BİREYLERDE FARKLI ÇALIŞMA POZİSYONLARINDA EL VE ÜST EKSTREMİTE KASLARININ ELEKTROFİZYOLOJİK VE FİZİKSEL TESTLERİNİN YAPILMASI

Gülşah KINALI

Biyomedikal Mühendisliği Programı

Doktora Tezi

Danışman: Prof. Dr. Sadık KARA

Üst ekstremitenin tekrarlı hareketlerinin aşırı kullanım yaralanmalarına yol açtığı bilinmesine rağmen yaralanmaya neden olan hareketleri ayırt etmek oldukça zordur. Bu tezin birincil amacı sağlıklı bireylerde farklı omuz pozisyonlarının kavrama kuvvetine ve üst ekstremite kaslarının elektrofizyolojik aktivitesi üzerine etkilerini belirlemektir. Bu çalışmada yaşları 18-30 arası olan 40 sağlıklı bireye farklı omuz açılarında el kavraması yaptırıldı. Bu aktiviteler esnasında deneklerde BIOPAC Elektromyografi ve el dinamometresi kayıtları yapılarak ilgili veriler analiz edildi. Analiz sonucunda; her omuz açısında en yoğun Elektromyografi aktivitesinin el bileği ekstansör grup kaslarında olduğu, omuz fleksiyonu ile birlikte deltoid kas aktivitesinin belirgin şekilde arttığı, el bileği fleksörlerinin Elektromyografi aktivitesinin pozisyonlara bağlı değişim göstermediği ve omuz fleksiyonuna bağlı olarak el kavrama kuvvetinin belirgin şekilde düştüğü tespit edildi. Çıkan bu sonuçlara göre omuz fleksiyonu arttıkça kas aktivitesi ve buna bağlı muhtemel kas yorgunluğu artarken el fonksiyonelliği azaltmaktaydı. Bu durum hem mesleki hastalık bakımından risk hem de ilgili fonksiyonun verimli kullanılırlığını azaltan bir durum olduğu için ileriki çalışmalarda omuz üstü çalışma gerektiren hallerde kullanılabilecek yorgunluk azaltıcı aparatlar ve kullanılacak sistemlerin verimliliğinin Elektromyografi analizleri ile incelenmesinin yararlı olabileceği kanaatine ulaşıldı.

Anahtar kelimeler: Elektromyografi, Sinyal işleme, İşle ilgili üst ekstremite kas iskelet hastalıkları, el kavrama kuvveti, omuz üstü çalışma, meslek hastalıkları

CHAPTER 1

INTRODUCTION

Recently, musculoskeletal disorders have become the most frequent occupational disorder in the world. It has been reported that more than one million people suffer from musculoskeletal disorders in the United Kingdom. In the United States more than 600,000 people have lost work days and 57 million require a health care visit due to occupational disorders each year. The world population is 6.9 billion people, and 3.1 billion work in the industrial sector. This population is a huge human resource, but without prevention methods there are high risk factors that for occupational diseases [1,2].

Some occupations have very high risk factors for occupational diseases, such as automotive production workers, dentists, and air conditioning workers. Even though humans have been replaced by machines in some tasks in automobile production, humans are still required for some skilled tasks. Musculoskeletal disorders are one of the most common causes for lost work days in the workplace. Recent studies have indicated lost work days due to musculoskeletal disorders in the automobile industry, particularly automobile assembly workers suffering from upper extremity and low back disorders. As overuse injuries upper extremity disorders has been indicated. There is a high degree of upper extremity overuse injuries occurring in the automotive, ship yard and air conditioning assembly and poultry industries. The industrial sectors seeking for preventative solutions such as ergonomic designs, trainings for employee and regular checks which been set up to detect early symptoms [2,3].

As they are functionally important, the upper extremities can be affected by many injuries in daily and working life [4]. Working high-level static contact, awkward postures and carrying a static load for long periods of time cause upper extremity disorders. Work-related musculoskeletal disorders are painful disorders of the joints, ligaments and muscles due to work-related factors [5].

The functional importance of the upper extremities is mainly impacted by trauma and overuse injuries. High levels of static contraction, prolonged static loads and inappropriate postures cause upper extremity disorders. Work-related disorders are injurious disorders of the muscles, joints and ligaments caused by work activities [6].

The upper extremities are characterized by motility, grip and manoeuvre. They are a very mobile and dynamic part of the body. The upper extremities are comprised of the shoulder complex, arm, forearm and hand. The way these components are associated makes analysing a single function of each component difficult. The shoulder complex's primary function is to position the upper extremity for functional utilization of the arm and hand. Thus, the hand can perform its necessary duty of gripping. Therefore, shoulder movements and grip are biomechanically associated. Grip is necessary for completing daily activities successfully. Grip force measurement is a regional evaluation method, and for many years it has been a criterion for hand function evaluation. Recently, it has been the preferred functional test for determining functional capacity and exploring work-related disorders and prevention methods [6-8].

Gripping is an important skill of the upper extremities. The ability to make normal gripping patterns depends on the anatomy of the hand and the functionality of supportive normal components. Several muscles achieve hand gripping. Ligaments and bones give direction to the movement. Proprioceptive senses from the skin and joints carry information about the quality of movements to the cortex.In addition to gripping for functionality, the hand and wrist joints and all of the other upper-extremity joints are responsible for positioning. With the combination of functionality and positioning, the gripping skill can be used effectively [9-11].

Gripping is an important skill of the upper extremities in order to perform daily activities. Hand grip measurement is a segmental evaluation method used for the assessment of hand disorders, and more recently for following work related disorders, and for identifying work ability as functional test. Hand gripping measurements are used for a wide range of purposes, such as identifying the level of impairment and to set up treatment targets. They can also be used to design ergonomic work places in order to prevent work-related disorders [4,12].

According to this information, the upper extremities have two main tasks: reaching objects and gripping.

Purpose and Hypothesis

The body and upper extremities use different ranges of motion to achieve daily and working tasks. Past studies show that gripping strength changes according to shoulder flexion degrees. Nevertheless, there is not enough study in literature about the changing levels of gripping at different shoulder angles, and there is no Turkish study about this issue at all. There is also not enough anthropometric study about the relationship between occupation and handgrip.

Some studies in recent literature investigate the risk factors of overhead work, but they did not observe electromyography and hand gripping together. We noticed in the outcome of these past studies that there is a lack of study in the relationship between electromyography activity and hand grip strength during overhead work. The main objective of this study is to investigate the electrophysiological outcomes of exercising above shoulder level, a major risk factor in work-related upper extremity disorders, and the influence of different working angles of the arm on gripping.

Although there have been studies on the risks of exercising above shoulder level, no studies were found that monitored the electromyography activity of the muscles and grip simultaneously. The main objective of this study is to investigate the electrophysiological outcomes of exercising above shoulder level, a major risk factor in work-related upper extremity disorders, and the influence of different working angles of the arm on gripping [13-15].

CHAPTER 2

LITERATUR REVIEW

2.1. Identification of anatomical and biomechanical terms related upper extremity

This chapter included identification of each of the components in upper-extremity kinematics and muscle function. There are biomechanics terms of location and motion which are used in this study for assessment and clarification of upper-extremity biomechanics (Table 2.1). Also, in this chapter we will give information about work related muscle skeletal disorders [9-11].

Terminology is very important to learn about extremity biomechanics. Our biomechanics is explained in three dimensions. The human body is three sections according to these dimensions and depended plans. The sagittal plane divided the body vertically into medial and lateral parts, the coronal plane divided the body vertically into anterior and posterior parts while the transverse divided the body horizontally into superior and inferior parts [16]. These plans have been demonstrated in Figure 2.1

Motion term is used for identify an anatomical movement of joints around of a pivot point that means center point of movement. All body movements have different range of motion. Figure 2.2 shows of general movements of upper extremity.

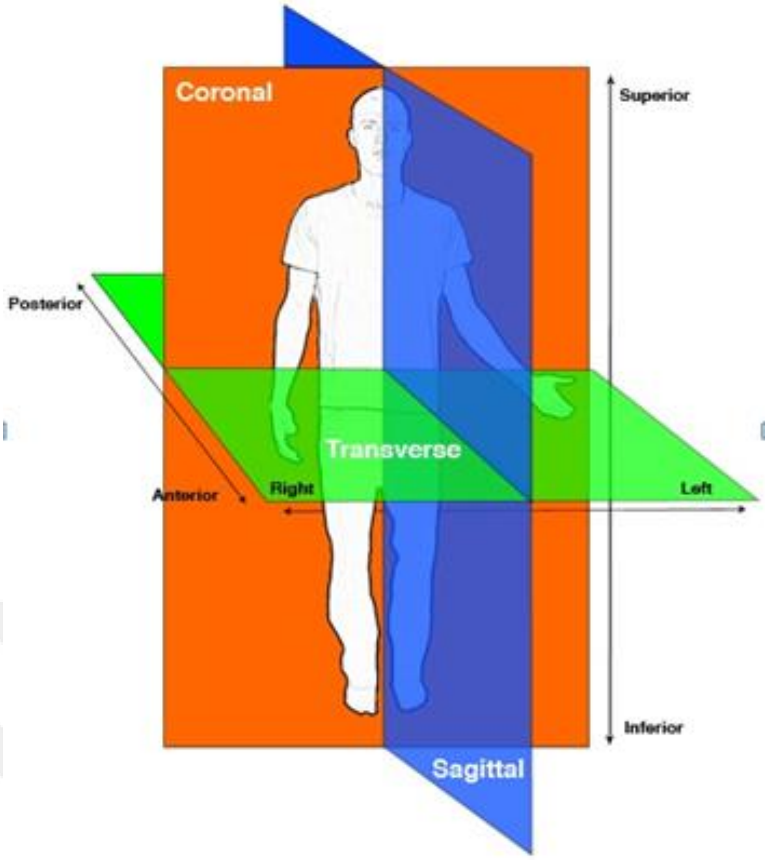

Figure 2.1 Anatomical plans of body
(http://valerietonnerhealthcoach.blogspot.com.tr, April 2016)

Table 2.1 Anatomical vocabulary to identify upper extremity

Anatomical Term	English Identification
Anterior	Front
Posterior	Back
Superior	Up
Cranial	Head
Inferior	Feet Side
Medial	Close to longitiduinal axis
Lateral	Away to longitudinal axis
Proximal	Upper part of bone
Distal	Low part of bone

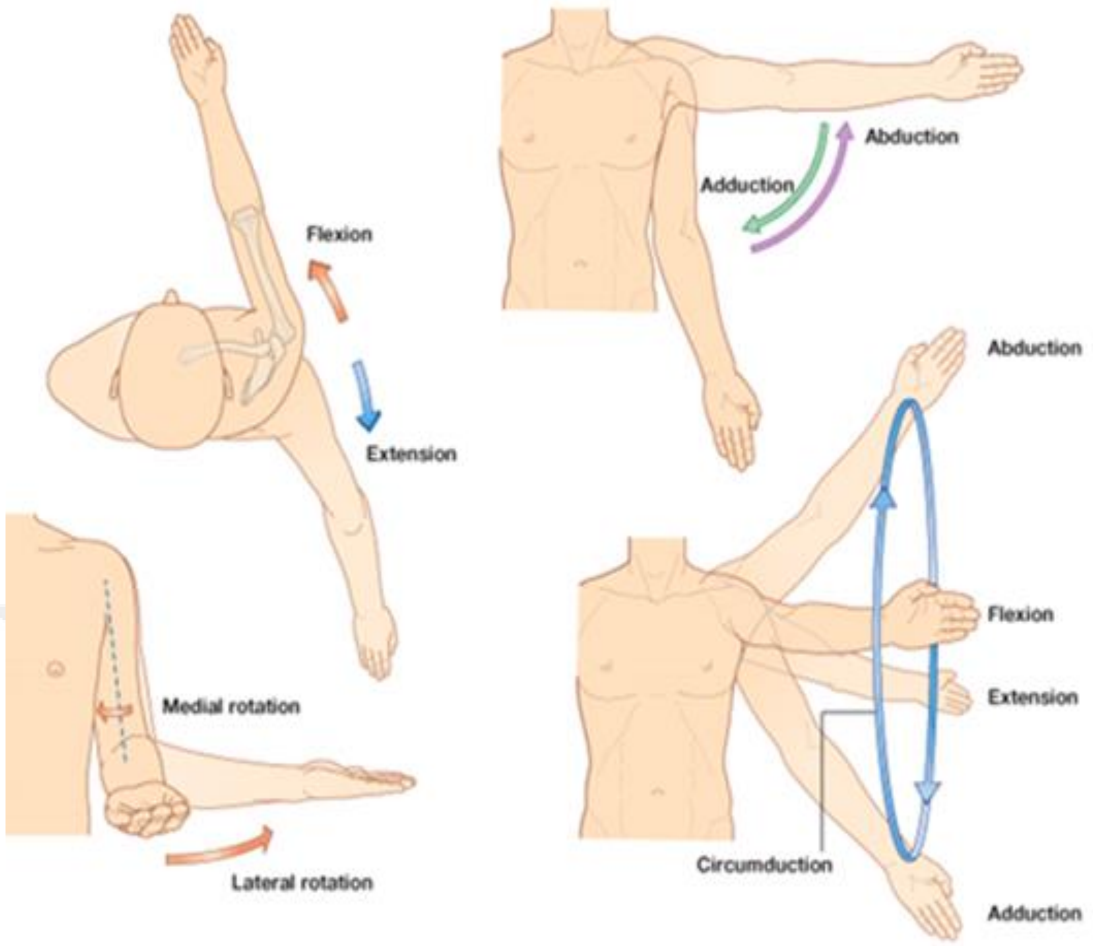

Figure 2.2 Upper extremity movements
(Gray's Anatomy, www.studentconsult.com, modified by Drake et al)

In order to understand more about the functionality of the upper extremities, these terms have to learn which have been given. Flexion is refers to a movement that decreases joint angle. Extension is refers to a motion that increases joint angle. Abduction is refers to a motion apart from body Adduction is refers to motion close to body (Figure 2.2). [17,18].

2.2. Overview of Functional Anatomy of Upper Extremity

Upper extremities anatomically divided as upper arms, forearms, and hands, and are connected to the body by the shoulder joint. The shoulder complex is structed by the clavicle and scapula. The scapula forms a joint with the arm at the humerus and the proximal point of the clavicle forms a joint with the thorax at the sternum while the distal point of the clavicle articulates with the acromion of the scapula, forming the acromioclavicular joint. This structure provide of the gleno humeral joint combined lack of articulation gives the opportunity to the shoulder a high range of motion and makes it the most mobile of all the joints in the human body. Figure 2.3 have shown that articulations of upper extremity and parts of upper limb such as, up arm, elbow, forearm, wrist, hand [19].

Shoulder formed by four main joint—the sternoclavicular joint, the acromioclavicular joint, the glenohumeral joint and the scapulothoracic joint. More specifically, the strernoclavikular joint is the only skeletal articulation between the upper extremity and the axial skeleton. The other joints are stabilized by ligaments. This structure gives different kind of motion skill to the shoulder. The shoulder can have high range of motion that it can call overhead motion due to these forms of anatomy and biomechanics connection (Figure 2.4) [18, 19].

Elbow joint have three articulations in order to movements of elbow they are the humeroradial joint the humeroulnar joint and the proximal radio ulnar joint [18, 20].

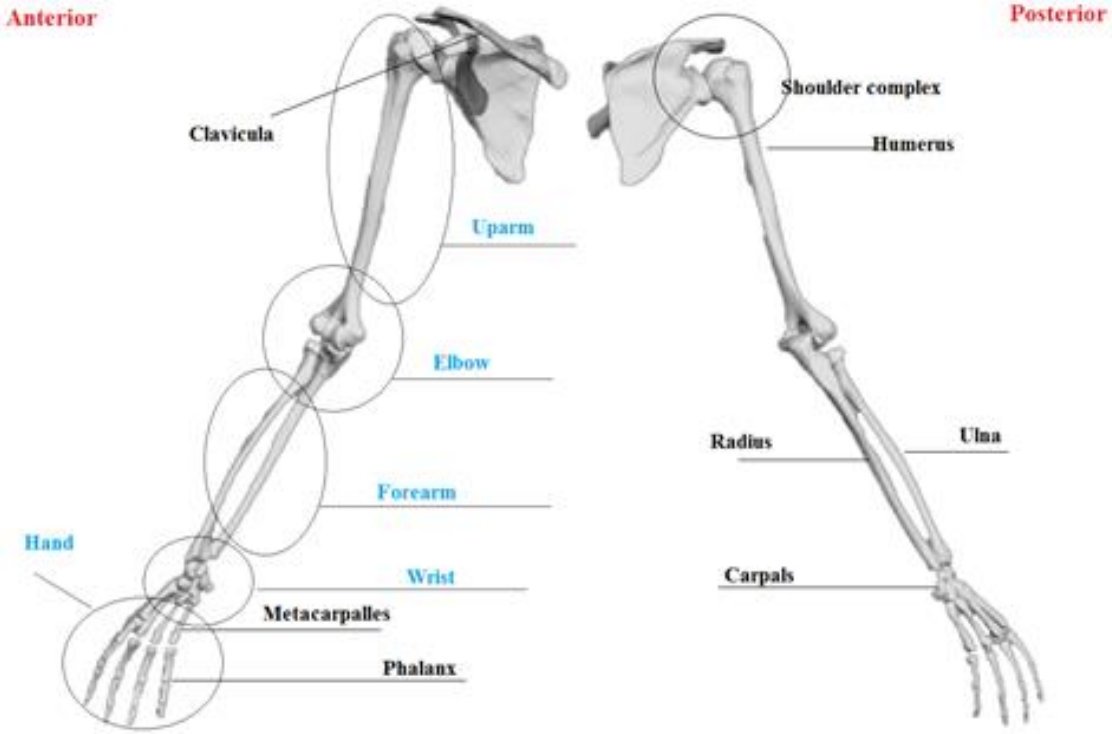

Figure 2.3 Bone Parts of Upper Extremity (www.bodylightbooks.com)

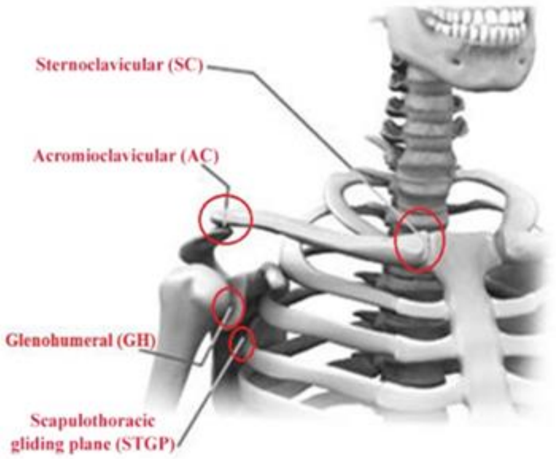

Figure 2.4 Shoulder Joints,
(Modified by G. Kinali, www.primarypictures.com, January 2016)

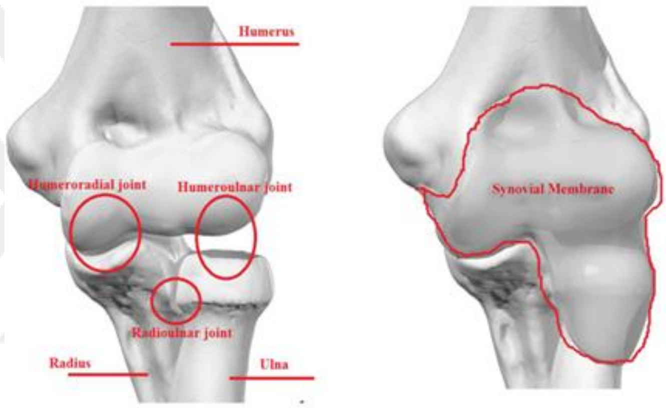

Figure 2.5 Elbow joints
(Modified by G. Kinali fromwww.primarypictures.com, January 2016)

Muscles of Upper Extremity

The upper extremity muscles are especially important in our study. Understanding muscles tasks in order to make movement in extremity and identifying the origin and insertion ofmuscles to find exact motor points during electromyography measurement was very important. We give this section to explain the muscles of upper extremity due to this mission. Two anatomical groups are considered in this study: the shoulder group and the elbow group.

In Figure 2.6 shows that the main upper extremity muscles have been illustrated such as m. serratus which is responsible of scapula protraction and m. trapez which is responsible of scapula retraction [21].

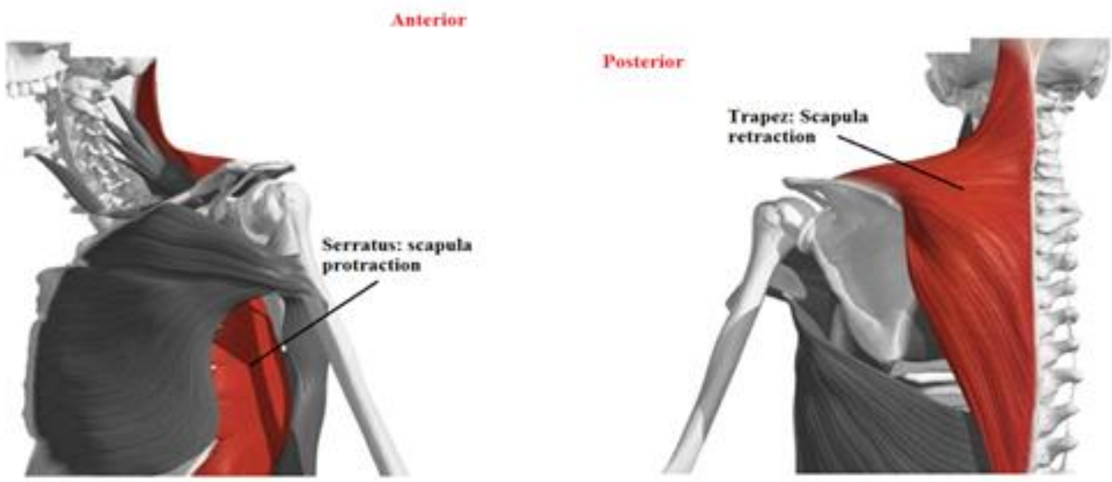

Figure 2.6 Left shoulder serratus and trapezius muscles
(Modified by G Kinali fromwww.primarypictures.com, January 2016)

In Figure 2.7., m. deltoid illusturated that while is main flexor, abductor and extensor muscle of shoulder and m. pectoralis major is responsible of adduction and internal rotation. Also, m. latissimus dorsi is a big muscle which is responsible of adduction, internal rotation and extension of upper extremity. Figure 2.8 shows that The other three rotator cuff muscles are the infraspinatus, the subscapularis muscle is make internally rotates the shoulder and the teres minor is which adducts and externally rotates [17,18,22].

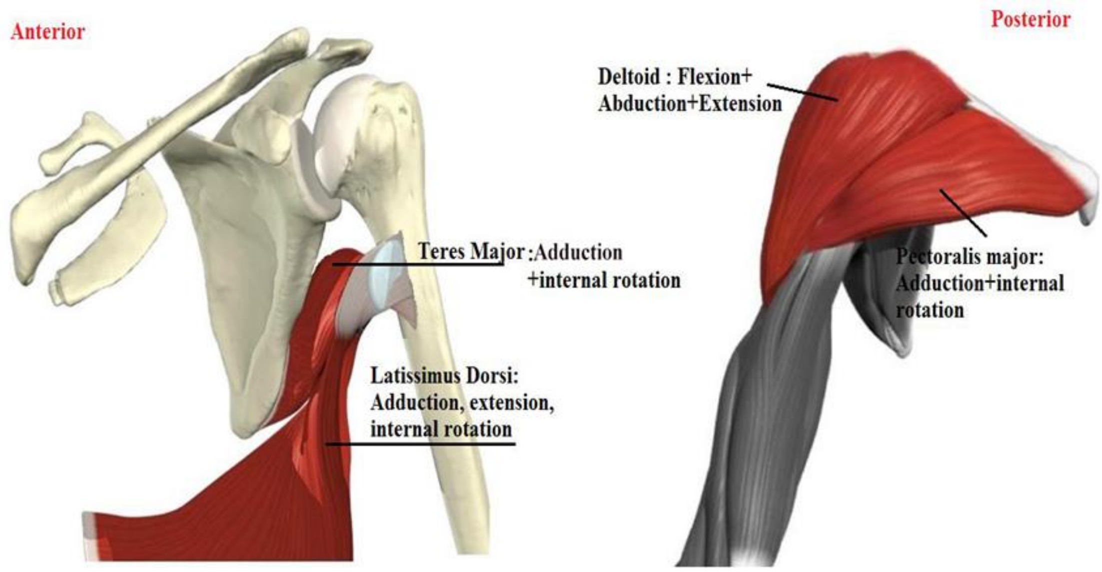

Figure 2.7 M. teres major, M. deltoid, M. latissimus dorsi
(Modified by G. Kinali from www.primarypictures.com, January 2016)

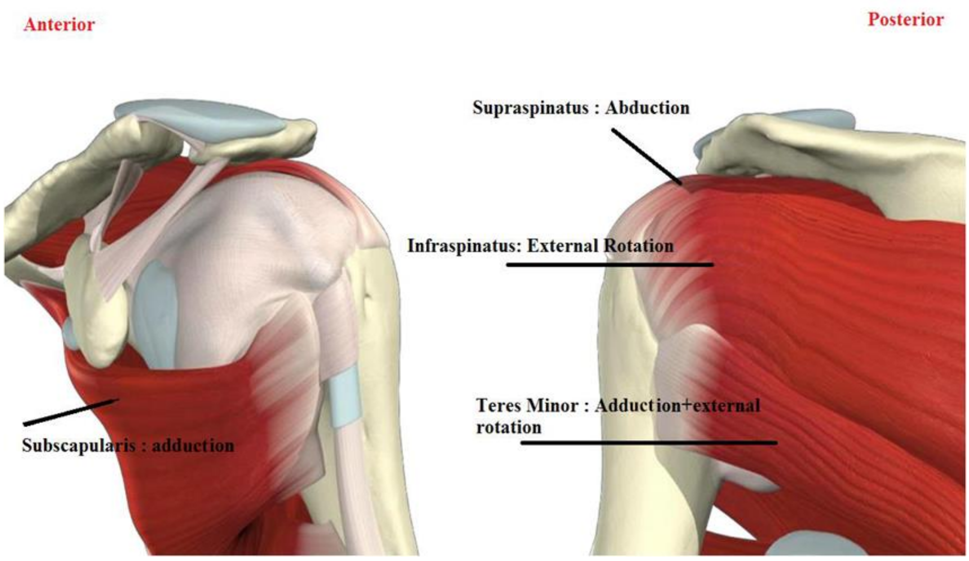

Figure 2.8 M.subscapularis, M. infraspinatus and M. teres minör
(Modified by G Kinali from www.primarypictures.com, January 2016)

The elbow group forced by three main muscle groups: the biceps brachii, brachialis and triceps (Figure 2.9). The biceps and triceps cross both the elbow and the shoulder while brachialis acts only at the elbow joint. The biceps main function is to supinate the forearm and flex the elbow, particularly if the forearm is supinated. The triceps is as a major extensor of the elbow [22, 24].

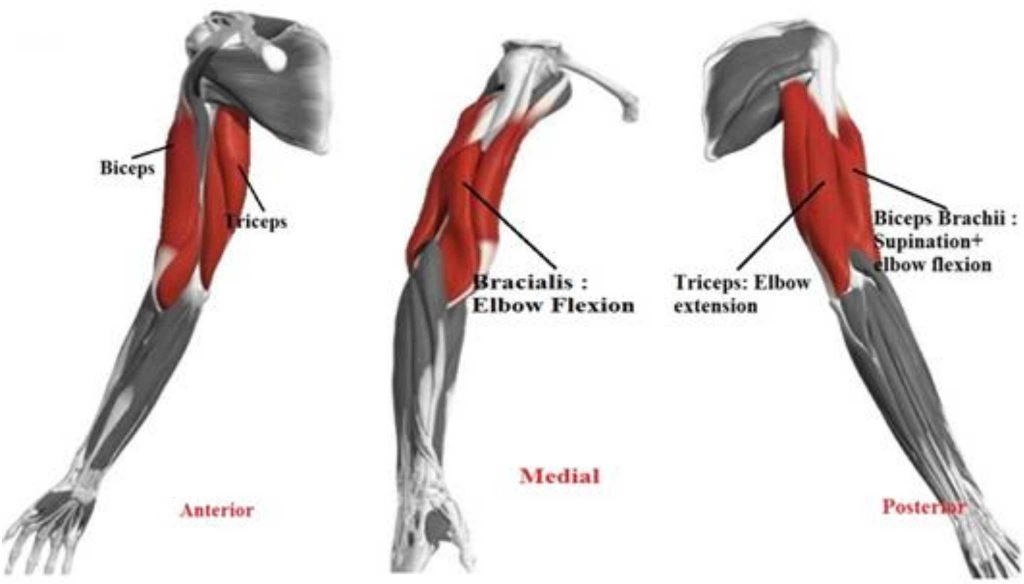

Figure 2.9 M.subscapularis, M. infraspinatus and M. teres minör, Left Shoulder
Modified by G Kinali from www.primarypictures.com, 2016)

Forearm muscles are important to achieve gripping function. Gripping is most important skill of upper extremity to grasp objects. While the shoulder muscles make able to reach to the object with flexion and other movements, forearm muscles lead to the hand to make grasping and leaving of objects. Figure 2.10 and 2.11 shows the main flexor and extensor forearm muscles.

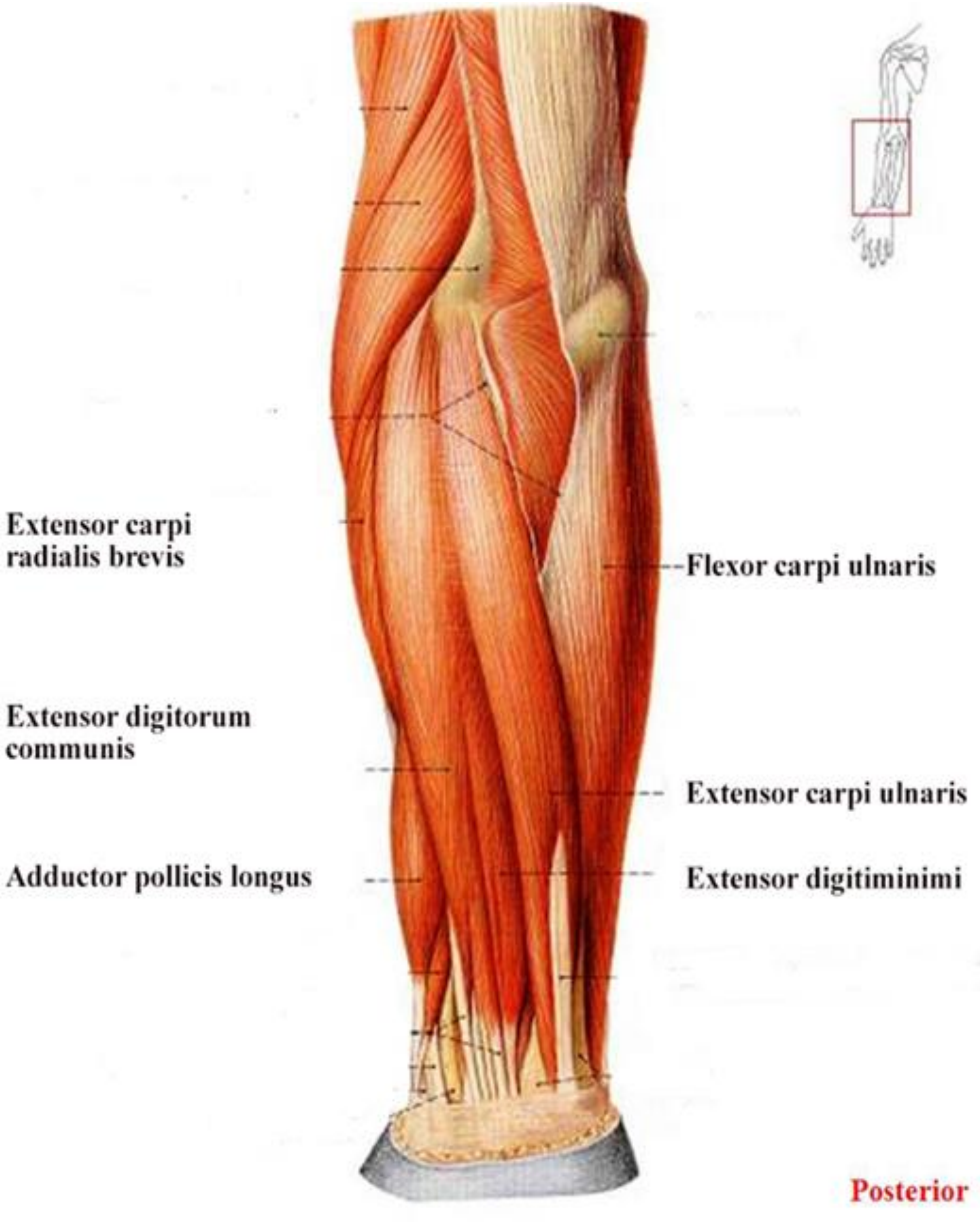

Figure 2.10 Forearm exstansor muscles of and fingers
(Modified by G. Kinali from www.netterimages.com, January 2016)

Also in Figure 2.12 motor points and landmarks of these muscles which is very important to find motor points during electromyography measurement and also evaluate of grasping as functionally. Table 2.3 is describing briefly of the function of these muscles [23-26].

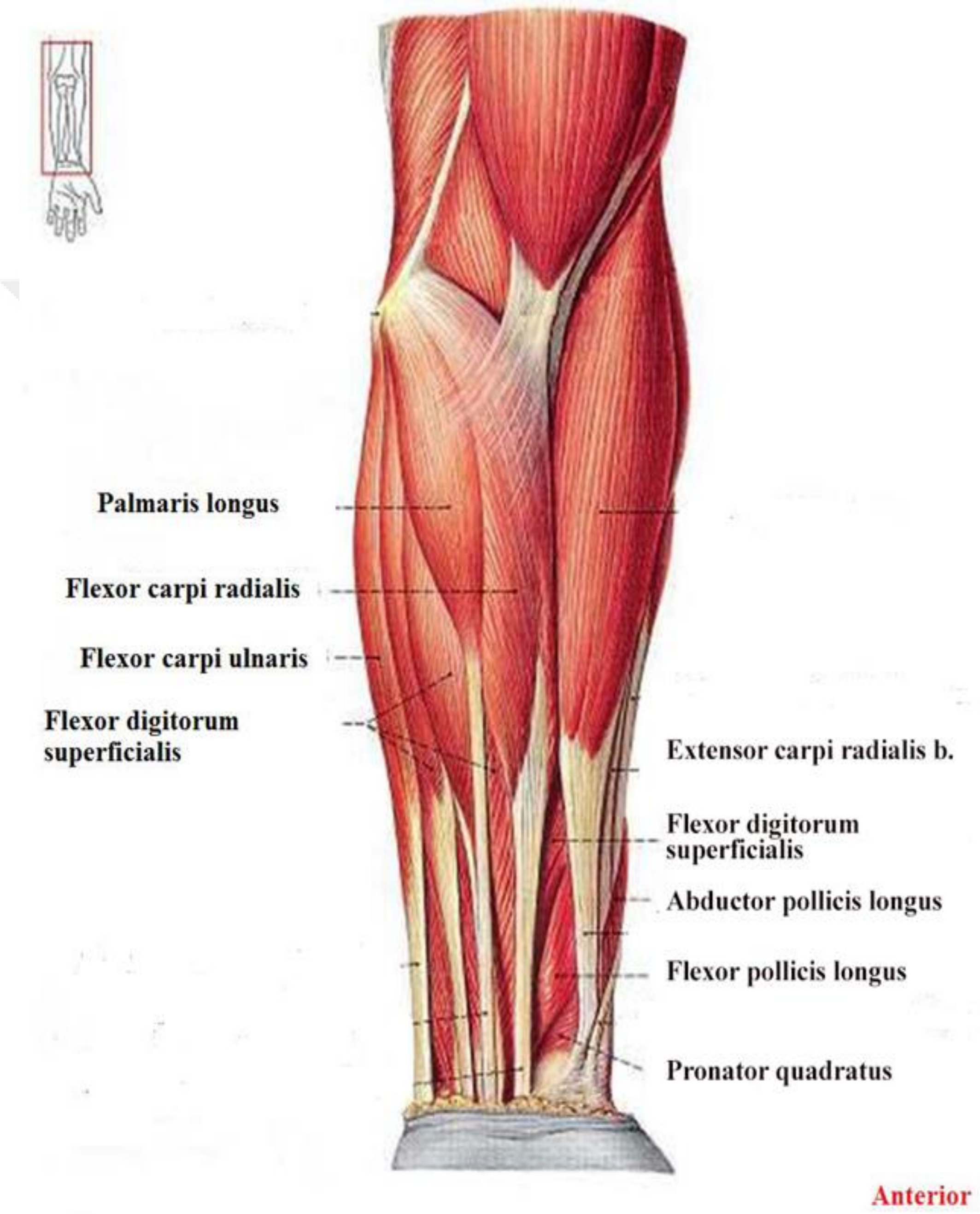

Figure 2.11 Forearm flexor muscles of hand and fingers
(Modified by G. Kinali from www.netterimages.com, January 2016)

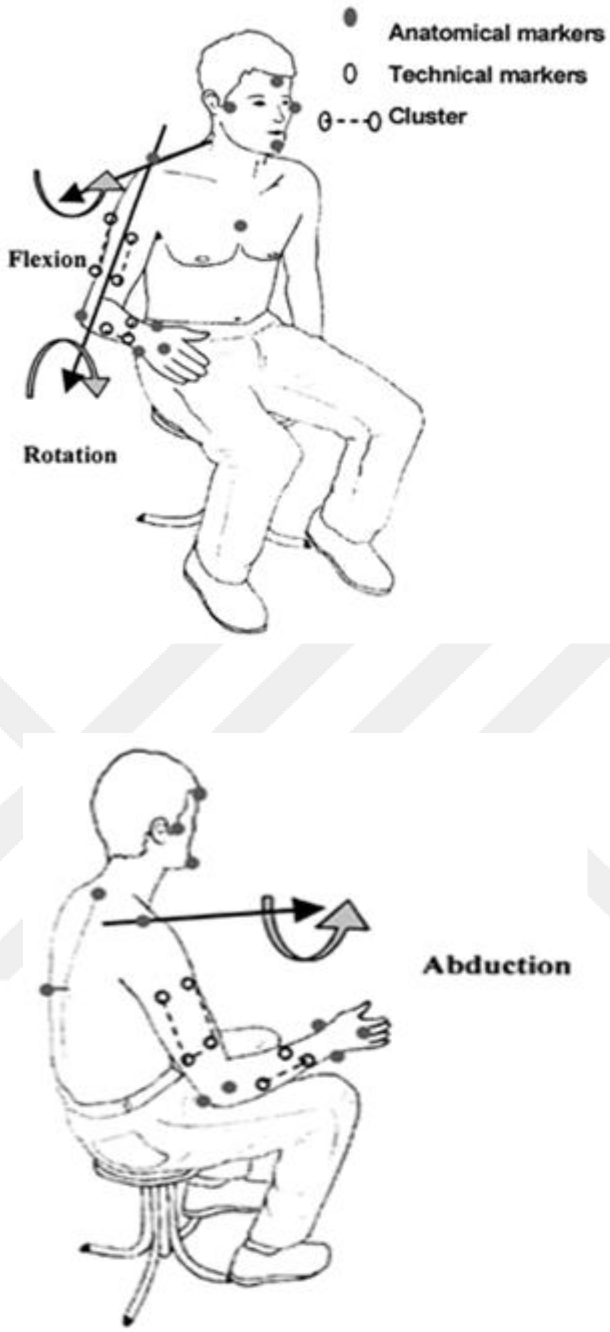

Figure 2.12 Upper Extremity markers and motor points
(www.nature.com, January 2016)

Nerve Suply of Upper Extremity

Nerve Supply of upper extremity roots from C5-T1 segment of cervical region. Ulnar, median and radial nerves are mainly responsible of grasping and motion of upper extremity such as reaching objects (Figure 2.13). The nerves have two main functions: motor and sensory. Sensory functions of the nerves as dermatom, illusturated in figure 2.14. [27].

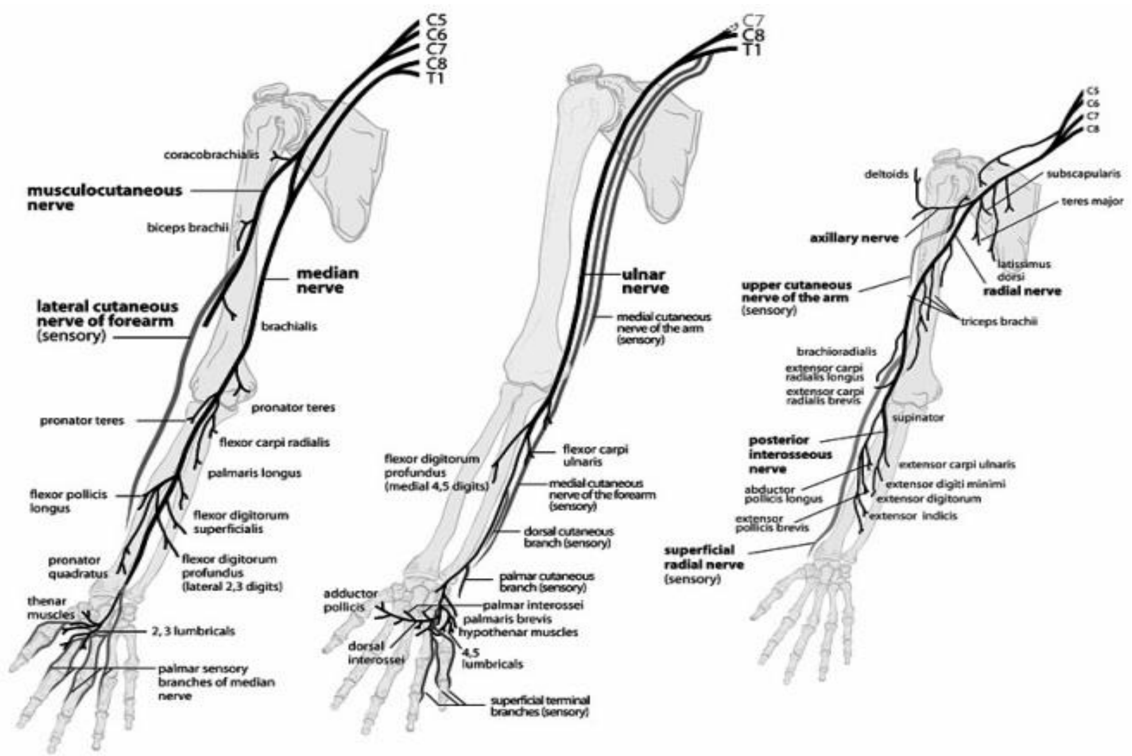

Figure 2.13 Nerves of upper extremity as motor function (www.aafp.org, January 2016)

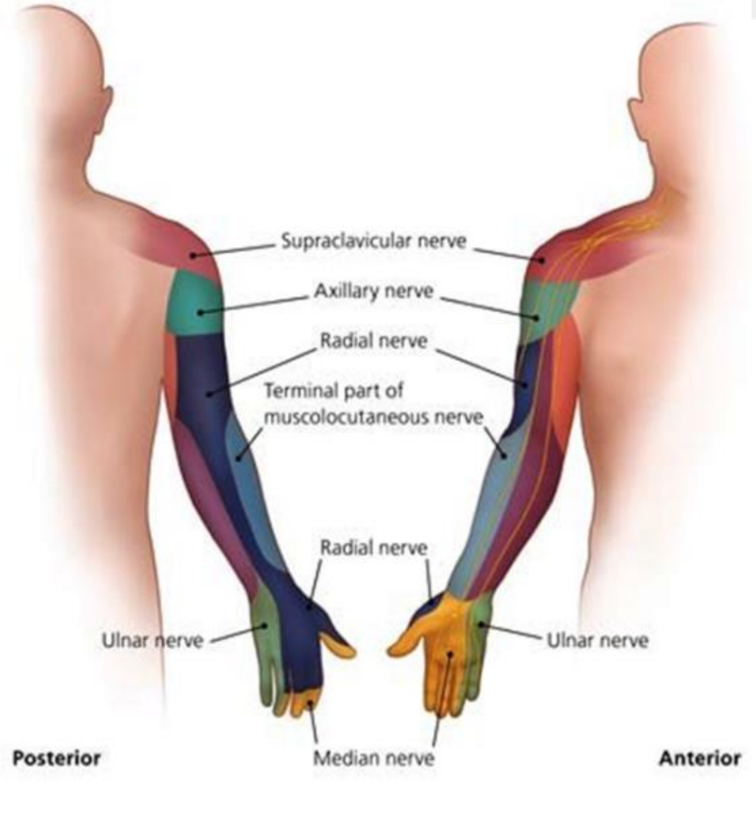

Figure 2.14 Nerves of upper extremity as sensory function (www.aafp.org, January 2016)

2.3. Importance of Upper extremity for Work Related Muscle Skeletal Disorders

In parallel with industrialization of countries, the provision of conditions in which employees work in health and safety has been one of the most important problems. In modernized societies, thanks to technological developments and industrialization from which all individuals of the society benefit, the prevention of health and safety problems of employees has been a remarkable target to improve social health. As a result of the increase in industrial activities, the importance of the fact that employees represent a great majority of a society and that changes emerging in their health will considerably affect social health has gained ground. Therefore, studies on occupational health and diseases are so vital in terms of the level of social health, social order and total productivity [28-32].

The upper extremity is mainly influenced from trauma and overuse injuries in terms of its functional importance. High levels of static contraction, prolonged static loads and inappropriate postures cause upper extremity disorders. Work related disorders are injurious disorders of the muscles, joints and ligaments caused by work activities [33, 34].

The upper extremity is characterized by motility, grip and maneuver. It is a very mobile and dynamic part of the body. The upper extremity is comprised of the shoulder complex, arm, forearm and hand. These components are associated that analyzing a single function of each is difficult. The shoulder complex's primary function is to position the upper extremity for functional utilization of arm and hand. Thus, the hand can perform its necessary duty of gripping. Therefore, shoulder movements and grip are biomechanically associated [2, 3].

60% of all injuries on job are caused by diseases of musculoskeletal system. The diseases are characterized by continual pain on tendons and other soft tissues. For industries, one of the most common diseases of musculoskeletal system is low back pain. Work-related risk factors, lifting heavy objects, repeating similar movements and working in bad posture are the most common causes. Besides, individual risk factors such as inadequate muscle flexibility and being overweight are known to play a critical role in stimulating diseases of musculoskeletal system. Today, work-related diseases of musculoskeletal system are represented by different definitions in literature. The most commonly used terms are: overuse syndromes, cumulative trauma disorders, relapsing trauma disorders [35-37].

According to the definition made by World Health Organization (WHO), work-related diseases are not only known and accepted occupational diseases but they are also diseases on whose emergence and development, working conditions and workplace conditions affect as well as some other factors [2,3].

Taking a leave due to a disease is called as “temporary disability” in Spain. The condition causes Spain to lose 39 million workdays and a cost of 1700 million euro. In Portugal, the number of applications to hospitals owing to a work-related disorder was found higher than the number of applications to national health services. More detailed and broader studies are required on this subject. In the USA, more than 600.000 employees have workday loss each year due to WR MSD-related disorders, and thus, more than 57 million health care treatments are carried out. The figure is meant to be 60% of all treatments carried out for injuries [1,2].

Diseases of musculoskeletal system are a group of diseases that involve muscle, joint and bone structures and are characterized by pain, movement restriction and disruptions of structures and functions of musculoskeletal system. Work-related diseases of musculoskeletal system in employees are mostly observed on areas of waist, neck and wrist. The symptoms of work-related diseases of musculoskeletal system are pain, swelling, indurations, paresthaesia, and formication, loss of coordination and power loss. Diseases of musculoskeletal system have considerable effects on general well-being and life quality of employees. Chronic pains resulted from diseases of musculoskeletal system widely affects life and lowers the level of life quality. The disruptions of physical and mental health of individuals with complaints about chronic pain resulted from the diseases of musculoskeletal also cause disruptions of their social functions. The disruptions in recreational activities and social relations of patients, the side-effects of the medicines taken, frequent applications to hospitals or clinics also restrict total time that they spend with their families [38-40].

Researchers have etiologically divided risk factors of work-related diseases of musculoskeletal system into groups of work-related factors, individual factors and psychosocial factors. Although environmental risk factors (such as vibration, hot and cold weather, and lighting) are commonly cited within work-related factors, recent studies categorize environmental risk factors as another group [38-40].

The most effective way to combat against diseases of musculoskeletal system is the application of preventive methods. Ergonomic and environmental changes should be conducted in workplaces. For the evaluation of risk factors, ergonomics should be evaluated. Employers should be informed regarding health problems and their results. At the same time, employees should be more careful about preventing injuries. Thus, with the preventive and alterative aspects of ergonomics science, better solutions in diseases of musculoskeletal system may be achieved [12, 41, 42].

The evaluation of work-related risk factors is normally calculated by considering the criteria of intensity, repetition and time. There are various ergonomic risk evaluation methods to evaluate potential risks regarding diseases of musculoskeletal system. The statements of employees, observational evaluations and physical measurements are included. However, it has been known so far that only some of risk factors causing MSD regarding work have a higher level of relation with work [43-45].

The evaluation of individual risk factors and the evaluation of functional capacity are objective tests evaluating individuals' ability to work. Measurements of functional capacity could be carried out before employment period or during preventive period to obtain symptoms of diseases or during rehabilitation period to evaluate the ability to work. These tests offer information about individual features. Individuals with a higher strength are known to have better outcomes when they return to work after a disease. According to the results of physical measurements, the effectiveness of planned stretching exercises was shown [46, 47].

Though increasing automation, mechanization and other ergonomic interventions in automobile manufacture replaced individuals in assembly lines, many individuals are still required for specific operations. One of the sectors in which diseases of musculoskeletal system are highly diagnosed is the sector of automobile manufacture. The most commonly observed diseases are related to foot, waist and wrist [48, 49].

2.3.1. Most Common Work Related Upper Extremity Disorders

Regards to topics of the study we have give examples fromshoulder region muscle skeletal disorders. Shoulder impingement is a very general problem among workers who are working overhead. The decreasing of subacromial space between the acromion and the humeral head, can cause shoulder impingement, see in Figure 2.15. This space becomes smaller during overhead activities or when lifting the arm to the side [13, 21, 50].

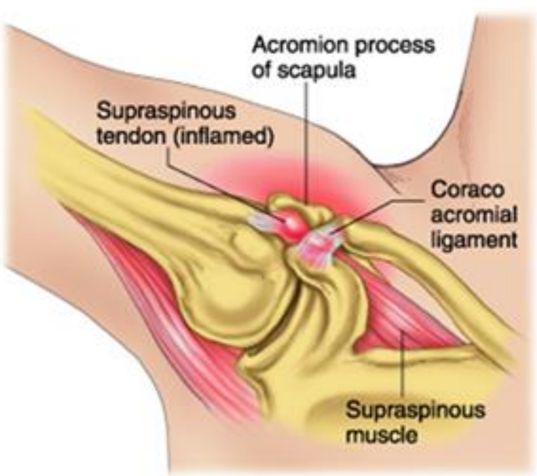

Figure 2.15 Impengement syndrome
(www.mdguidelines.com 2016)

A rotator cuff injury is painfull musculoskeletal poroblem where the tendons are fully or partially injured. The cause of the tendons' injury can be due to either extrinsic or intrinsic factors, including trauma or degeneration due to work related activities. (Figure 2.16.) [13,22,51].

Figure 2.16 Roator Cuff Tear
(http://www.josephbermanmd.com/2016)

Osteoarthritis also is very general problem in shoulder joint depends on many factors: genetic factors, anatomic factors, such as age and gender, and biomechanical risks factors, such as joint injury and repetitive using in work [51,52].

There is also, lots of important work related upper extremity disorders. Mostly hand and wrist region affecting from WR MSD [3]. Most Common hand and wrist region disorders are carpal tunnel syndrome trigger finger and dequarvein tenosinovit.

Carpal Tunnel Syndrome occurring in wrist region where the median nerve going thorough to the hand from carpal tunnel. Pressure due to working over extansion and also over contraction of muscles due to repetitive gripping cause to the disorder. Most of the legal cases happening due to CST in workplaces [6, 9].

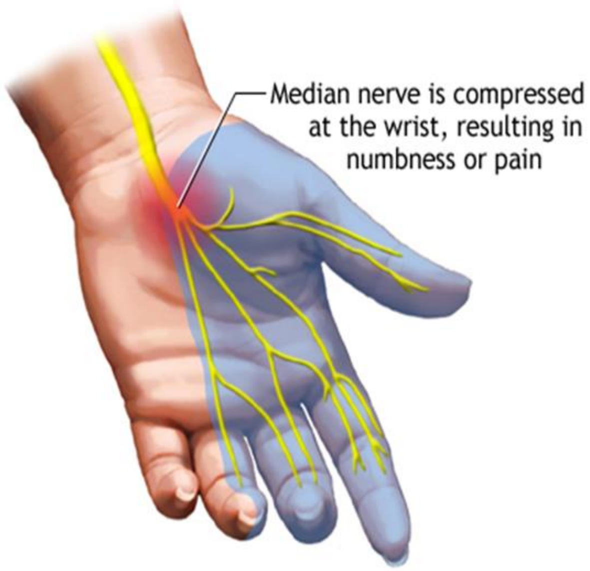

Figure 2.17 Carpal Tunnel Syndromme
(www.acunaturalhealth.com.au, 2016)

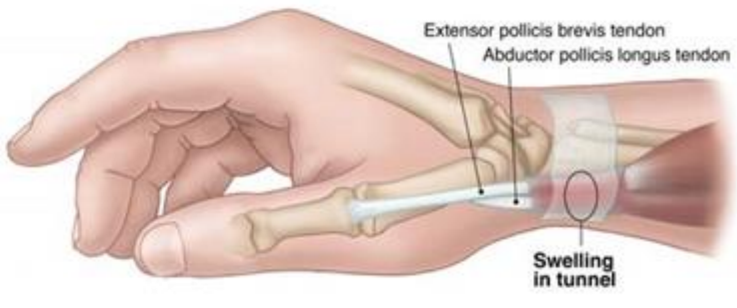

Figure 2.18 Dequarvain Tenosynovitis
(www.martinkneeandsports.com/2016)

Dequarvain tenosynovitis is the disorder due to repetitive abduction movement of thumb. Generally workers who are working with their thumb to assemlying parts suffering from dequarvein disorder (Figure 2.18).

Trigger finger is catcing new workers generally because of over gripping without necessary to achive their task (Figure 2.19). The workers giving unnecessary gripping up to they become experienced worker and finally they get trigger finger. Trigger finger is painful condition on flexor tendons of hand [6,9,25,28,29].

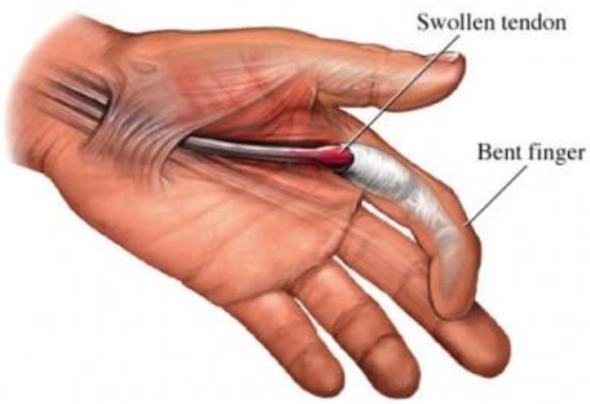

Figure 2.19 Trigger Finger
(https://uvahealth.com, 2016)

2.3.2. Functional Evaluation of Grasping

Shoulder movements and grip are biomechanically associated. The upper extremity is characterized by motility, grip and maneuver. It is a very mobile and dynamic part of the body. When the shoulder joints provide to range to reach of upper extremity, the hand is makes grasping to touch and cover objects. The hand and shoulder is biomechanically associated. Regards to this information, the hand must be evaluated as functionally during shoulder motions.

Grip is necessary for completing daily activities successfully. Grip force measurement is a regional evaluation method, and for many years, it has been a criterion for hand function evaluation. Recently, it has been the preferred functional test to determine functional capacity and explore work related disorders and prevention methods [4-8].

The term grip strength refers to the force of hand grasp and is usually measured isometrically using a dynamometer held in the subject’s hand which is squeezed as hard as possible. Grip strength force is measured in kilograms, pounds or newtons [53]. Grip strength can be measured quantitatively using a hand dynamometer, see in Figure 2.20.

Figure 2.20 Using of hand dynamometer
(G.Kinali, İstanbul Gelişim University Lab. May 2016)

2.3.3. Electromyography of Upper Extremity

Electromyographiy (EMG) signal is detecting motor unit action potential (MUAP) by muscles (Figure 2.21) Electromyography have range of using area, espechially clinically, also many biomechanic research based on EMG results. Data decomposition technics is allow to see EMG signal clear and meaningfull [54,55].

The upper extremity is mainly influenced from trauma and overuse injuries in terms of its functional importance. This reason cause to using EMG in upper extremity mostly. EMG measurement takes signals from muscles motor unit (Figure 2.21). Each motor unit connecting to spinal cord with nerves. EMG is clarifying of motor unit working as electrically. Also these signals converting to image with decomposition with some transformation technics in signal processing (Figure 2.22).

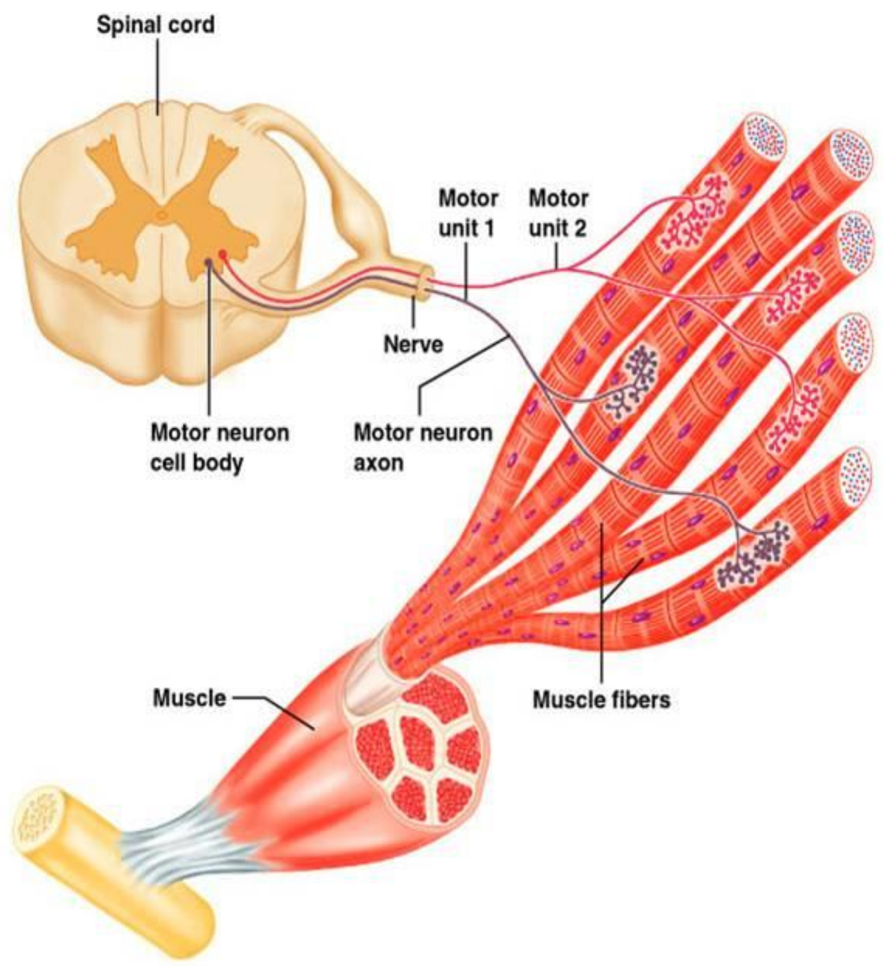

Figure 2.21 Motor Unit Action Potential
(www.studyblue.com, 2016 April)

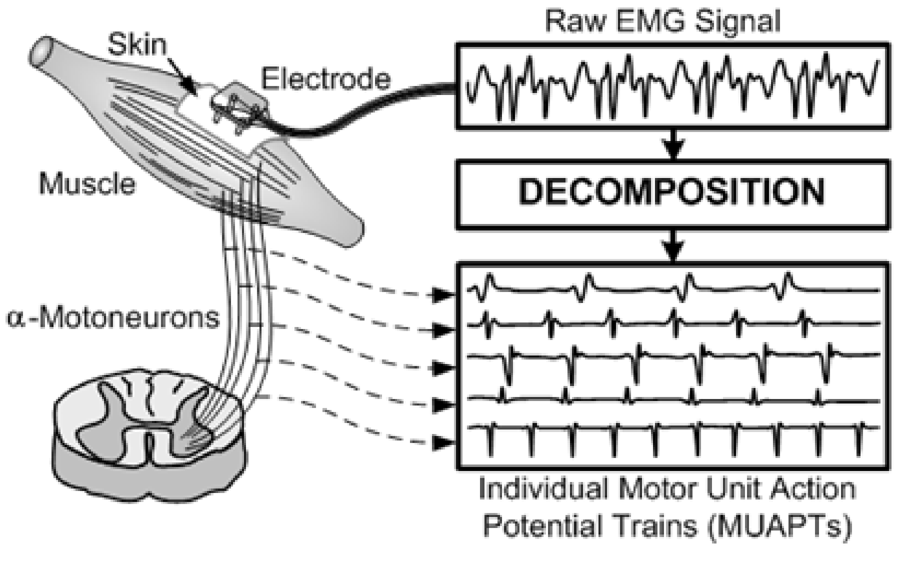

Figure 2.22 Decomposition of EMG signal
(www.bu.edu, 2016 April)

Upper extremity is functionally important part of body also industrial workers is suffering from Muscular Skeletal Disorders (MSD) related upper extremity. Recently still, lack of evidence about root cause of work related upper extremity disorders. Although there are studies on the risks of exercising above shoulder level, no studies were found that simultaneously monitored the electromyography activity of the muscles and grip. The main objective of this study is to investigate the electrophysiological outcomes of exercising above shoulder level, a major risk factor of work related upper extremity disorders, and its influence on grip in different working angles of the arm [7, 8, 55].

Upper extremity disorders are huge social problem in araound of World. Many government seeking for exact preventetive solutions. Beside of preventetive methods, they are looking for some new equipments. Boiomedical Engineering area a field to give answer this requirements [4]. Electrophysiologic measurement devices giving objective informations about body such as electromyography measurement.

Notional Institute Health has called the field as Biomedical Enginnering Area. Biomedical Enginnering area provide new measurement and treatment device to solve disorders and makes preventetive devices. Some resources call the area as Medicine Enginnering. Medicine Engineering is much more big area such as have genetic, tissue, bioinformatic studies.

As Biomedical Enginnering phd study, we try to put to the literature an information about preventetive and biomechanic aspects of work related upper extremity disorders. We will explain the biomechanic results of different working positions with using electrophysiological tests from biomedical engineering are and also physical tests from physiotherapy area [5,7,3].

There ise wide range of root cause of upper extremity disorders. But to call them as ‘work related upper extremity disorder we need to have objective results. As legal issue, to judge as work related disorder need to certain evidences about disorders but there is still lack of evidence about this kind of disorders [4,3].

Regard to requirement about work related disorders identification we set up this study as preventetive and biomechanic research. The main objective of the study is to find out clear and objective evidences about work related upper extremity disorders.

CHAPTER 3

METARIAL AND METHOD

The aim of this chapter is to introduce the properties of the materials that was used and the methods that was performed throughout this research.

3.1. Participants:

61 healthy Gelisim University College of Health Sciences students between the ages of 18 and 31 participated in the study. By having an arbitrary selection among the college students, 100 invitations were sent, and 70 students accepted. Exculusion criteria: Students with a neurological disability due to a musculoskeletal disease, a severe cardiopulmonary disease, severe hearing loss, a history of surgery within the past six months, a history of epilepsy and a chronic neurologic disease were not included. Prior to the study, the students underwent a physical exam and were asked to complete a questionnaire (Figure 3.1, 3.2.) (Appendix A)

Nine students were unable to participate: five were older than 30, one was diagnosed with acute multiple sclerosis, two had a chronic cardiopulmonary disease, and one had a chronic neurological disability due to a musculoskeletal disease. Data for 61 participants were collected, and 40 of the healthiest electromyography values were analyzed. Recordings with extreme noise; where the participant misunderstood the directions; or with a short grip duration were not considered to increase accuracy. (Figure 3.3)

Before the study, documentation of medical ethics was taken from the local ethics committee, Sadi Konuk Eğitim ve Araştırma Hastanesi with desicion number is 2015-06, and the project received approval from the Gelişim University Administration; additionally, each participant was given an informed consent form. (Appendix A)

Figure 3.1 Explaining of measurement cycle to the participant

Figure 3.2 Explaining of measurement

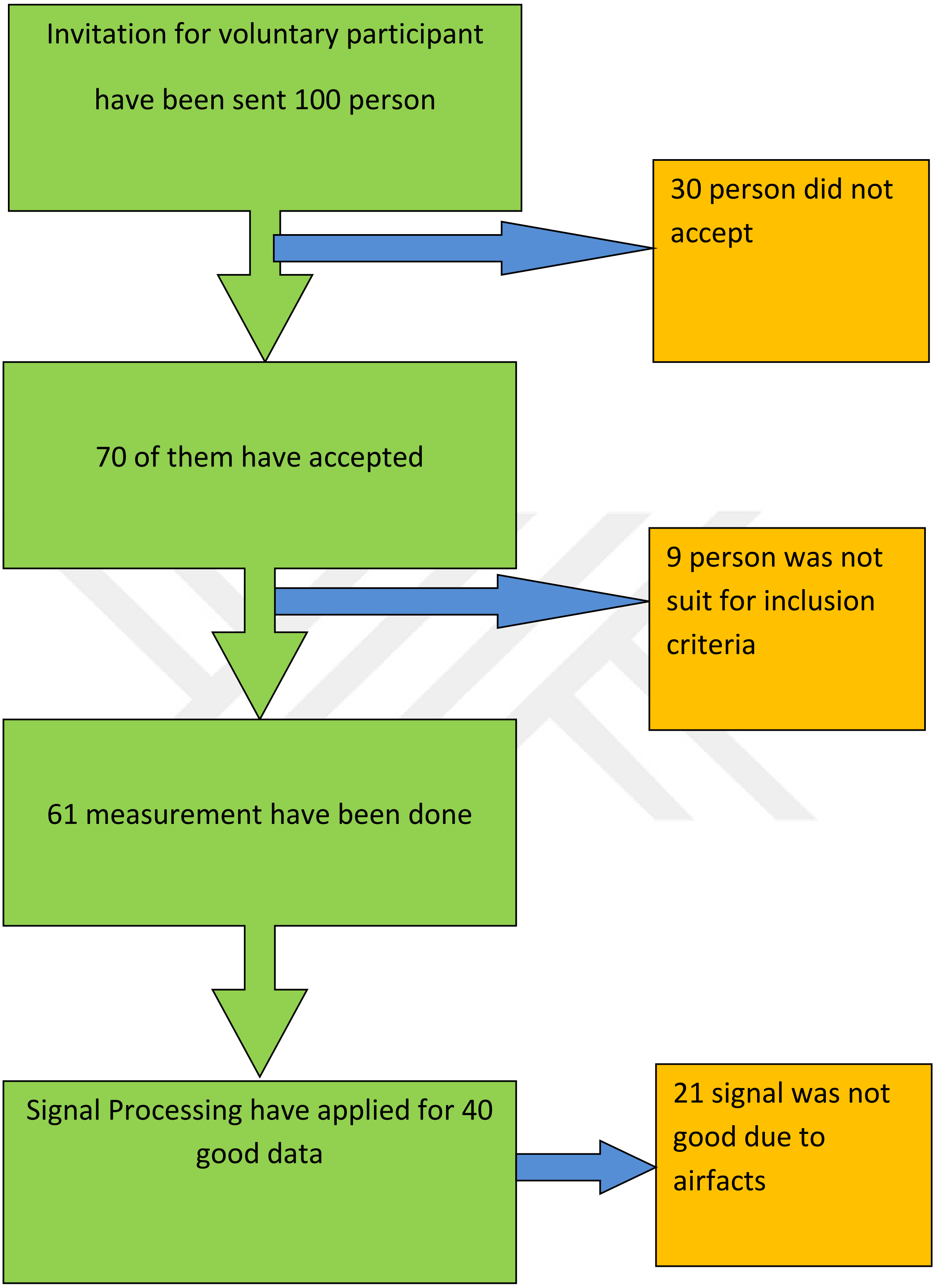

Figure 3.3 Selection of the participants and proceeding of data

Prior to the study, the students underwent a physical exam and were asked to complete a questionnaire. The informations such as age, gender and dominant hand have collected by using a questionarre which has been prepared before for the study. Additionaly, the informations have taken from the participants such as exercising behaviour, smoking and about past diseases (Appendix B).

2.2. Methods

3.2.1. Collectiong Electromyoraphy Signals and Hand Grip Strength

BIOPAC (bio electro signal collection device) was used to measure changes in the electromyographic activity of the muscles related to stabilization of the shoulder and contributing of movements and gripping of upper extremity. For gripping Maximum Voluntary İsometric Contractions (MVIC) were measured to quantify the action potentialof all the muscles. The EMG signals were processed as full-waves once they were collected at a sampling signal acquisition rate of 1,000 Hz. The raw data measured for standardization were converted to root mean squares (RMS). (Figure 3.4-3.6)

Figure 3.4 Measurement device Parts -1 (a-USB enterence, b-DC Input)

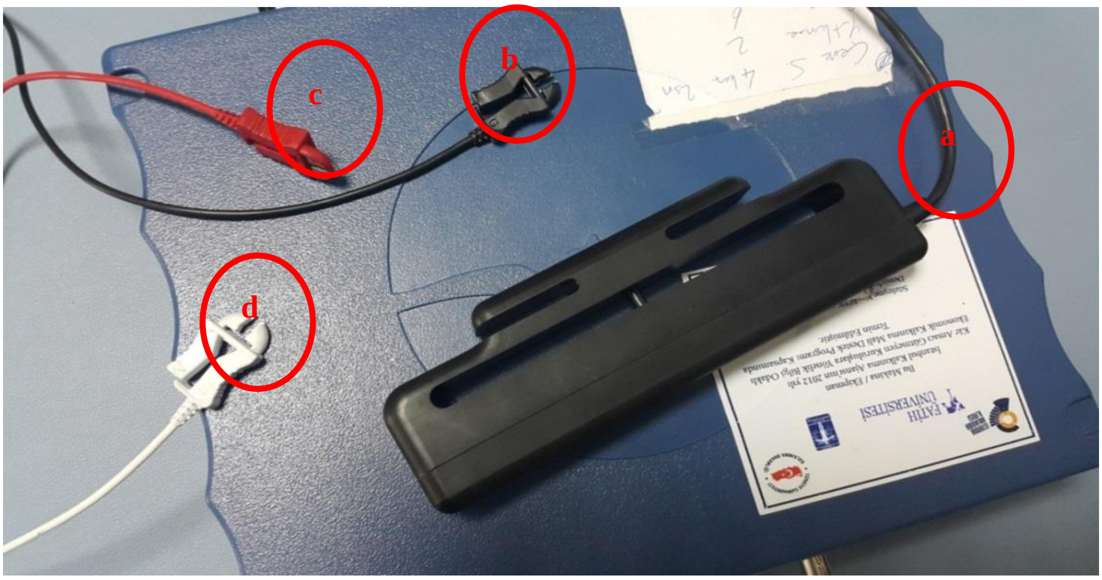

Figure 3.5 Measurement device parts -2

(a-grip dynamometer, b-grounding electrodes, c and d- motor point electrodes)

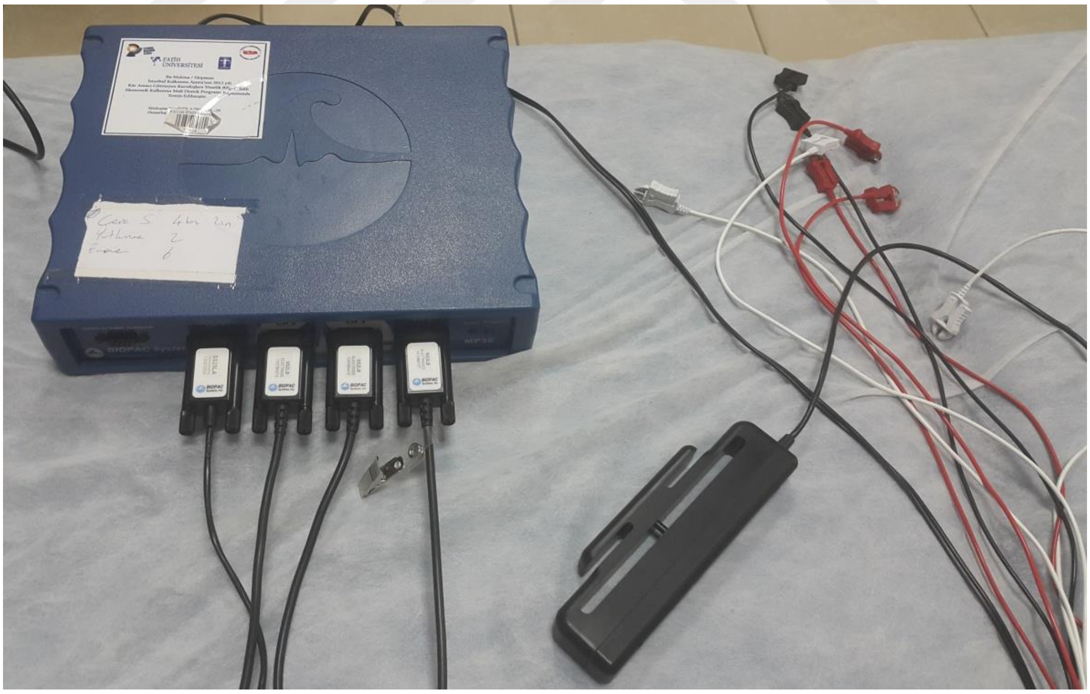

Figure 3.6 Measurement device parts -3 (Connecting of all channels)

Figure 3.7 Measuerement place
(Istanbul Gelişim University, Physiotherapy Labratory)

Upon arrival to measurement area as see in Figure 3.7, students were asked to rest for 30 min and refrain from overexerting their hands. Students with hairy arms were asked to get a trim, and the students' arms were shaved prior to the measurements. Participants were informed on the objectives, measurement procedures, grip duration, rest breaks, movement positions and repetitions. (Figure 3.8).

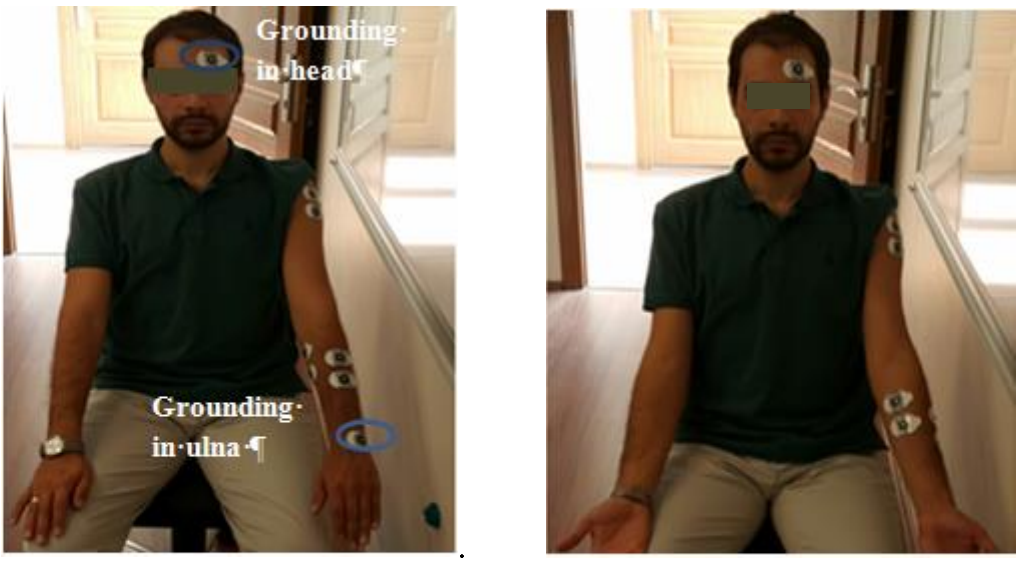

Figure 3.8 Placement of Grounding Electrodes, head and ulnar styloid

Grounding electrodes were placed on the ulnar styloid, olecranon and forehead (Figure 3.8, 3.9). For the measurements, a 2-cm diameter Ag-Ag/Cl electrode were placed in 0,5-cm intervals on the anterior deltoid and motor points of the wrist extensors and flexors determined by a physiotherapist (Figure 3.9, 3.10). Grip strength was measured by the dynamometer of Biopac Systems, Santa Barbara, CA, USA in pounds, and EMG measurements were between 0 and 1000 mhz. Measurements were taken five positions with three repetitions, including four shoulder angles and a standard grip (Table 3.2) [20-21, 56-58].

Figure 3.9 - Placement of Grounding Electrodes, olecranon

Table 3.2 Position names according to shoulder and elbow degree

Shoulder Flexion	Position Name
0 °	**1**
45 °	**2**
90°	**3**
135 °	**4**
0 ° Shoulder Flexion, 90° Elbow	**Standard Grip Test Position**

Figure 3.10 Surface Electrodes Ag-CL, Kendal Brand

During the measurements, a 2-cm diameter Ag-Ag/Cl electrode (Figure 3.10) were placed in 0,5-cm intervals on the anterior deltoid and motor points of the wrist extensors and flexors determined by a physiotherapist. To make motor point determination an isometric contraction expected from each muscles such as wrist extansion for extensor group muscles in posterior side on forearm, wrist flexion for anterior side of forearm and shoulder flexion for ant. Deltoid muscle. Most contractile area in each muscle has determined as motor point to take EMG.

Practice Application Order:

1. Inform the participant about the study by introducing the movements (Figure 3.11).

Figure 3.11 Introducing of measurements movements

2. Provide the participant with an informed consent and a healthy life questionnaire (Appendix C)

3. Seat the participantand adjustthe height of the chair (Position hips and knee at 90° with feet placed completely on the ground) (Figure 3.12) [7,8]

Figure 3.12 Seating correction of the participant

4. When the participant is sitting 10 cm from the wall, mark the position of the acromion on the wallas a pivot.

5. Use the pivot to mark the grip and flexion points at 0°,45°,90° and 135° (Table 3.1) for each participant (a physiotherapist marks the points with removable colored play dough that is in (Figure 3.13)

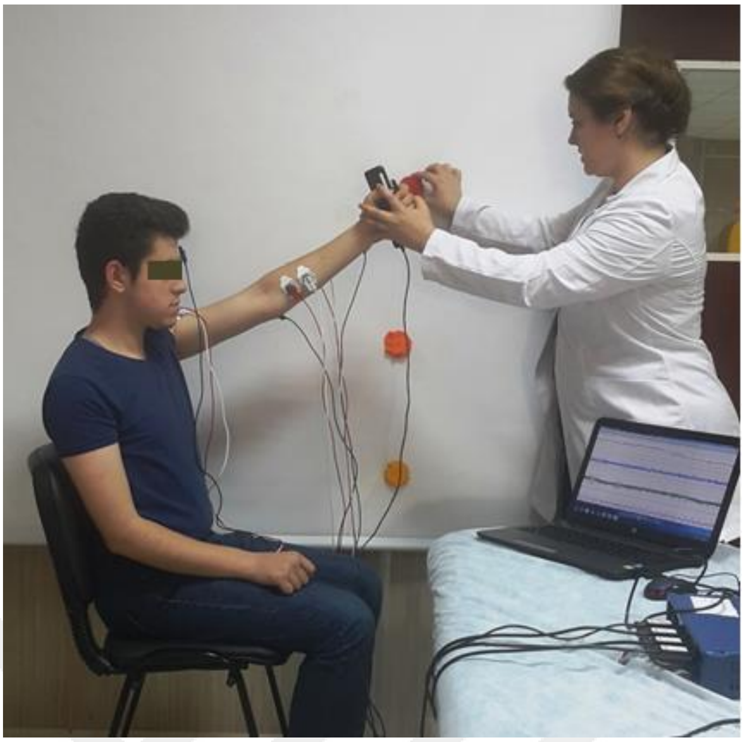

Figure 3.13 Colored marks position during measurement

6. Surface electrodes are placed on the anterior deltoid and the hand wrist flexors and extensors. The motor points are identified by a physiotherapist by palpating the isometric contraction at the middle of the joint on each participant (Figure 3.14).

Figure 3.14 Surface electrodes placement by physiotherapist

7. Motor point electrodes are placed on each muscle in0.5-cm intervals. Grounding electrodesare placed on the olecranon (flexors), the ulnar styloid (extensors) and the forehead (deltoid). (Figure 3.15.)

Figure 3.15 Grounding electrodes Identification
(a-forehead, b-olecranon, c-ulnar styloid)

8. Channels were connected in the following order throughout the study: (Figure 3.16)

Figure 3.16 Channnels of measurement cycle
(CH 1.Hand dynamometer, CH 2.Extensors, CH 3. Flexors CH 4. Deltoid)

9. Measurements were taken at 0°, 45°, 90°, 135° and standard grip, respectively, for three repetitions per position. In each measuring step, a 30 s break is given. Directions are given based on the chronometer. (Figure 3.17., Figure 3.18, Figure 3.19)

Figure 3.17 Measurements in different degrees.

Figure 3.18 Arm positioning correction during measurement

Figure 3.19 Arm positioning correction-2 during measurement

As explained before, measurements has been done with a sequence. Each measurement cycle applied as standart about gripping time, arm positions, gripping duration. To make biofeedback effect we choose to use colored markers on the wall. The participants well informed about the measurement cycle. Wrong measurements has been cancelled and repead again after necesarry resting period.

Signal Processing and Statical Analysis

Body signal is everthing in Daily life which are we see, if we see them in medicine or biology we call them as biosignal. For example, if we wants to take body signal from person such as body temperature or heart rate we can call them as physiologic signals. Physiologic signals are subtitle of the biosignals. A health Professional may take thish kind of signals frequently in working time. Electrocardiography (ECG), Electroencephalogram (EEG), Electrooculogram (EOG), and Electromyogram (EMG) have range of using area as biomedical signal in biomedical enginnering and medicinal practice. They offer as to make clear of body working. [48]

Bio signal anaysis is a tool to make understanding of body signals has which meanings about health sitiuation of person or root cause of clinical problem. Bio signal processing offering us to making images about the situaion.

There is wide range of body signals about identification such as analog or digital. A biosensor carry signal to measurement device. A biosensor is interacts with body to catch a signal to measurement device. After collecting datawith biosensors, biosignal techniques are appling to make clear of the body signals. There is wide range of methods to transfer of information to understantable images such as sampling, quantization and fourier transforms. These methods make to body signals as clear visual images and graphs.[55]

EMG signals and grip strength were recorded with a BIOPAC system. Measurements for each participant were saved as an 8.5 min file, which was analyzed with MATLAB. During the procedure 15 grip actions were made, an algorithm is improvedto calculate the instant of gripping. The points greater and lower than the mean were identified, and the points greater than the mean were defined as the grip point. To increase the algorithm's accuracy, disconnections less than 3 s were connected, and grip times less than 3 s were eliminated.

The root mean square of EMG signals with corresponding grip times were calculated using the Formula below. Then, the mean for grip is calculated. Lastly, the process is repeated for each participant, and the average mean is calculated. Thus, the individual results from the three channels and five positions were compared using the RMS.

$$X_{RMS} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2}$$

Figure 3.20 RMS Formula

CHAPTER 4

RESULTS

After electromyography and gripping force measurement with BIOPAC machine, we transferred the measurement files to the MATLAB programme.We analysed the results in MATLAB program. MATLAB is software which provides to make clear and able to analyse the EMG or other body signals. We used 4 signals from upper extremity. One of them was grip force recorded as kg and the other ones was electromyography recorded as Mili Volt (mV).

The maximum grip time for each subject was estimated using the force measuring signals. RMS of the related values was calculated. First, the average of the repetitions was calculated for every participant, and then, the group mean was calculated and added to the graph. Figure 4.1 shows the experimental values of maximum grip force for a single subject used to predict grip time and raw EMG values from the three channels. During measurement cycle we give to the participant information about grip and relax timing. For example, in Figure 4.1, the change in raw EMG values of the deltoid can be seen with the naked eye. Each highest level of contraction estimated by MATLAB automatically.

During the movement and gripping of upper extremity, we have take EMG signal from m. Deltoideus, extansor group muscles and also fleksor group muscles of wrist on forearm. Deltoid muscles was second active muscles during the movement of upper extremity (Figure 4.2). Fleksor muscles activation was less than m. deltoid ann wrist extansores (Figure 4.3). Also Figure 4.5 shows single grip force. Extansor group muscles have most bigger activity during each position of movement (Figure 4.4).

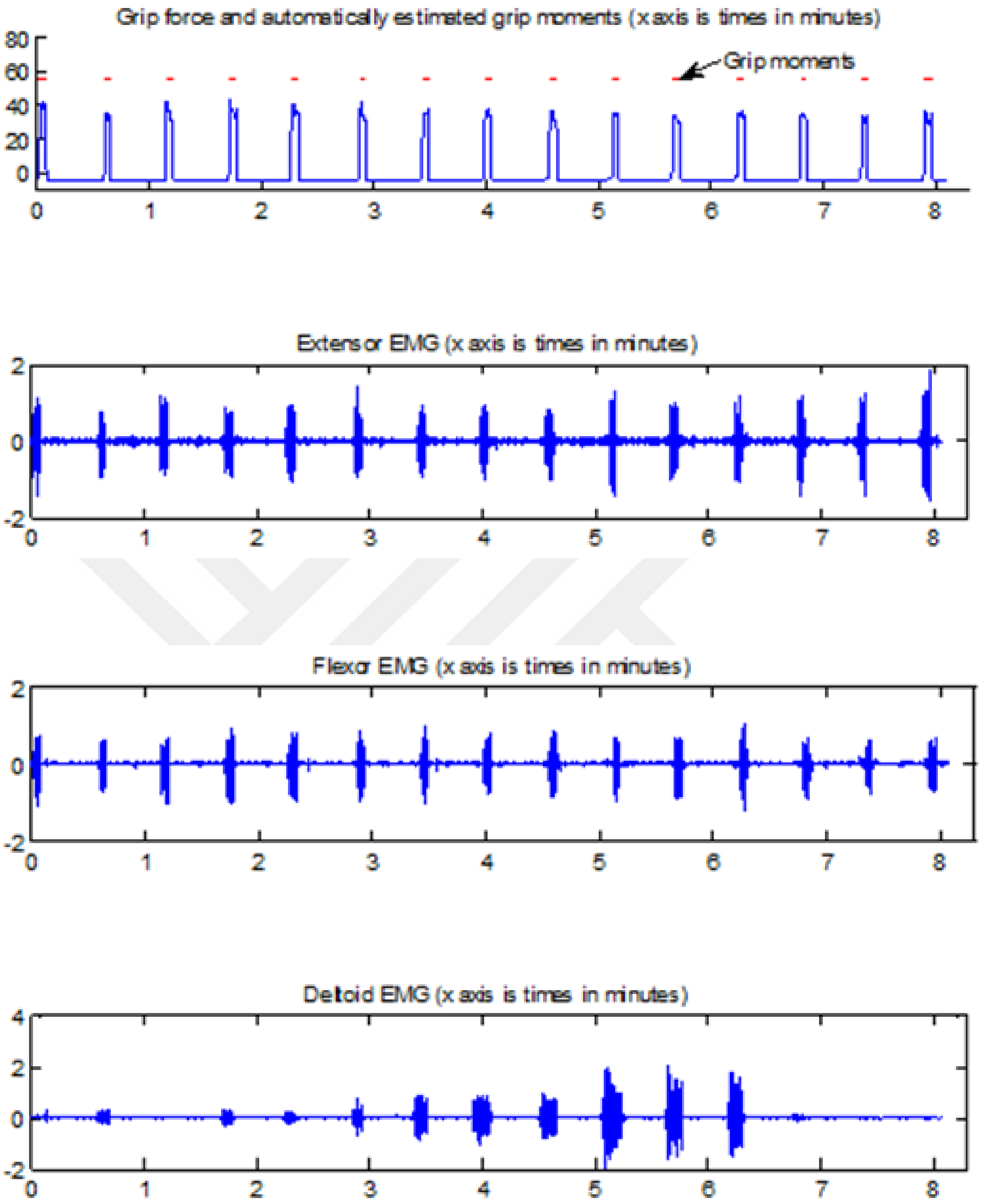

Figure 4.1 Estimating of gripping times in MATLAB

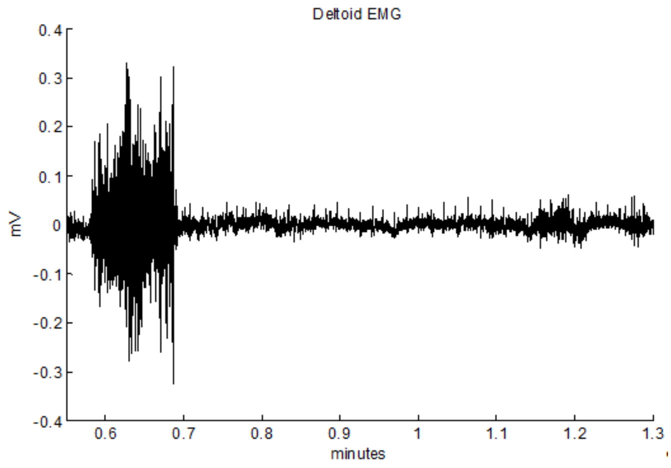

Figure 4.2 Deltoid EMG

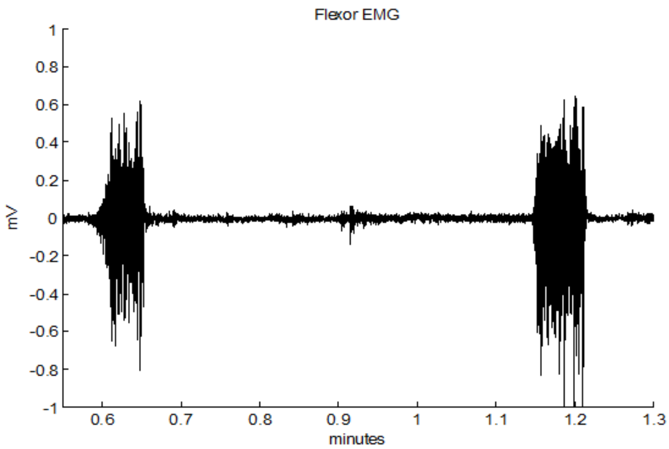

Figure 4.3 Flexor EMG

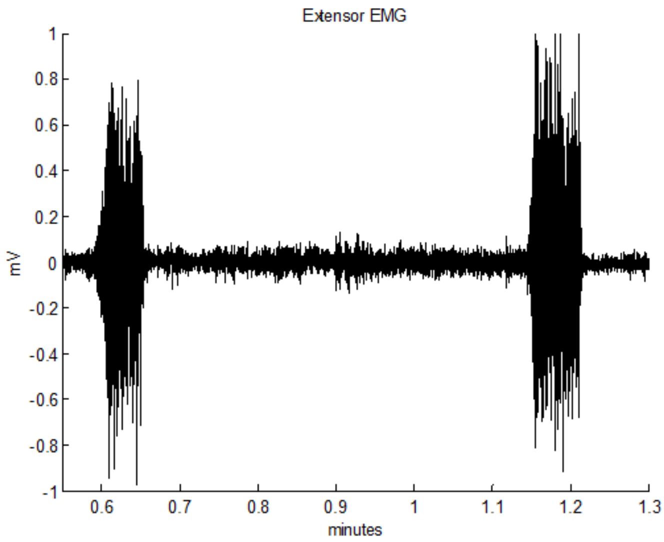

Figure 4.4 Extansor EMG

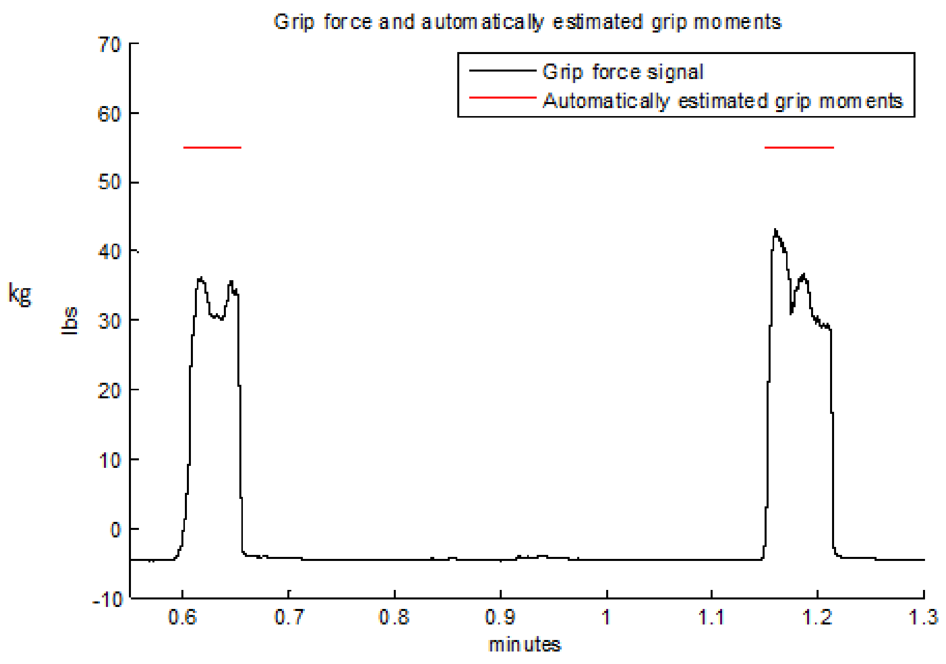

Figure 4.5 Grip force time automatic estimation

Grip moments estimated in MATLAB. During the measurement we told to the lead to participant to make maximum isometric contraction. This contraction times and durations showing in Figure 4.5 and Figure 4.6. In Figüre 4.6 is showing gripping duration. We told to the participant to make gripping 5 seconds (sc) and the graphing showing that generally we the participants achive this timing.

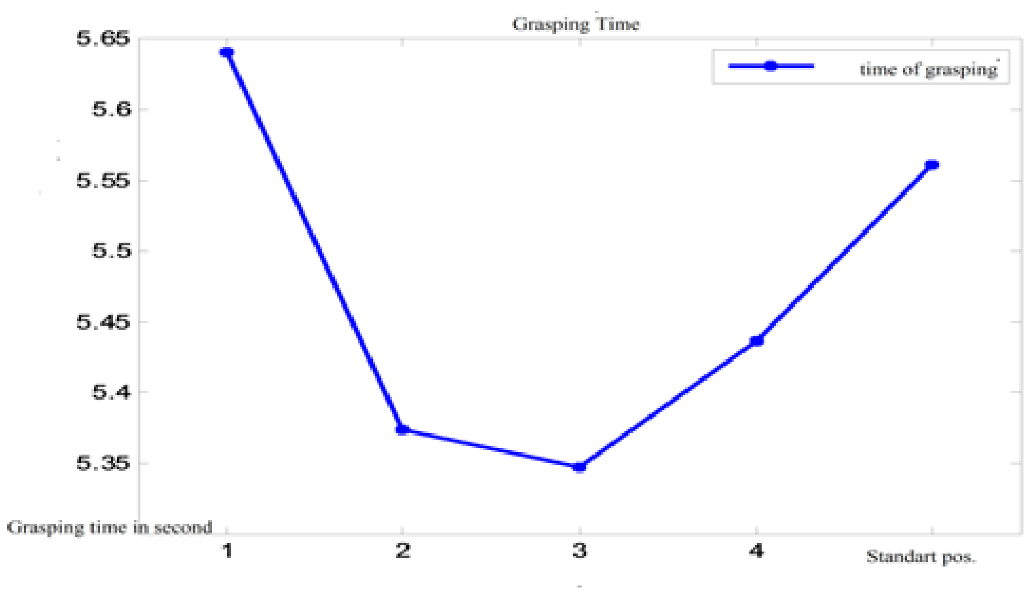

Figure 4.6 Time of grasping

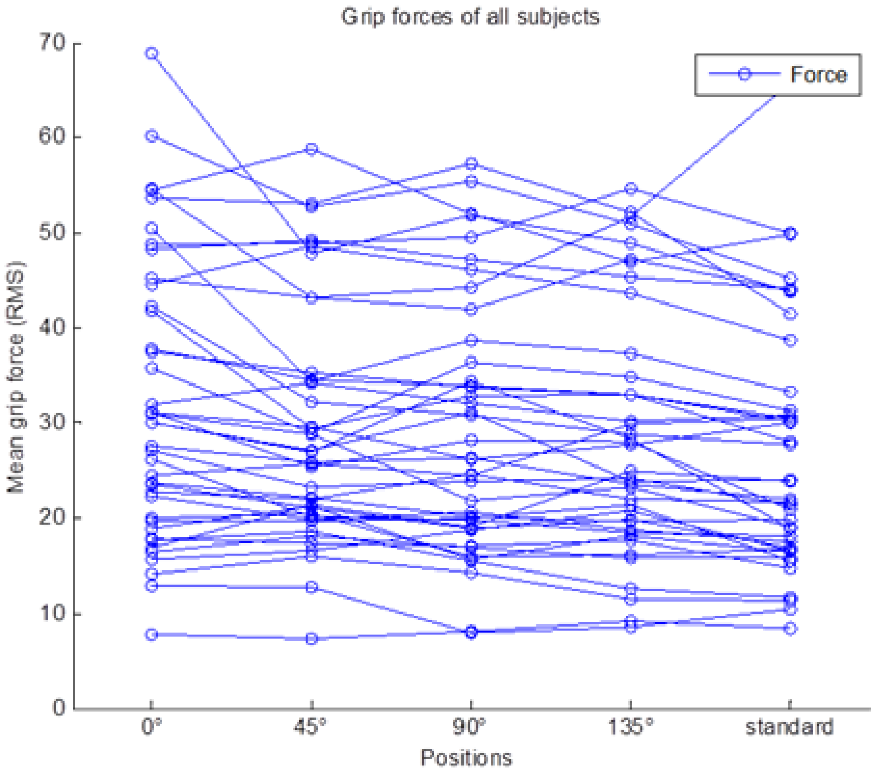

Figure 4.7 Grip forces of all participants

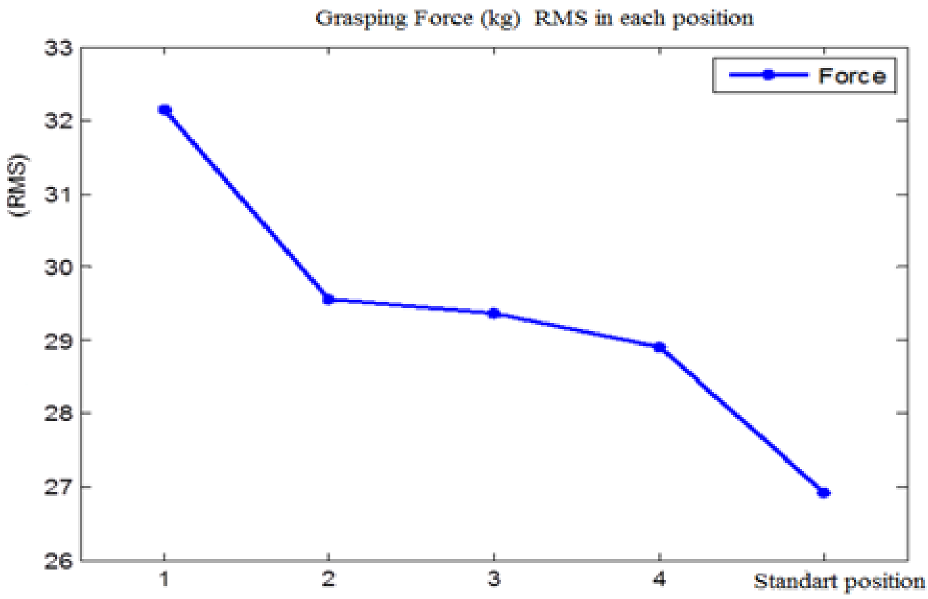

Figure 4.8 Grip Forces RMS in each position

According to results, the most active muscles during grip and shoulder flexion are the wrist extensors, but as shoulder flexion increases, the deltoid begins to activate.

As the Figure 4.9 showing shoulder flexion increases, overall muscle activity increases, and grip force decreases, this will be explained in discussion (Figure 4.10).Also standart deviations calculated for each signal (Figure 4.11).

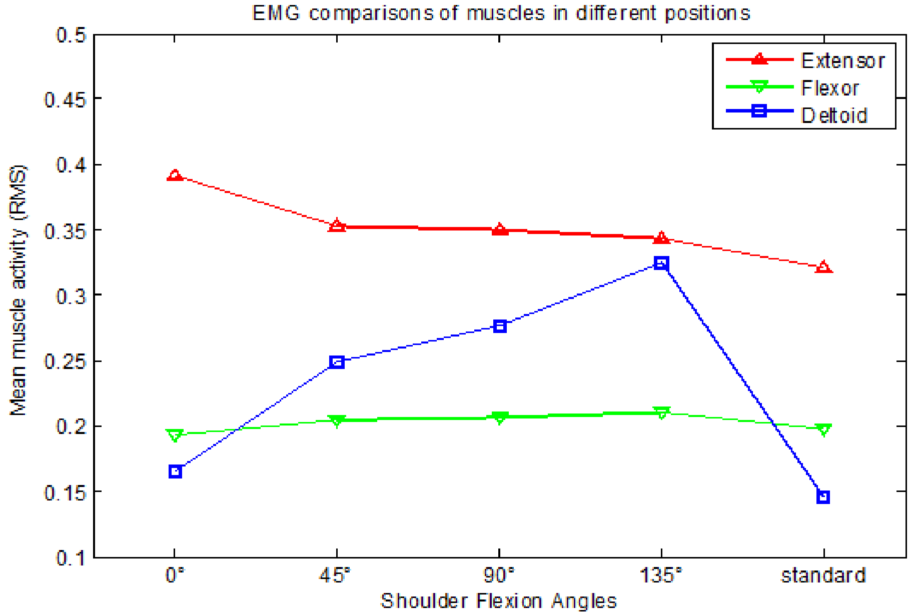

Figure 4.9 EMG comparisons of muscles in different positions

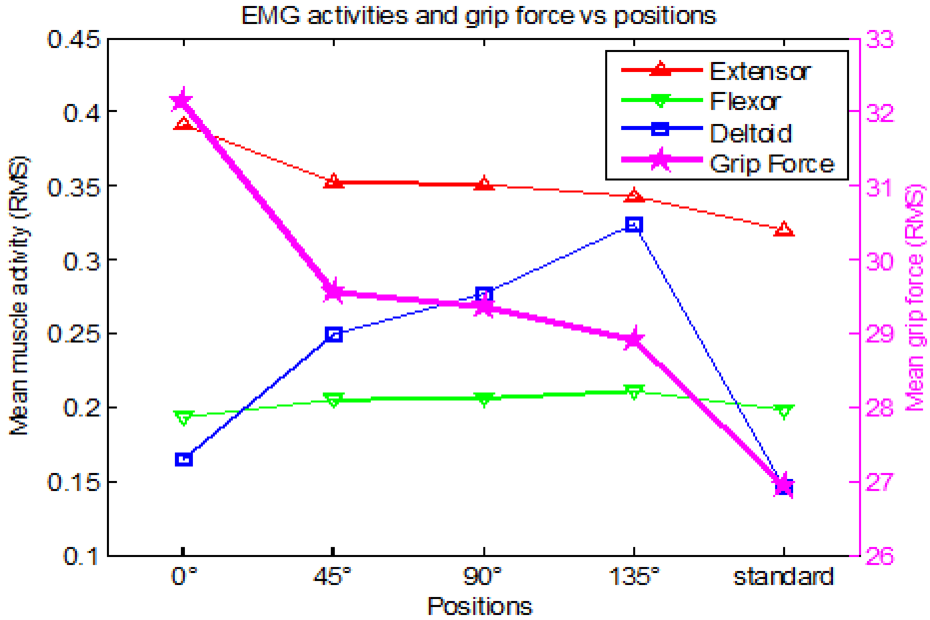

Figure 4.10 EMG activities and grip force vs positions

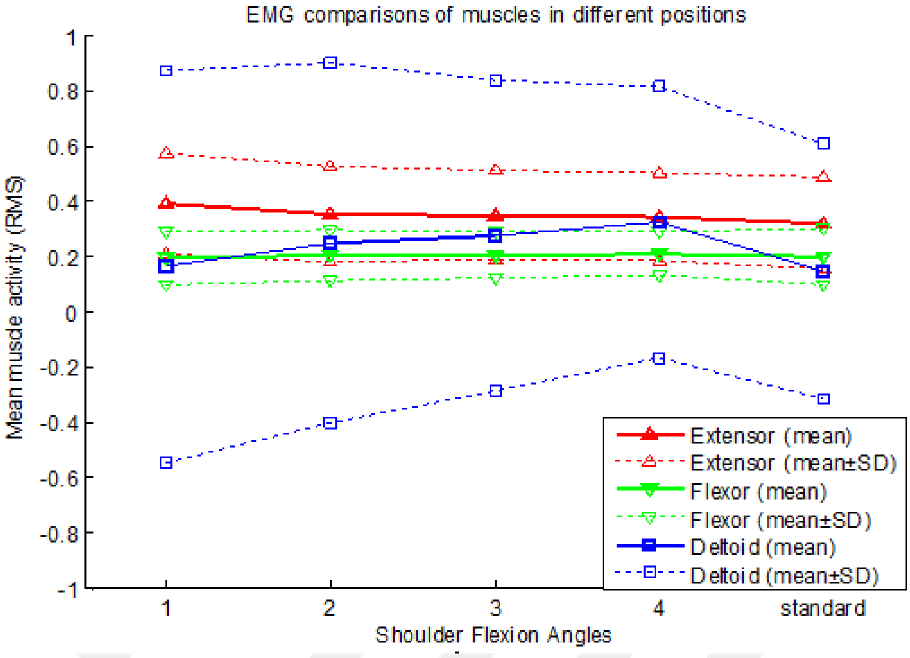

Figure 4.11 EMG activities means and standart deviations

ELECTROMYOGRAPHY RESULTS OF MUSCLES

EMG signal results of extansor muscles:

The most active muscles during grip and shoulder flexion are the wrist extensors, And we found statical meaningfull results that as shoulder flexion increases, overall muscle activity increases, and grip force decreases, this will be explained in discussion (Table 4.1 , 4.2.)

Table 4.1 Ekstansor Muscles Mean and SD changes in EMG signal analysis

Position Name	Mean ± SD
1*	0.39 ± 0.18
2	0.35 ± 0.17
3	0.35 ± 0.16
4	0.34 ± 0.16
5	0.32 ± 0.17

Table 4.2 T test for extansor group muscles EMG results accoording to 5 position

Comparing Positions	P value
1 and 4*	0.02863
2 and 4	0.66272
3 and 4	0.726
5 and 4	0.28111

EMG results of deltoid:

In this study we have take measurement from the anterior deltoid muscle. As shoulder flexion increases, the deltoid begins to activate. As the angle of shoulder flexion increases, deltoid activity increases at twice the rate ($p<0.05$) (Table 4.3,4.4)

Table 4.3 Deltoid muscle EMG signal mean and SD results (N=40)

Position	Mean ± SD
1*	0.16 ± 0.71
2	0.25 ± 0.65
3	0.28 ± 0.56
4	0.32 ± 0.49
5	0.15 ± 0.46

Table 4.4 T test for deltoid muscles EMG results accoording to 5 position

Comparing Positions	P value
1 and 4*	0.043251
2and 4	0.3113
3 and 4	0.4871
5 and 4	0.003913

EMG results of flexor muscles:

Electromyography measurement have taken from flexor group muscles where are anterior side of the forearm. Activity in the hand wrist flexors does not change with shoulder flexion (Table 4.5, 4.6.)

Table 4.5 Flexor muscle EMG signal Mean and SD results

Position Name	Mean ± SD
1	0.19 ± 0.10
2	0.20 ± 0.09
3	0.21 ± 0.08
4	0.21 ± 0.08
5	0.20 ± 0.10

Table 4.6 T test for flexor group muscles EMG results accoording to 5 position

Comparing Positions	P value
1	0.12336
2	0.59602
3	0.68525
5	0.28326

Hand grip strength results according to shoulder positions

RMS of each channel and maximum grip force of the dominant hand can be seen in 40 participants at various degrees of shoulder flexion in (Figure 4.6). The graph shows that the greatest activity in grip is observed in the extensors ($p<0.05$). As shoulder flexion increases, overall muscle activity increases, and grip force decreases (Table 4.7 ,4.8.)

Table 4.7Grip force results Mean and SD according to each position (N=40)

Position	Mean ± SD
1	32.14 ± 14.98
2	29.56 ± 12.84
3	29.37 ± 13.48
4	28.90 ± 13.19
5	26.94 ± 13.12

Table 4.8 T test for grip force accoording to 5 position

Comparing Positions	P value
1 and 4	0.076921
2and 4	0.69628
3 and 4	0.78662
5 and 4	0.24859

CHAPTER 5

DISCUSSION

5.1 Overview of overhead work

Overhead work is most serious working position for work related shoulder disorders. Industrial workers, frequently causes is awakward overhead postures and loading profiles to complete ordered task, potentially elevating injury risk. A seious correlation has been find between working with overhead work which approximately 90 of flexion and the development of MSD. Electromyography activity has frequently been used to calculate muscles mapping related with overhead work. Wulf et al, have shown that overhead work can cause to shoulder diseases according to their MRI based study results. [4]

In previous studies, it has been shown that performing exercises overhead is a serious risk factor for upper extremity disorders. This study focused on the change in upper extremity EMG values and grip force at different degrees of shoulder flexion. The objective was to observe the signals of overhead work on electrophysiology of upper extremity muscles and hand function [56-59].

Our study shows that working above shoulder level is the most exhausting position for upper extremity muscles. As the angle of the arm increases, hand function deteriorates. According to the outcome, overhead work is a risk factor for work related upper extremity disorders, and grip force deteriorates as the muscles fatigue while stabilizing the arm in an upright position. The third result found that in addition to reach and grip the upper extremity muscles also play a crucial role in stabilizing.

5.2 Deltoid muscle electromyography activation during overhead work

Won-Gyu Yoo et al. investigated the effect of exercises above shoulder level on electrophysiologic muscular activity. They found that overhead exercises cause fatigue in the superior trapezius and discomfort in the shoulder joint by affecting scapular position. In our research, we found that the deltoid was highly activated compared to other shoulder muscles at 135° shoulder flexion [60,61].

Overhead work cause to muscle fatigue on anterior deltoid muscle acoording to their EMG based study. They identified muscle fatigue that, combination of percevied

and an eventual decline in force production ability. Repetetive work has been shown to impair recovery when rest opportunities within day and between work shifts are inadequate [60,61].

According to these results, overhead work causes fatigue in muscles that are directly and indirectly inserted in the shoulder. In this study we find that increasing in shoulder flexion during the work cycle, muscle activity increasing and this can contrubuted to shoulder disorders.

5.3 Extansor Muscles

Haggand et al. found that wrist flexors showed more fatigue than extensors during grip in their electrophysiological research on grip force. indicated that wrist extensors contracted against flexors during grip, showing how wrist extensors become more active during grip. In another biomechanical model, the relationship between the wrist extensors and flexors is clarified through the torque principle between the hand and wrist [62].

Our study also shows that wrist extensors were more active. We observed that extensors are crucial in stabilizing the upper extremity. Although the flexors performed finger flexion for the intial part of grip, the wrist extensors became more active to stabilize the wrist.

5.4 Grip Strength

According to our study, the upper extremity exerts considerable energy as a stabilizer in addition to its more common functions of reach and grip. Grip force is closely related to upper extremity force. The shoulder joint provides stabilization during grip to perform the appropriate movement. The shoulder’s main function is flexion, and it is frequently used in daily activities. Therefore, our research investigated how shoulder flexion influences grip force. No studies investigating this relationship were found. In our research, the greatest grip force was observed in 0° shoulder flexion, which showed a reasonable decline as shoulder flexion increased.

According to our findings, the upper extremity exerts force to lift and stabilize the arm during shoulder flexion, resulting in the decline of grip force. The decline in grip force with increased shoulder flexion can be interpreted as hand function decline. In this regard, overhead work causes shoulder muscle fatigue and prevents effective hand function, which affects occupational health and efficiency [63].

CONCLUSIONS AND RECOMMENDATIONS

Overhead work is a crucial risk factor of work related disorders. Because the worker is unable to perform adequate grip functions, he/she becomes fatigued, decreasing efficiency. If the force exerted by the worker to hold his arm up is decreased, it will reduce the risk for disorders and increase efficient utilization of the hand, which will bring about the acquisition of health, time and workforce [64-70].

Limitations of the study are, we could not choose needle electrodes due to etic rules difficulty. Electromyography measurements is sensetive measurements due to some artifacts such as noise, magnetic field, fatty tissue and lack of biofeedback during measurement. We tryed to come over this problem during the signal processing with cleaning of artifacts in signals. [71-80].

Deltoid muscles and extansor group muscles become fatigued after upper extremity working. Preventetive exercises trainings should be use to struggle cumulative trauma disorders. Regulary checks should be use to detect early symtoms on workers. Grip forces is recently use for detect to hand and upper extremity disorders symptoms and after the study we offering also electromyography analysis can be usefull early detection methods to help preventetive physiotherapy solutions in workplaces [3,81,82].

According to our research, overhead work places workers in a hazardous position and decreases efficiency. Ergonomic solutions should be developed to prevent muscle fatigue and decreased grip force. A carrying system may be used for the weight carried by the worker. Moreover, it is recommended to rotate task among the overhead workers to protect the upper extremity muscles. To allow effective rotation system, the human resource departments should work with health and safety requirements. Lack of technic skill is handicap for rotational working. Also, physiological requirements must be solve regards to human nature, such as long working hours, not enough micro breaks [83-95].

Ergonomic solutions must be apply and also ergonomic workplaces must be design according to antropomethric datas. Ergonomy is a science to make worker and workers balance to healthy working life. Some interventions such as exercise trainings and functional capasity evaluations are already offering by occupational physiotherapists.

Innovative research teams should be establish from health and engineering proffesionals such as occupational physiotherapists, occupational doctors, ergotherapists and biomedical engineers. We observe that lack of biomedical device in this field to make effective early detection, design and follow up health situation [101-104].

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CURRICULUM VITAE

Name Surname: Gülşah Kınalı

Place and Date of Birth: Sakarya / 15-05-1982

Address: Orta Mah, 1 Nolu Sok. No:25 – Sakarya / Adapazarı

gulsah.kinali@gmail.com

B.Sc. : Abant Izzet Baysal University, Physiotherapy and Rehabilitation (2005)

M.Sc. : Abant Izzet Baysal University, Health Science Institute (2009)

Physiotherapist 2005-2006 **Adatıp Hospital***(Clinic applications in physiotherapy)*

Specialist 2007 – 20012 **Toyota Motor Manufacturing Turkey** *Outsource (Ergonomy programs management, worker rehabilitation, preventetive physiotherapy)*

Paediatric Physiotherapist 2013-2014 **Avrupa Çocuk Rehabilitasyon Merkezi** **(** *Developmental children disorders rehabilitation)*

*Lecturer, **İstanbul Bilim University** 2012-2013, (Physiotherapy dept. Teaching)*

*Lecturer, **İstanbul Gelisim University** 2013-…(Physiotherapy dept. Teaching)*

Articles

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APPENDIX-A

T.C. SAĞLIK BAKANLIĞI BAKIRKÖY DR. SADİ KONUK EĞİTİM VE ARAŞTIRMA HASTANESİ

BAKIRKÖY DR. SADİ KONUK EĞİTİM VE ARAŞTIRMA HASTANESİ

KLİNİK ARAŞTIRMALAR ETİK KURUL DEĞERLENDİRME FORMU

K-Q TSE-ISO-EN 9000

BAŞVURU BİLGİLERİ		
	ARAŞTIRMANIN AÇIK ADI	**Sağlıklı Bireylerde Farklı çalışma pozisyonlarında el ve üst ekstremite kaslarının elektrofizyolojik ve fiziksel testlerinin yapılması**
	ARAŞTIRMA PROTOKOL KODU	**2015/79**
	KOORDİNATÖR/SORUMLU ARAŞTIRMACI UNVANI/ADI/SOYADI	**Öğr.Gör. Gülşah Kınalı,Arş.Gör. Mustafa Selman Yıldırım, Prof.Dr.Sadık Kara**
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ UZMANLIK ALANI	**Gelişim Üniversitesi**
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ BULUNDUĞU MERKEZ	**Gelişim Üniversitesi Fizyoterapi ve Rehabilitasyon**
	DESTEKLEYİCİ	
	DESTEKLEYİCİNİN YASAL TEMSİLCİSİ	
	ARAŞTIRMANIN FAZI	
	ARAŞTIRMANIN TÜRÜ	Diğer ise belirtiniz:Prospektif Gözlemsel
	ARAŞTIRMAYA KATILAN MERKEZLER	TEK MERKEZ ☒ ÇOK MERKEZLİ ☐ ULUSAL ☐ ULUSLAR ARASI ☐

DEĞERLENDİRİLEN BELGELER	Belge Adı	Tarihi	Versiyon Numarası	Dili
	ARAŞTIRMA PROTOKOLÜ	30.03.2015	1	Türkçe ☒ İngilizce ☐ Diğer ☐
	BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU	30.03.2015	1	Türkçe ☒ İngilizce ☐ Diğer ☐
	OLGU RAPOR FORMU	30.03.2015	1	Türkçe ☒ İngilizce ☐ Diğer ☐
	ARAŞTIRMA BROŞÜRÜ			Türkçe ☐ İngilizce ☐ Diğer ☐

DEĞERLENDİRİLEN DİĞER BELGELER	Belge Adı		Açıklama
	ARAŞTIRMA BÜTÇESİ	☒	
	DİĞER:	☐	

KARAR BİLGİLERİ		
	Karar No:2015/06/17	**Tarih: 30.03.2015**
	Yukarıda bilgileri verilen başvuru dosyası ile ilgili belgeler araştırmanın/çalışmanın gerekçe, amaç, yaklaşım ve yöntemleri dikkate alınarak incelenmiş ve uygun bulunmuş olup araştırmanın/çalışmanın başvuru dosyasında belirtilen merkezlerde gerçekleştirilmesinde etik ve bilimsel sakınca bulunmadığına toplantıya katılan etik kurul üye tam sayısının salt çoğunluğu ile karar verilmiştir. Klinik Araştırmalar Hakkında Yönetmelik kapsamında yer alan araştırmalar/çalışmalar için Türkiye İlaç ve Tıbbi Cihaz Kurumu'ndan izin alınması gerekmektedir.	

BEAH KLİNİK ARAŞTIRMALARI ETİK KURULU	
ÇALIŞMA ESASI	Klinik Araştırmalar Hakkında Yönetmelik, İyi Klinik Uygulamaları Kılavuzu
BAŞKANIN UNVANI / ADI / SOYADI:	**Uz. Dr. Gülsüm Oya HERGÜNSEL**

Unvanı/Adı/Soyadı	Uzmanlık Alanı	Kurumu	Cinsiyet		İlişki *		Katılım **		İmza
Uz. Dr. Gülsüm Oya HERGÜNSEL	Anesteziyoloji	BEAH	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐	
Doç. Dr. Sadık Sami HATİPOĞLU	Çocuk Hastalıkları	BEAH	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐	
Prof.Dr. Ayşe KAVAK	Dermatoloji	BEAH	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐	
Prof.Dr. Fatma Tülin KAYHAN	K.B.B.	BEAH	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐	
Doç.Dr. Özlem KAPTANOĞULLARI	İç Hastalıkları	BEAH	E ☐	K ☒	E ☐	H ☒	E ☒	H ☐	
Prof.Dr. Osman KARAKAYA	Kardiyoloji	BEAH	E ☒	K ☐	E ☐	H ☒	E ☒	H ☐	
Uzm. Dr. Asuman GEDİKBAŞI	Biyokimya	BEAH	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐	
Prof.Dr. Ufuk EMEKLİ	Plastik Ve Estetik Cerrahi	İ.Ü.İst. Tıp Fak.	E ☒	K ☐	E ☐	H ☒	E ☐	H ☐	
Prof.Dr. Gülsüm Nurhan İNCE	Halk Sağlığı	İ.Ü.İst. Tıp Fak.	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐	
Uz. Dr. Gülay ÖZGÖN	Farmakolog	İ.Ü.Cerrahpaşa Tıp Fak.	E ☐	K ☒	E ☐	H ☒	E ☐	H ☐	
Prof.Dr.Abdülbaki KUMBASAR	İç Hastalıkları	İ.Ü.İst. Tıp Fak.	E ☒	K ☐	E ☐	H ☒	E ☐	H ☐	
Can ÇELİK	Biyomedikal	Dijimed Bil.Çöz.	E ☒	K ☐	E ☐	H ☒	E ☐	H ☐	
Rana KONYALIOĞLU	Biyoistatistik	ARK İst. Danış.	E ☒	K ☐	E ☐	H ☒	E ☐	H ☐	
Avukat Özkan TÜM	Hukuk	İst. Sağ. Müd.	E ☒	K ☐	E ☐	H ☒	E ☐	H ☐	
Selim ÖZDEMİR	Eğitim Görevlisi	Şükrü Balcı MYO	E ☒	K ☐	E ☐	H ☒	E ☐	H ☐	

APPENDIX -B

Gönüllü olarak katılmış olduğunuz bu çalışmanın adı: ''Sağlıklı Bireylerde Farklı çalışma pozisyonlarında el ve üst ekstremite kaslarının elektrofizyolojik ve fiziksel testlerinin yapılması''dır. Çalışma bilimsel bir araştırmadır. Araştırmanın amacı el kaslarının farklı çalışma pozisyonlarında ortaya çıkardıkları elektrofizyolojik ve fiziksel durumların incelenebilmesidir. Bu amaçla araştırmada size elektromyografi testleri ve el kavrama kuvveti ölçümleri yapılacaktır.

Bu kapsamda araştırmaya katılan gönüllü olarak çalışma alanına rahat ve kol bölgenizi sıkmayan bir kıyafet ile gelmenizi, ölçüm saatinden yarım saat önce gelerek dinlenmenizi ve bu süre içinde mümkün olduğunca ellerinizle bir iş yapmamanız gerekmektedir. Bu bir araştırma çalışmasıdır ve size sonucunda herhangi bir tedavi uygulamasını içermemektedir. Çalışmaya katılmanız kendi isteğinize bağlıdır. İstediğiniz zaman hiçbir ceza ödemeksizin ayrılabilirisiniz.

Gereğinde bakanlık, etik kurul ve buna benzer otoriteler sizin kayıtlarınıza ulaşabilme yetkisine sahiptir, bu çalışmaya dahil olarak bunu kabul etmiş sayılırsınız. Araştırma yayınlansa dahi kimlik bilgileriniz kamuoyu ile paylaşılmayacak ve gizli tutulacaktır. Bu çalışmaya 200 sağlıklı gönüllü birey dahil edilecektir. Ölçümler için 1 kez gelmeniz ve 2 saat ayırmanız gereklidir.

Çalışma ile ilgili bir bilgi almanız ya da iletişime geçmeniz gerektiği halde Gülşah Kınalı ile 0 (539) 370 94 19 no'lu telefondan ya da gulsah.kinali@gmail.com e–mail adresinden ulaşabilirsiniz. Çalışmadan elde edilen veriler el kaslarının farklı çalışma koşullarındaki analizini sağlayacak ve bu konu ile ilgili araştırmalarda kullanılacaktır.

Lütfen aşağıdaki açıklamayı okuyunuz

Bilgilendirilmiş Gönüllü Olur Formundaki tüm açıklamaları okudum. Bana, konusu ve amacı belirtilen araştırma ile ilgili yazılı ve sözlü açıklama, aşağıda adı belirtilen kişi tarafından yapıldı. Araştırmaya gönüllü olarak katıldığımı, istediğim zaman gerekçeli veya gerekçesiz olarak araştırmadan ayrılabileceğimi ve kendi isteğime bakılmaksızın araştırmacı tarafından araştırma dışı bırakılabileceğimi biliyorum

Gönüllünün

Ad :

Soyad:

Tarih:

İmza:

APPENDIX-C (HEALTHY LIFE QUESTIONARRE)

Ad:

Soyad:

Cinsiyet

Yaş:

Telefon Numarası:

Dominant El:

Sigara Kullanımı: Hayır_

Evet_ Paket/Gün

Alkol Kullanımı: Hayır_

Evet_ Haftada kaç kez

Aktif Spor Alışkanlığı:

Hiç Yapmıyorum__

Haftada 3 kez'den az__

Haftada 3 kez'den fazla__

Daha Önce Geçirilmiş Hastalıklar:

....

Kullanılan İlaçlar:

....

Notlar:

....