



The National Ribat University
Faculty of graduate studies and scientific Research

**Detection of the peroneus quartus muscle in
Sudanese people by using MRI**

A thesis submitted in partial fulfillment Required for
MSc in Clinical Anatomy

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قال تعالى

بسم الله الرحمن الرحيم

وفوق كل ذي علم عليم

صدق الله العظيم

الآية 76

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Special Thanks to Dr. Mazin Abdulsattar for his help

Dedication

To my parents.

My dear wife for his selflessness support,

Patience and to be in my life

Kind people.....All Sudanese.

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مستخلص الدراسة

العضلة الشظوية الرابعة هي عضلة شظوية إضافية يمكن أن توجد في ساق الإنسان وبعض الحيوانات كالشimpanزي وبعض الثدييات ، وهناك القليل من البحوث المتعلقة بها .

أجريت هذه الدراسة لمعرفة نسبه وجود هذه العضله باستخدام فحص الرنين المغناطيسي على مفصل الكاحل لعينه عشوائيه من المرضى المراجعين لقسم الأشعه والتصوير الطبي في مستشفى الرباط الجامعي ومستشفى الأطباء في مدينة الخرطوم في جمهورية السودان وفي كلا الجنسين ولفئه عمريه محددة تراوحت من عشرون الى سبعون سنة.

الهدف من هذه الدراسة هو معرفة نسبة وجود العضلة الشظوية الرابعة في الرجال والنساء

ومعرفة موقعها وتواجد العضلة الشظوية الثالثة معها ومقارنة النتائج مع الدراسات السابقة.

أجريت هذه الدراسة على 100 مريض 62 (62%) من الذكور و 38 (38%) من الإناث وبعد إجراء الفحص تبين وجودها في 8 (8%) من المرضى 6 (6%) من الذكور، منفردة في 2 (2%) منهم ، بينما تواجدت مع العضلة الثلاثيه في 4 (4%) منهم ، فيما وجدت العضلتين مجتمعتين في 2 (2%) من إناث فقط.

من النتائج وبصوره عامة لوحظ وجود أي من العضلتين لا يعتمد على جنس الشخص كذلك

تبين أن وجودها في الذكور هو ضعفه عند الاناث و في القدم اليسرى أكثر من القدم اليمنى كما وأنه

ليس هناك أعراض مصاحبة لوجودها في معظم الحالات.

توصلت الدراسة الى أن وجود هذه العضلة ذو أهمية كبيرة حيث يمكن أن يُشخص عدم وجودها على أنه تمزق طولي أو قطع كاذب في العضلة الشظوية القصيرة أو فقدان في الإسناد إلوحشي للقدم خلال السير، وألم القدم بدون التعرض لإصابة ، و يمثل وجودها مصدر مهم للحصول على الأنسجة الترقيعية في عمليات جراحة الكسور الإصلاحية.

Abstract

Peroneus quartus muscle is an accessory fibular muscle that can be found in human legs and also present in chimpanzees and in a number of mammals.

This study was done to determine the proportion of the presence of these muscle using screening by MRI on the ankle of a random sample of patients who attended to the Department of Medical Imaging at The Ribat and AL-Atebaa hospitals in the city of Khartoum, in Sudan, of both sexes and with specific age.

Objectives of this work is to study the difference in the presence of peroneus quartus between males and females and to know its location and the presence of the muscle and the peroneus tertius together and to compare this study with previous studies.

This study was conducted on 100 patients, 62 (62%) of them were male and 38 (38%) females. The study showed that the muscle was present in 8 (8%) of the patients, 6 (6%) were males, in 2 (2%) of them found separately and with peroneus tertius in 4 (4%), while presented together in 2 (2%) females only.

Depends on the results it has observed that the presence of any of the two muscles does not depend on the sex of the person as well as showing that its presence in the male is twice than that in females and in the left foot over the right foot. Also there were no symptoms associated with its presence in most cases.

After completion of the study it has been concluded that the presence or absence of this muscle is of great importance, where it can explain that its misdiagnosis as a ruptured, longitudinal tear or loss of lateral supporting foot during walking, ankle pain without exposure to trauma, and represent an important source for tissue reconstruction in orthopedics surgery.

List of Abbreviations

Fig	Figure
GE	General electric
MRI	Magnetic resonance imaging
PQ	Peroneus quartus
PT	Peroneus tertius
SPSS	Statistical package for the social science
STIR	Short time inversion recovery (MRI pulse sequence)
Tab	Table
T1	T1 weighted image (MRI pulse sequence)
T2	T2 weighted image (MRI pulse sequence)
US	Ultrasound
Yrs	Years

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List of Figures

Fig	Title	Page
4.1	Gender distribution	10
4.2	Gender distribution	11
4.3	Side distribution in male	12
4.4	Side distribution in male	12
4.5	MRI STIR coronal cut of right ankle of male	13
4.6	MRI T2W image axial cut of left ankle of male	13
4.7	Side distribution in female	14
4.8	Side distribution in female	15
4.9	Side distribution in both sexes	16
4.10	Side distribution in both sexes	16
4.11	Incidence of PQ & PT in male	17
4.12	Incidence of PQ & PT in male	18
4.13	MRI T2W sagittal cut of left ankle of male	18
4.14	Incidence of PQ & PT in female	19
4.15	Incidence of PQ & PT in female	20
4.16	MRI T2 axial cut right ankle of female	20
4.17	Incidence of PQ in both sexes	21
4.18	Incidence of PQ in both sexes	22
4.19	Incidence of PQ only & PQ + PT	23
4.20	Incidence of PQ only & PQ + PT	23
4.21	Side distribution of PQ	24
4.22	Side distribution of PQ	25

List of Tables

Table	Title	Page
4.1	Gender distribution	10
4.2	Side distribution in male	11
4.3	Side distribution in female	14
4.4	Side distribution in both sexes	15
4.5	Incidence of PQ & PT in male	17
4.6	Incidence of PQ &PT in female	19
4.7	Incidence of PQ in both sexes	21
4.8	Incidence of PQ only &PQ + PT	22
4.9	Side distribution of PQ	24

Contents

Title	Page
AL-Ayah	I
Acknowledgement	II
Dedication	III
Abstract (Arabic)	IV- V
Abstract (English)	VI
Lists of abbreviations	VII
Lists of figures	VIII
List of tables	IX
The contents	X-XI
Chapter I: Introduction & Objectives	
1.1. Introduction	1-2
1.2. Justification	3
1.3. Objective:	3
1.1.1. General objective	3
1.1.2. Specific objective	3
Chapter II: Literature Review	
2.1. Gross anatomy	4-5
2.2. Previous study	5-6
Chapter III: Materials and Methods	
3.1. Study design	7
3.2. Study area and duration	7
3.3. Study population:	7
3.3.1. Inclusion criteria	7
3.3.2. Exclusion criteria	7
3.4. Study variables	7
3.5. Sampling:	7
3.5.1. Sampling type	7
3.5.2. Sampling size	8
3.5.3. Sampling technique	8
3.6. Data collection:	8
3.6.1. Data collection tools	8
3.6.2. Data analysis	8
3.6.3. Data management	8
3.7. Ethical considerations	9

Chapter IV:	Results	
4.1. Results		10-25
Chapter V:	Discussion	
5.1. Discussion		26-27
Chapter VI:	Conclusion and Recommendations	
6.1. Conclusion		28
6.2. Recommendations		29
Chapter VII:	References	
References		30-32
Appendix		
Data collection sheet		33

Chapter I

Introduction and Objectives

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1. Introduction and Objectives

1.1. Introduction

The peroneus quartus muscle is an accessory fibular muscle compartments that can be found in humans legs. It is also present in chimpanzees and in a number of mammals.⁽¹⁾ The muscle was first described by Adolph Wilhelm Otto,⁽²⁾ a German [anatomist](#) and was subsequently studied in detail by Hecker.⁽³⁾ It forms part of one of the three groups of muscle variations that occur in the ankle,⁽⁴⁾ (peroneus tertius, peroneus quartus, peroneus digiti minimi). In most cases, the presence of this muscle is asymptomatic, and it is detected by chance during the examination, autopsy or surgery.^(5, 6)

However, in some cases, its presence is associated with certain symptom: pain in the ankle, with or without trauma; dislocation, spraining, or tearing of the peroneus brevis tendon; tendon calcification; or painful hypertrophy of the retrotrochlear eminence.^(5, 6, 7) The presence of the PQ muscle may simulate a longitudinal tear in the peroneus brevis tendon, but is differentiated by the presence of the muscle, when a muscle belly separated from the muscle belly of the peroneus brevis is present. Peroneus quartus is closely associated with the tendon of the extensor digitorum longus muscle.⁽⁸⁾

In most cases, its origin is posterior to the bifurcation of the belly of the peroneal muscles or in the peroneus brevis muscle; it may also originate in the

posterior face of the fibula or in the peroneus longus muscle. Its insertion is also variable, thus explaining the variety of names that it has received: accessory peroneus muscle (inserts into the tendon of the peroneus longus, in the sole of the foot); fibulocalcaneus muscle (inserts into the retrotrochlear eminence); fibulocuboid muscle (inserts into the tuberosity of the cuboid bone, inferiorly); or fibuloperoneus longus muscle (inserts into the tendon of the peroneus longus muscle or into the inferior retinaculum of the peroneal muscles, adjacent to the retrotrochlear eminence, may send a small tendon to the fifth digit. ^(6, 9, 10)

The nerve supply is also variable, may supply by superficial peroneal or deep peroneal nerve and receives its arterial blood supply via the anterior tibial artery. The peroneus quartus muscle acts predominantly as a pronator for the foot as do the other peroneal muscles (longus and brevis). It has been successfully used in surgical procedures to repair and reconstruct the retinaculum of the peroneal muscles, in treating subluxation of the tendons. ^(6, 11)

Studies on the incidence of the peroneus quartus muscle have presented greatly varying results, along with greatly varying nomenclature. Studies on cadavers have presented incidence rates ranging from (13%) to (23%). By using US, it was found to be present in 22% of the sample, by (MRI), it was found in 10% of the examinations. ⁽⁶⁾

Its absence in prosimians and simians and presence in humans,⁽³⁾ is believed that this muscle was an indication of evolution or adaptation to the environment, given that its main function is to raise the lateral edge of the foot and stabilize its pronation, which are important for evolution and maintenance of bipedal posture.⁽⁹⁾ The presence of this muscle, along with the presence of the peroneus tertius muscle, constitutes a strong indication of anatomical adaptation of the human ankle to the bipedal condition, thereby contributing towards stabilization and reinforcement of this important joint. This suggests that the symptoms associated with its presence are an indication that this adaptation has not yet completed its evolution.⁽⁹⁾

Therefore, given the anatomical and clinical importance of this muscle, the aim of this study is to quantify the presence of the peroneus quartus muscle and correlate its incidence with the individual's sex and concomitant presence of the peroneus tertius muscle.⁽⁸⁾

1.2. Justification:

Presence of peroneus quartus muscle in human legs may explain pain in ankle joint and exclude the tear or the rupture of peroneus brevis tendon, and its absence may explain lack of lateral support of ankle joint and abnormal gait.

1.3. Objectives:

1.3.1. General objective:

Study the presence of the PQ muscle in the anterior compartment of the leg in adult Sudanese .

1.3.2. Specific objectives:

- To study the difference of presence of the PQ muscle among Sudanese males and females.
- To study the position of the peroneus quartus muscle.
- To study concomitant presence of peroneus tertius.
- To compare results with the previous studies.

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Chapter II
Literature Review

2. Literature review

2.1. Gross anatomy:

The three Compartments of the leg is form by two intramuscular septa of a strong tight membrane (deep fascia) called fascia cruris. The three compartments are; anterior (extensors); posterior (flexors); lateral (peroneal).⁽¹⁰⁾

The Anterior compartment bounded medially by the tibia, laterally by the anterior septum, the muscles originated from tibia and fibula, inserted in the metatarsal bones, receive these blood supply and innervations by the anterior tibial vessels and nerve, respectively.⁽⁹⁾ The muscles are; tibialis anterior; extensor hallucis longus; extensor digitorum longus; extensor digitorum brevis.⁽¹⁰⁾

The posterior compartment bounded medially by the tibia, laterally by the posterior septum, divided by transverse septum into a superficial and a deep group. The muscles originated from the back of the femur, tibia and fibula, and inserted in the tarsal, metatarsal and phalangeal bones of the foot. They receive blood supply and innervations by posterior tibial vessels and nerve respectively.⁽¹⁰⁾ The muscles are arranged into 2 groups; the superficial group contains: gastrocnemius, soleus, plantaris, and the deep group which contains: popliteus, flexor digitorum longus, flexor hallucis longus, and tibialis posterior.⁽¹⁸⁾

The Lareral (peroneal) compartment which is bounded anteriorly by the anterior septum, posteriorly by the posterior one, their muscles originated from lateral surface of fibula, and inserted in the tarsal and metatarsal bones.⁽⁹⁾ They receive blood supply from the anterior tibial vessels and nerve supply by the superficial and deep peroneal nerves. The muscles of this compartment contain:

peroneus longus, peroneus brevis, peroneus quartus (very rare), and peroneus tertius (rare).⁽⁹⁾

2.2. Previous study:

In 2014 study done by Mi Sunhur, Hyung Sunwon. In Hyuk Chung under the name (A new morphological classification of peroneus quartus muscle). Eighty lower limbs of 40 formalin fixed adult Korean bodies were used in this study. The PQ was present in 13(16.3%) of 80 specimens. In two specimens, each one had two PQ with different origins and insertion sites. Thus, 15 cases of PQ were found in 13 specimens. The PQ originated from the fibularis brevis muscle in 12 (15%) cases.⁽²⁰⁾ In these cases, the PQ arose either as a muscle or as a tendon. The muscle fibers of the PQ merged into a tendon (8 of 12 cases) and inserted variously into the tendon of the peroneus brevis in 3 (3.8%) cases; the lateral surface of calcaneus in 2 (2.5%) cases; the inferior peroneal retinaculum in 2 (2.5%) cases, or the dorsal surface of the base of fifth metatarsal bone in one case (1.3%). The PQ arose as a tendon from the peroneus brevis in 4 of 12 cases. In three of these four cases, the PQ inserted into the lateral surface of calcaneus. The PQ arose from structures other than the peroneus brevis in 3 (3.8 %) cases. This study has demonstrated a new classification for the PQ and its anatomical variations and provided detailed data for the accurate identification of this muscle and relevant surgical procedures.⁽²⁰⁾

In another study done by Sergio Ricardo Rios Nascimento, Renato Watanabe Costa, Christiane Regina Ruiz and Nader Wafer in Sao Paulo, Brazil (2012), under the name: (analysis of the incidence of the peroneus quartus muscle using MRI). They evaluated 211 of MRI examinations of the ankles or hind foot; all the examinations were performed using the Signa Horizon Lx machine with a 1.5 T magnetic field and a quadrature coil for knees.⁽¹⁹⁾

Of these 211 tests evaluated, 91 (43.13%) were men, 44 (48.35%) of them on the right side, 47 (51.65%) on the left side, and 120 (56.87%) were women, 56 (46.67%) of these on the right side, 64 (53.33%) on the left. The total of the Ankles examined on the right were 100 (47.39%) and on the left ankle were 111 (52.61%).

The PQ muscle was observed in 16 ankles (7.62%), 7 of these (43.75%) were female and 9 (56.25%) were male. Overall, it was observed the presence of muscle in 5 (31.25%) right ankles and 11(68.75%) left ankles. At the end the PQ muscle was found in (7.62%) of the population, 75% of the ankles containing the PQ muscle are found with PT muscle. ⁽¹⁹⁾

Chapter III

Materials and Methods

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3. Materials and Methods

3.1. Study design:

This study is cross sectional retrospective study design

3.2. Study area and duration:

The study was conducting at The Ribat and AL-Atebaa hospitals, AL-Khartoum state, Sudan. It was held during the period between March and December 2015.

3.3. Study population:

3.3.1. Inclusion criteria:

The study was carried out in adult Sudanese patients of both sexes; age between 20-70 yrs, came for MRI ankle scanning in radiology department of The Ribat and AL-Atebaa hospitals.

3.3.2. Exclusion criteria:

Age less than 20 and more than 70 yrs old, patients with previous surgery or trauma to the ankles, patients with tumor were excluded from the study.

3.4. Study variables:

Age; gender; ankle side examined: left, right or both.

3.5. Sampling:

3.5.1. Sample type:

Simple random sampling.

3.5.2. Sample size:

100 patients were examined, 62 of them were males, 38 were females, who came to radiology department of The Ribat and AL-Atebaa hospitals for MRI ankles scan.

3.5.3. Sample technique:

MRI scan was conducting as follow; no patients preparations needed; without Gadolinium contrast used; no surface coil used. The patients scanned, while lying supine; MRI obtained in different pulse sequence (T1, T2weighted image and STIR) in three planes (axial, sagittal and coronal).

3.6. Data collection:

3.6.1. Data collection tools:

The methods of data collections include the MRI done by GE and Semense machines, of 1.5 T and interpreted and questionnaires in which data was collected and recorded.

3.6.2. Data analysis:

SPSS (Statistical Package for the Social Sciences) computer program was used and data collected analyzed by Chi-square test.

3.6.3. Data management:

Data was analyzed as mentioned above and then it was presented and described by using the text, charts, diagram, graphs and figures.

3.7. Ethical considerations:

Ethical clearance was obtained from the authorities of the faculty of graduates study at The National Ribat University. Authorization from the head of radiology departments in The Ribat and AL-Atebaa hospitals.

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Chapter IV

Results

4. Results

One hundred (100) adult Sudanese patients, who came to The National Ribat University and AL-Atebaa hospitals, radiology departments for diagnostic MRI ankle, were included in this retrospective study. Of these patients 62 (62%) were males and 38 (38%) were females as shown in table (4.1) and figs (4.1), (4.2).

Table (4.1): Gender distribution

Gender	Frequency	Percentage
Male	62	62%
Female	38	38%
Total	100	100%

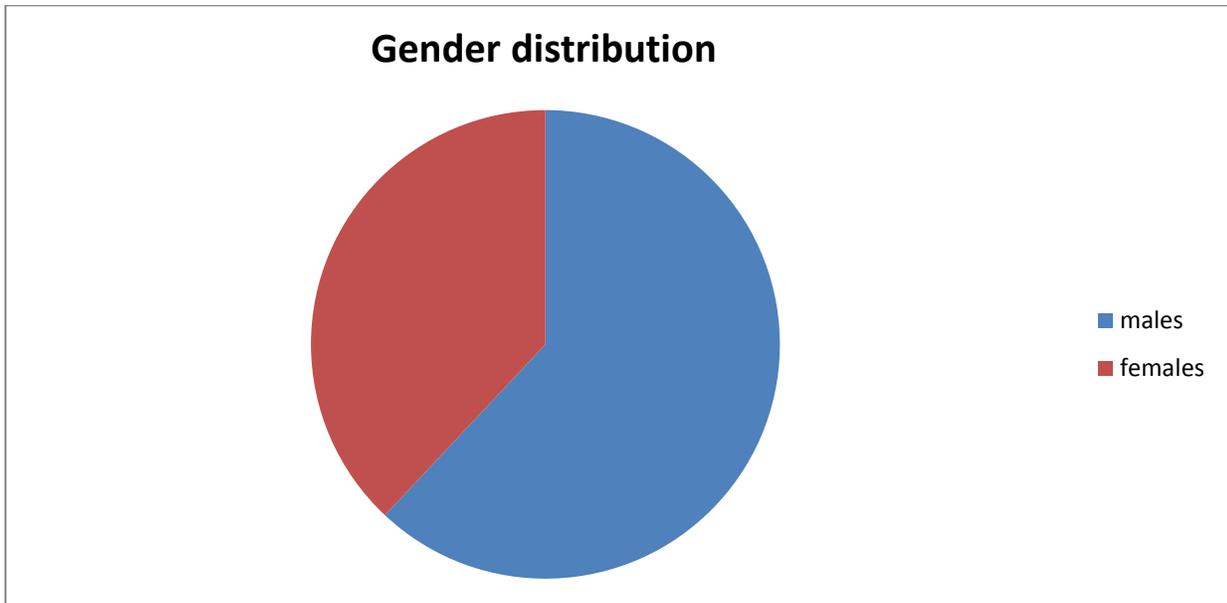


Fig (4.1): Gender distribution

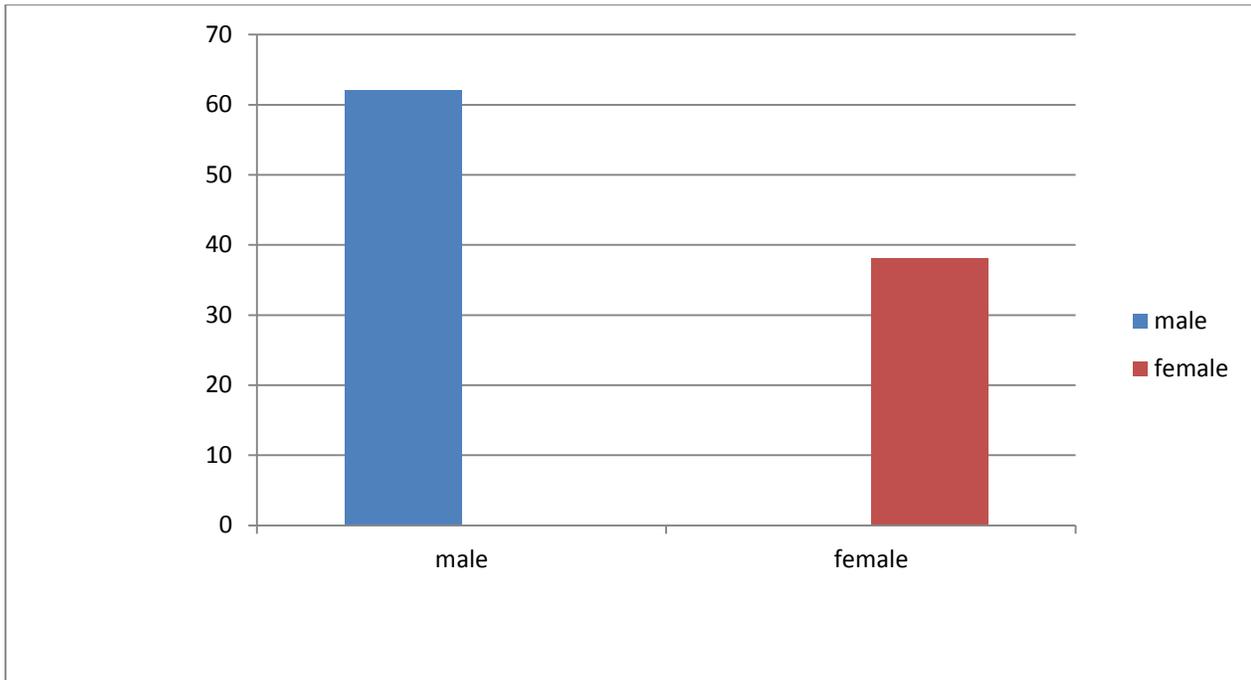


Fig (4.2): Gender distribution

From 62 male ankles reviewed, 40 (64.5%) were on the right side and 22 (35.5%) on the left side, as shown in table (4.2), figs (4.3 – 4.6).

Table (4.2): Side distribution in males subjects

Side	Frequency	Percentage
Right	40	64.5%
Left	22	35.5%
Total	62	100%

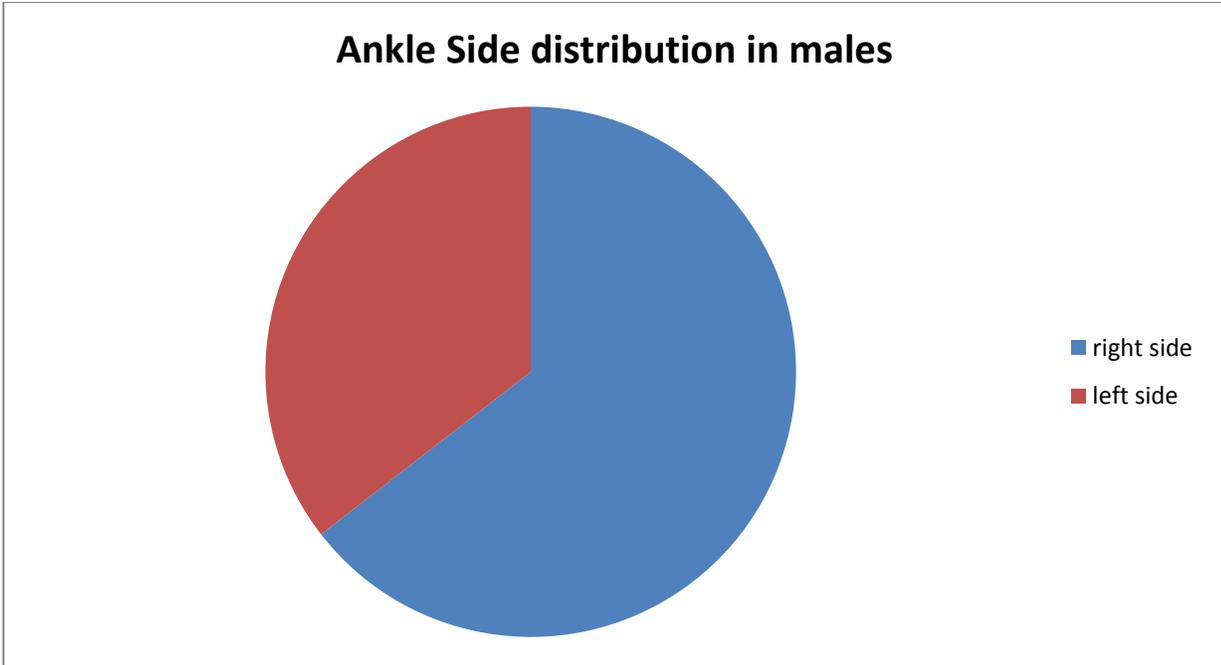


Fig (4.3): Ankle side distribution in male subjects

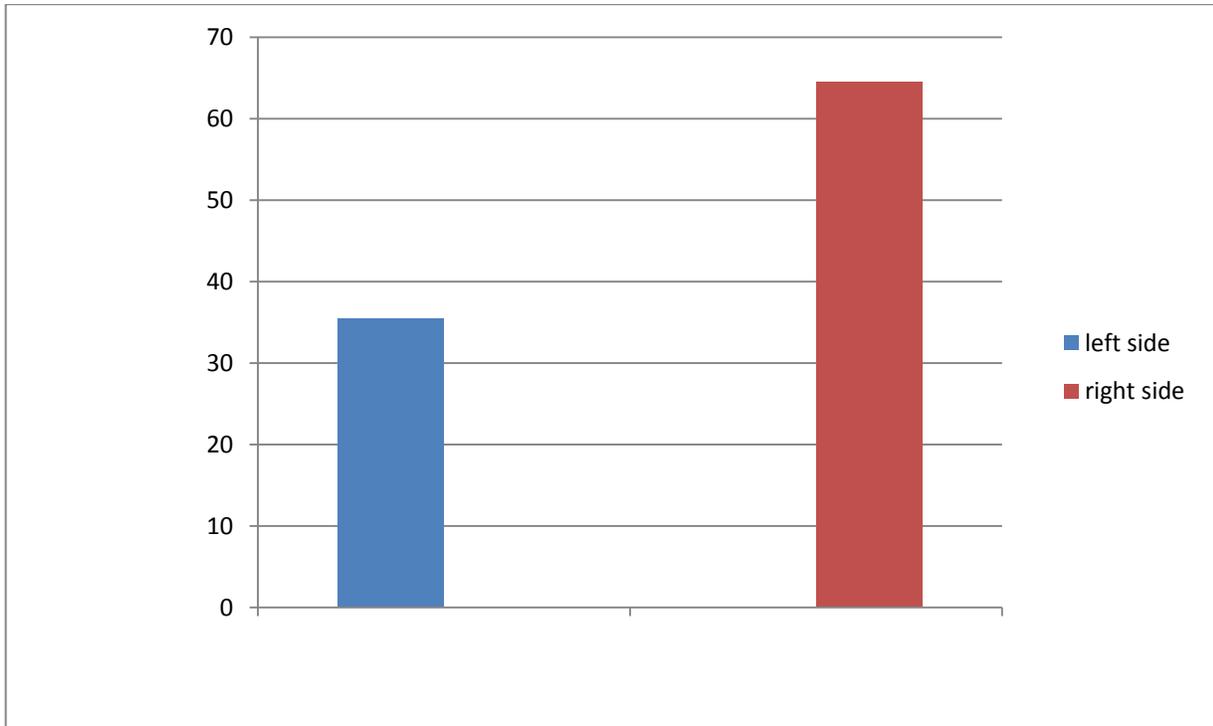


Fig (4.4): Side distribution in male subjects



Fig (4.5): MRI STIR coronal cut of right ankle of male subject shows the presence of PQ muscle (red arrow) .

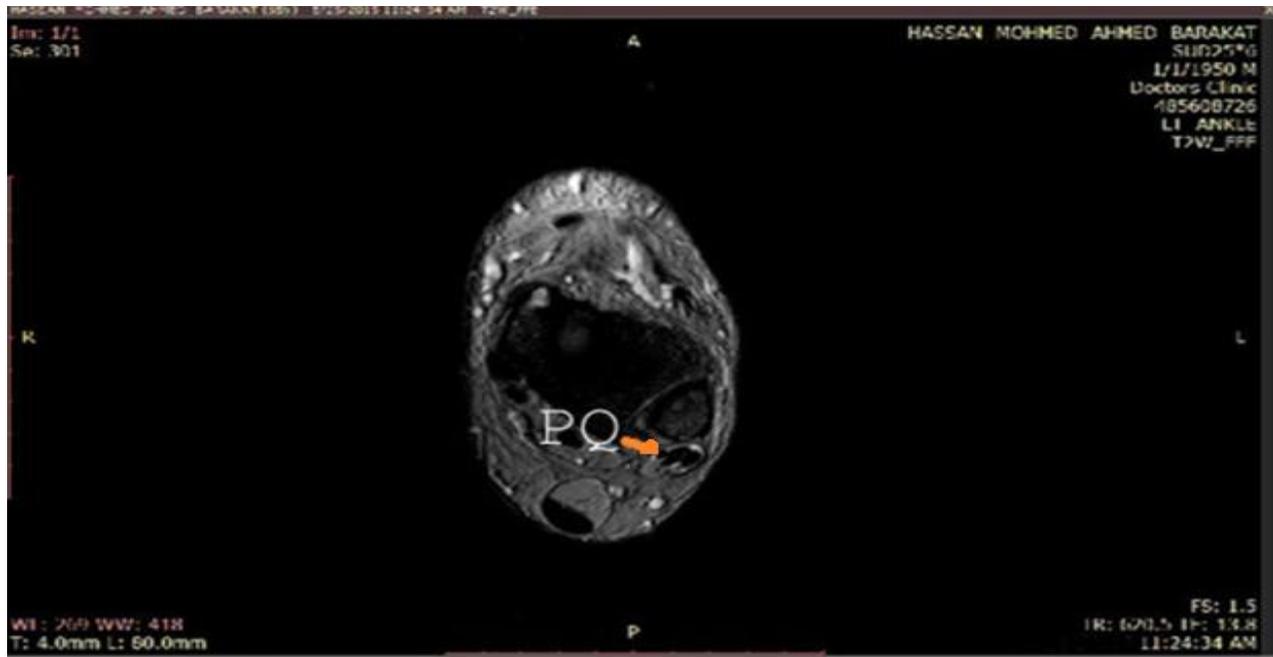


Fig (4.6): MRI T2W axial cut of left ankle of male subject shows the presence of PQ muscle (red arrow) .

From 38 female ankles reviewed, 20 (52.6%) were on the right side and 18 (47.3%) on the left side, as shown in table (4.3) and figs (4.7), (4.8).

Table (4.3): Ankle side distribution in female subjects

Side	Frequency	Percentage
Right	20	52.46%
Left	18	47.3%
Total	38	100%

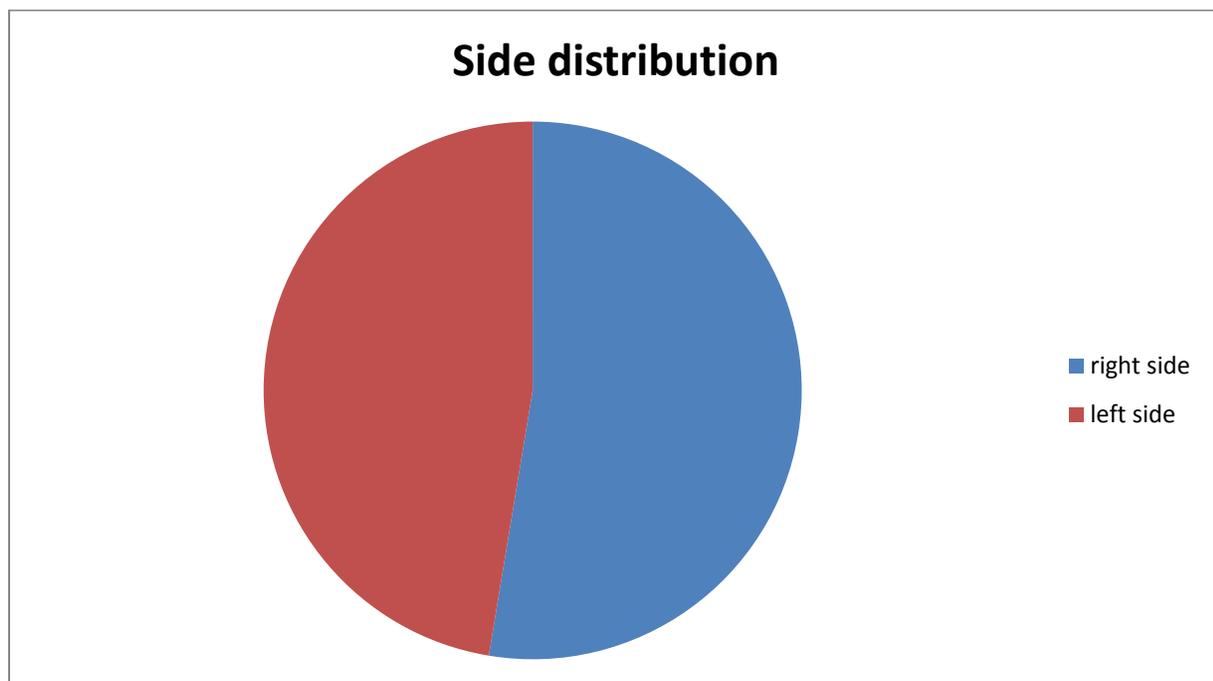


Fig (4.7): Ankle side distribution in female subject

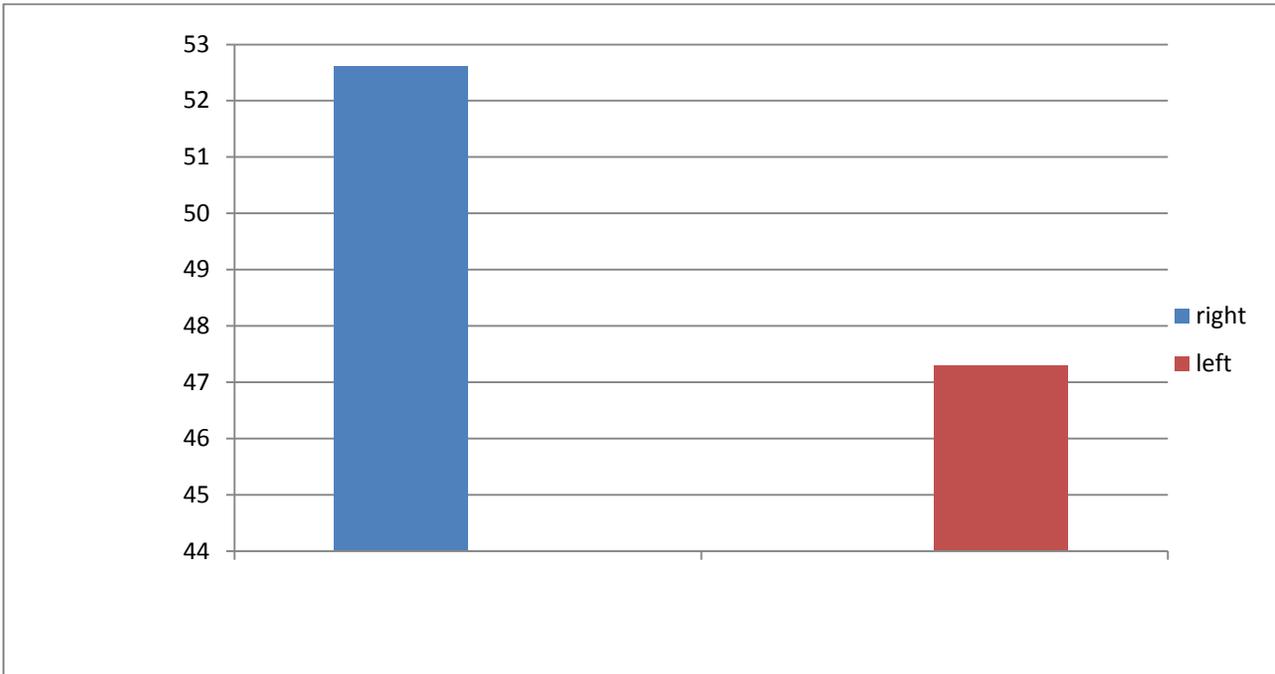


Fig (4.8): Ankle side distribution in female subject

From the 100 ankles examined of both sexes, 60 (60%) were on the right side, 40 (40%) on the left side, as shown in table (4.4) and figs (4.9), (4.10).

Table (4.4): Ankle side distribution in both sexes

Side	Frequency	Percentage
Right	60	60%
Left	40	40%
Total	100	100%

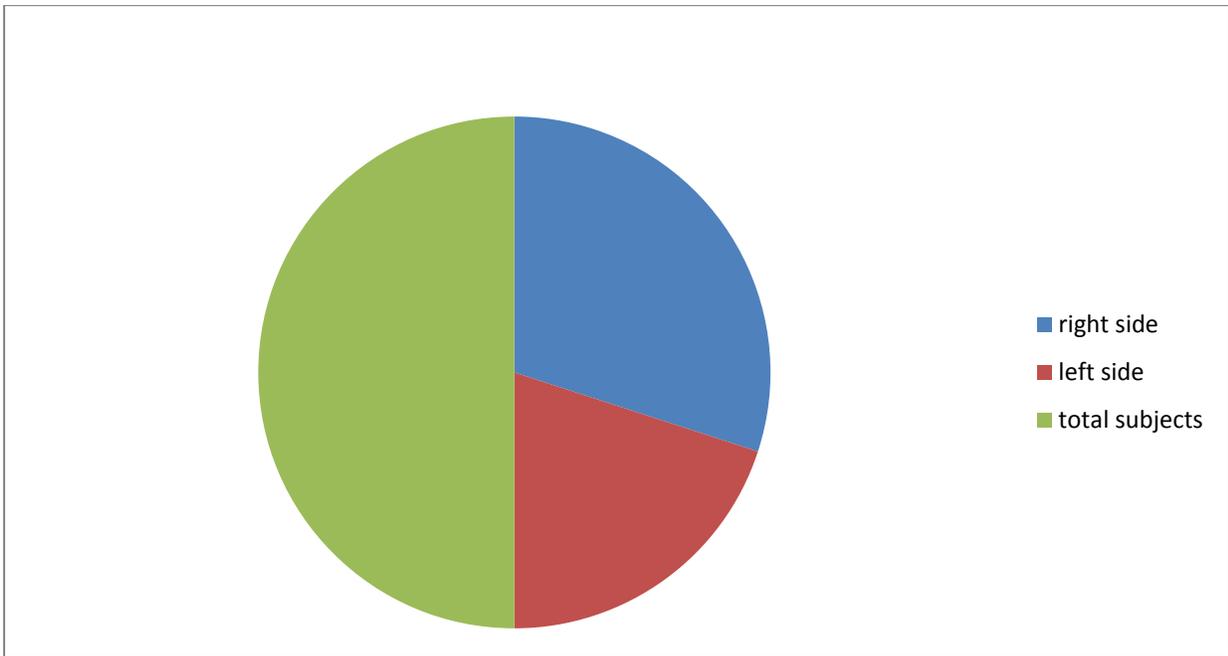


Fig (4.9): Ankle side distribution in both sexes

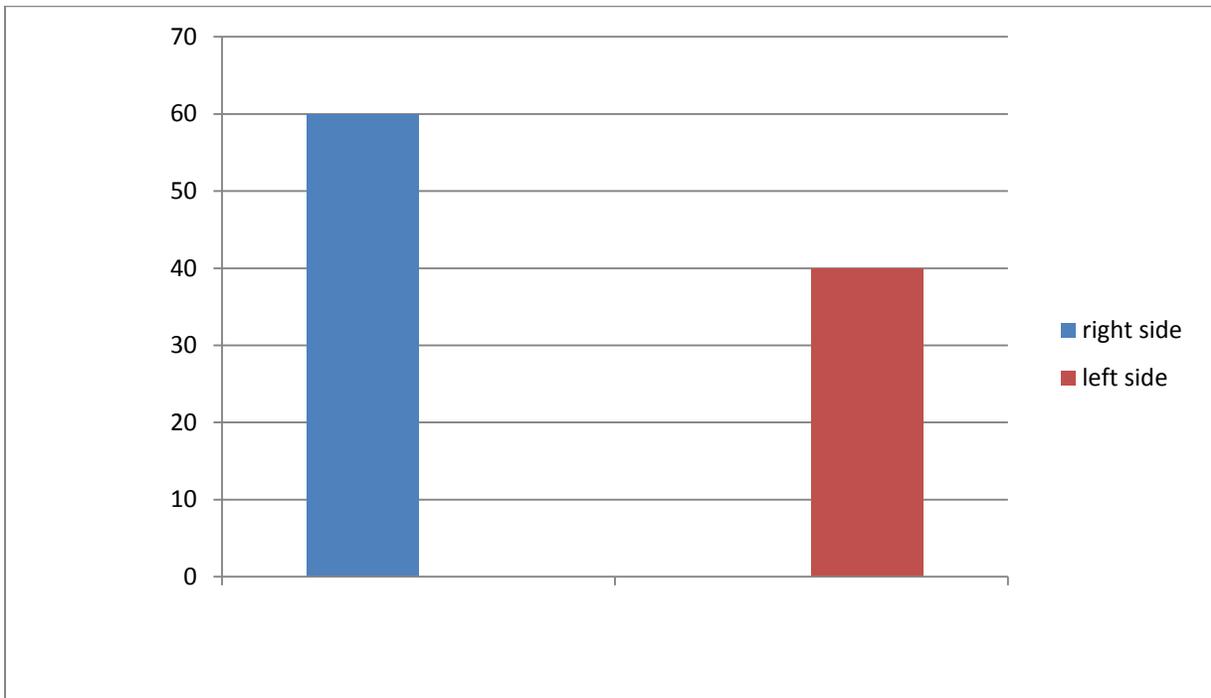


Fig (4.10): Ankle side distribution in both sexes

The PQ muscle was observed in six ankles of males, in those, two subjects have the PQ muscles only, as shown in table (4.5), fig (4.11), (4.12) and (4.13).

Table (4.5): The incidence of PQ and PT muscles in male subject

Muscle	Frequency	Percentage
PQ only	2	3.2%
PQ+PT	4	6.4%
Total	6	9.6%

In four of the six ankles of males in which observed the presence of PQ muscle have associated with the presence of the PT muscle, as shown in table (4.5), figs (4.11), (4.12) and (4.13).

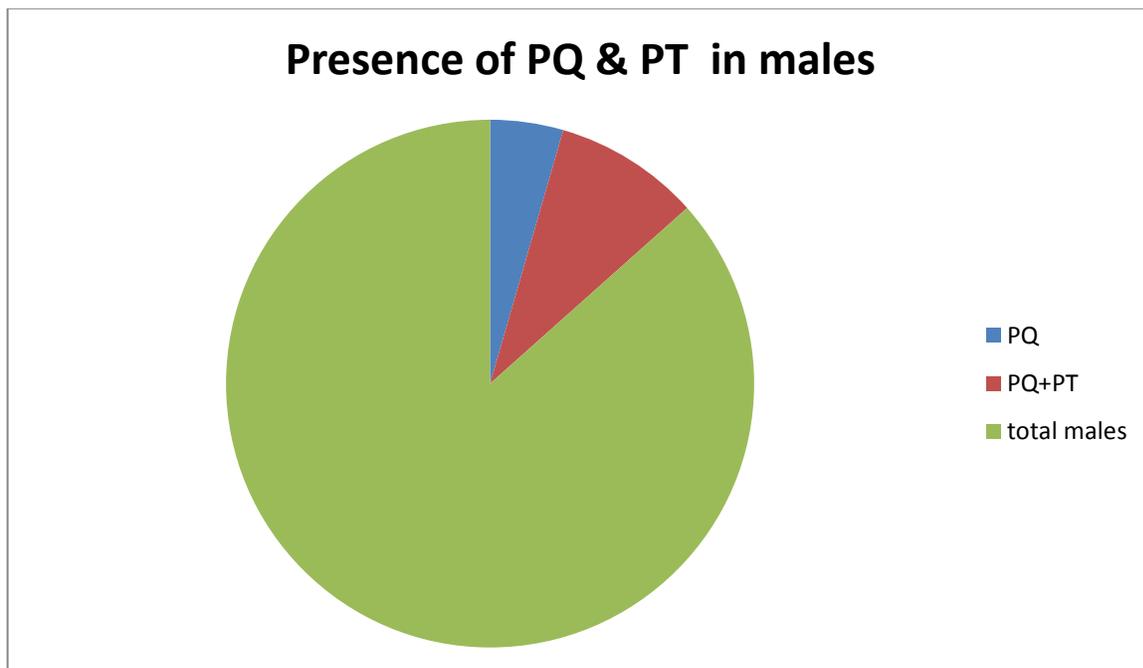


Fig (4.11): The incidence of PQ only, PQ & PT muscles together in males

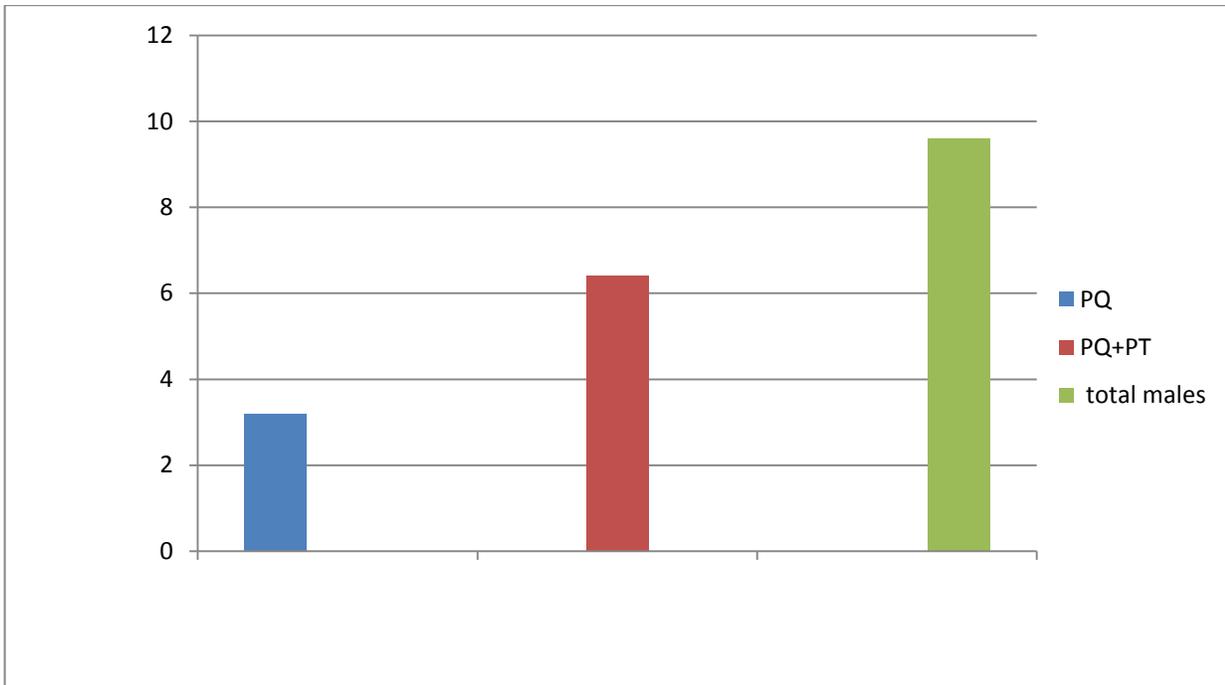


Fig (4.12): The incidence of PQ only, PQ & PT muscles together in males



Fig (4.13): MRI T2W sagittal cut of the left ankle of male subject shows the presence of PQ and PT muscles (red and green arrows respectively).

In two female subjects the PQ and PT muscles were observed together as shown in table (4.6), figs (4.14), (4.15) and (4.16).

Table (4.6): incidence of PQ & PT muscles in female subjects

Muscle	Frequency	Percentage
PQ only	0	0 %
PQ+PT	2	5.2%
Total	2	5.2%

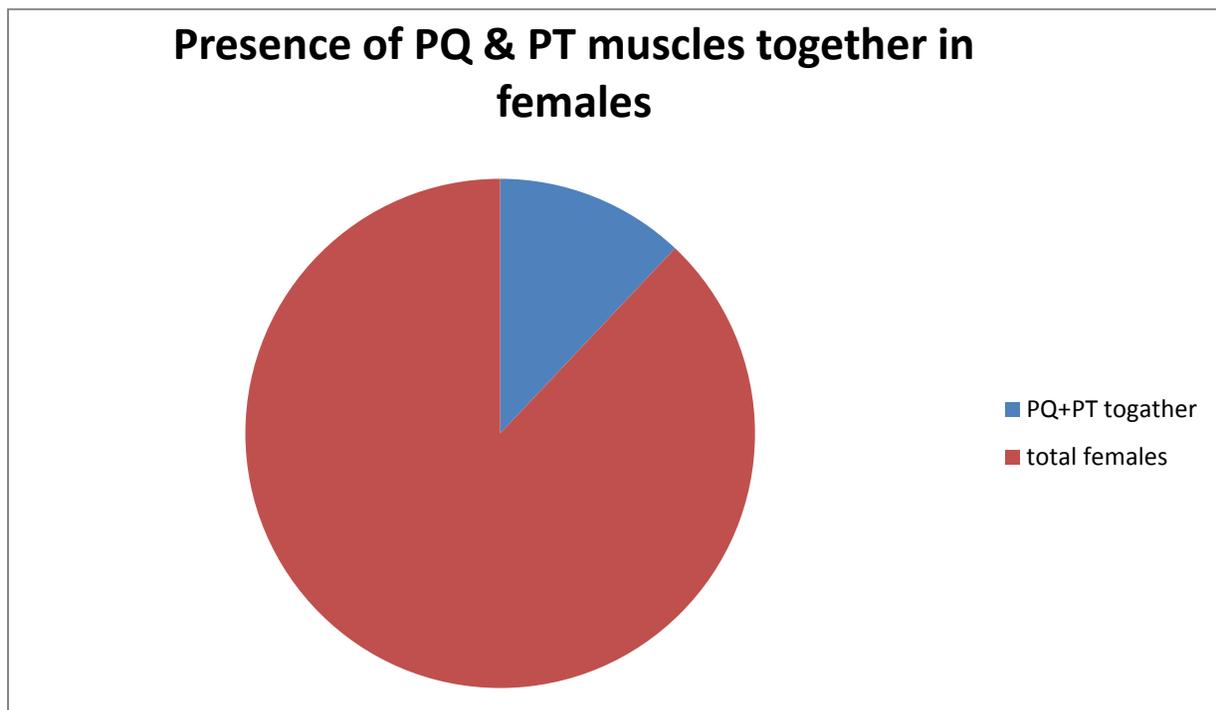


Fig (4.14): The incidence of PQ & PT muscles together in female subjects

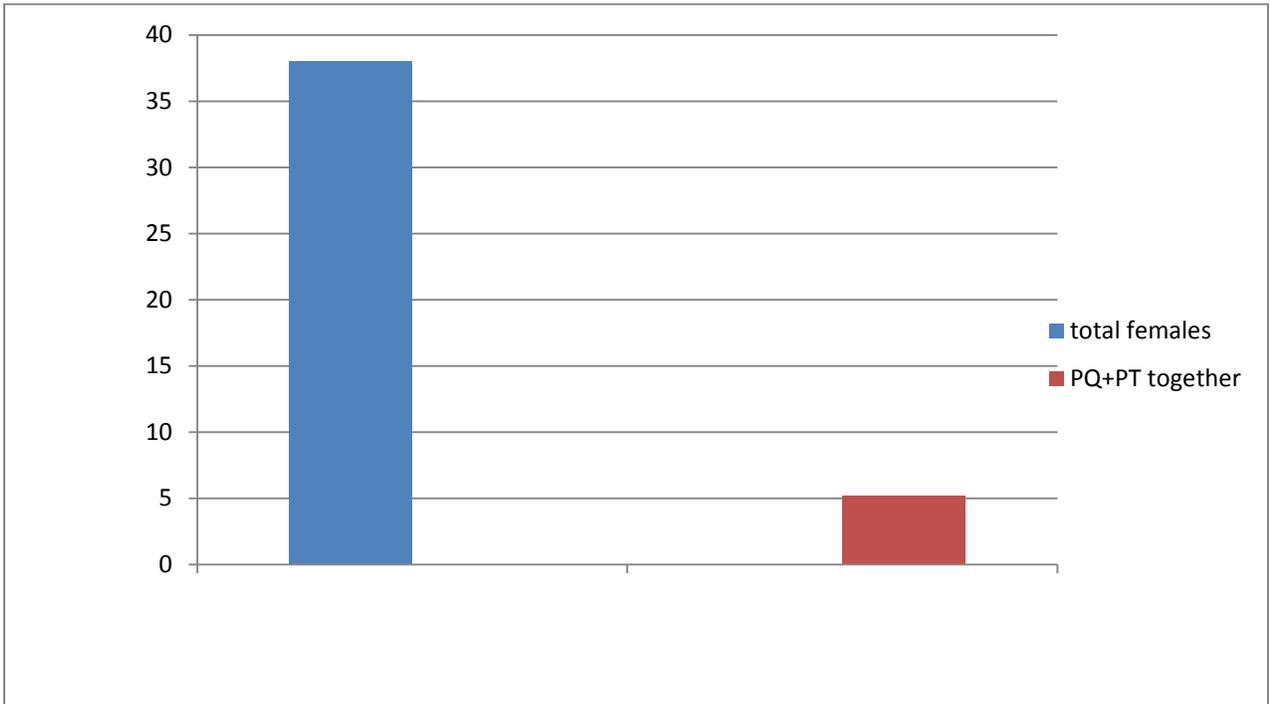


Fig (4.15): The incidence of PQ & PT muscles in female subjects

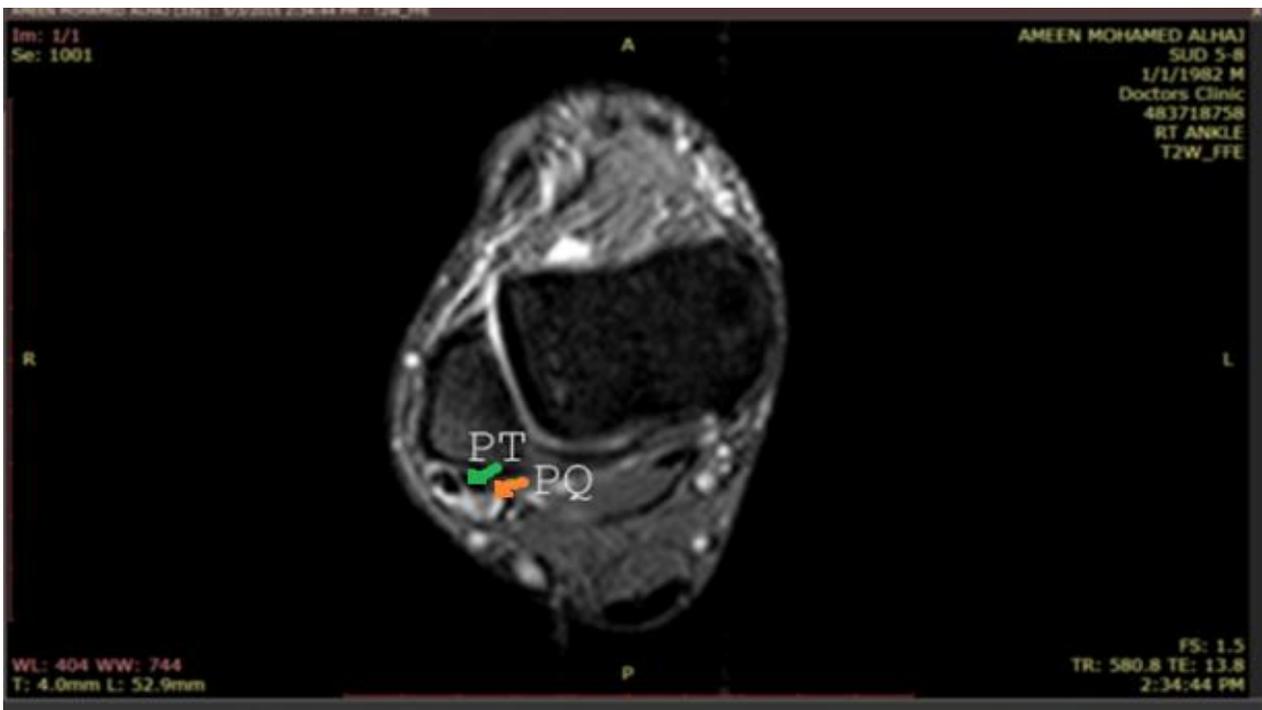


Fig (4.16): MRI T2W axial cut of the right ankle of female subjects shows the presence of PQ and PT muscle (red and green arrows respectively).

In all subjects underwent the study, the PQ muscle was observed in 8 (8%) ankles, six (6%) in males and 2 (2%) females, as shown in table (4.7), figs (4.17) and (4.18).

Table (4.7): The incidence of PQ muscle in both sexes

Gender	Frequency	Percentage
Male	6	6%
Female	2	2%
Total	8	8%

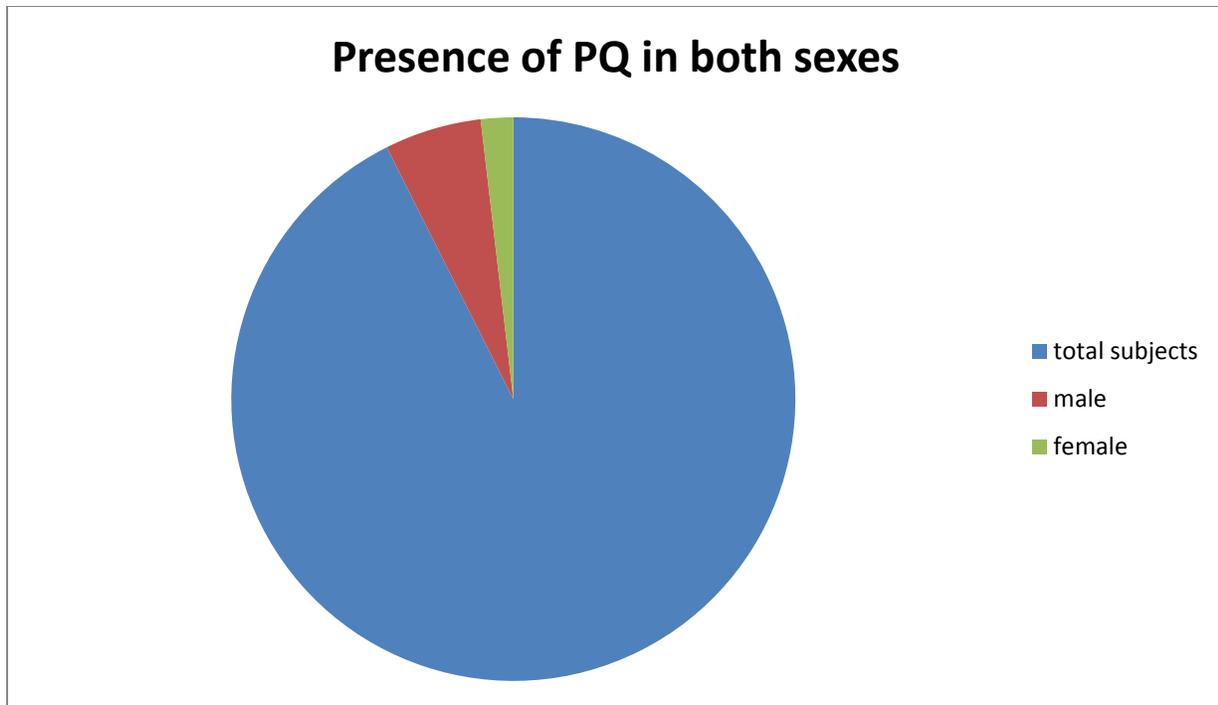


Fig (4.17): The incidence of PQ muscle in both sexes

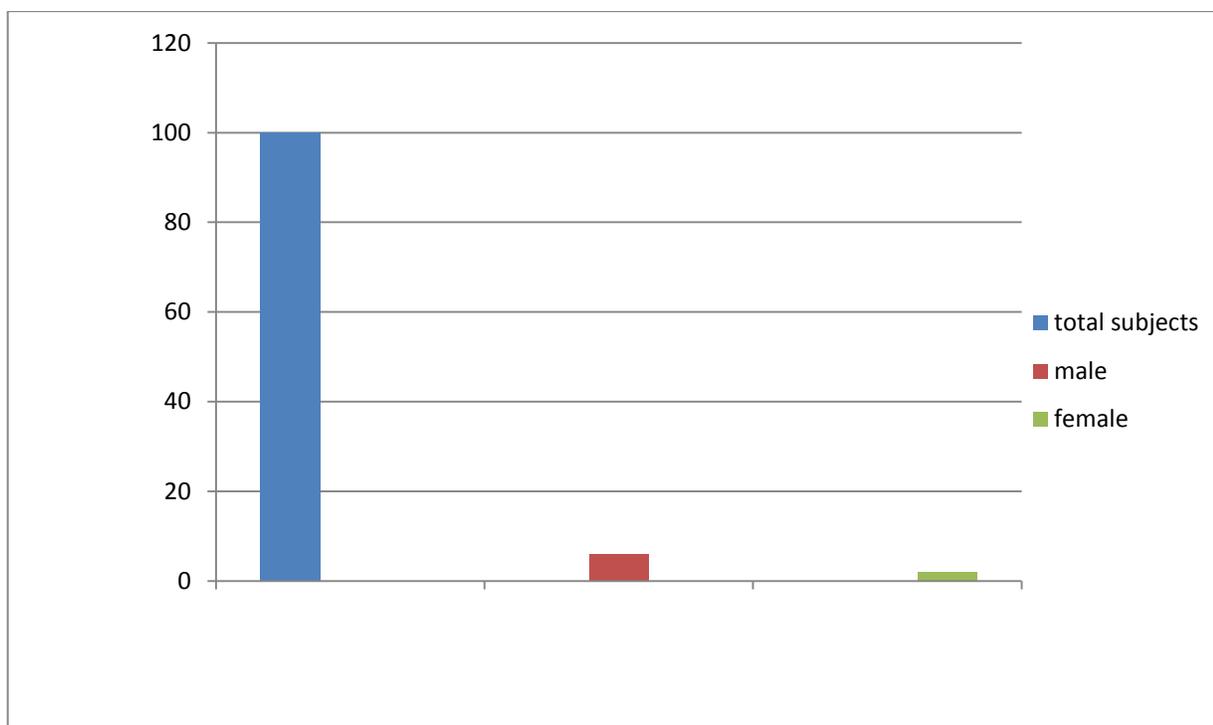


Fig (4.18): The incidence of PQ muscle in both sexes

From the ankle of the 8 (8%) subjects in which was identified the presence of PQ muscle, were associated with presence of PT muscle in 6 (6%) of them.

In 2 (2%) of them it was found the PQ without association with PT, as show in table (4.8) and fig (4.19), (4.20).

Table (4.8): The incidence of PQ only & PQ + PT in all subjects

Muscle	Frequency	Percentage
PQ only	2	2%
PQ+ PT	6	6%
Total	8	8%

Presence of PQ with or without PT

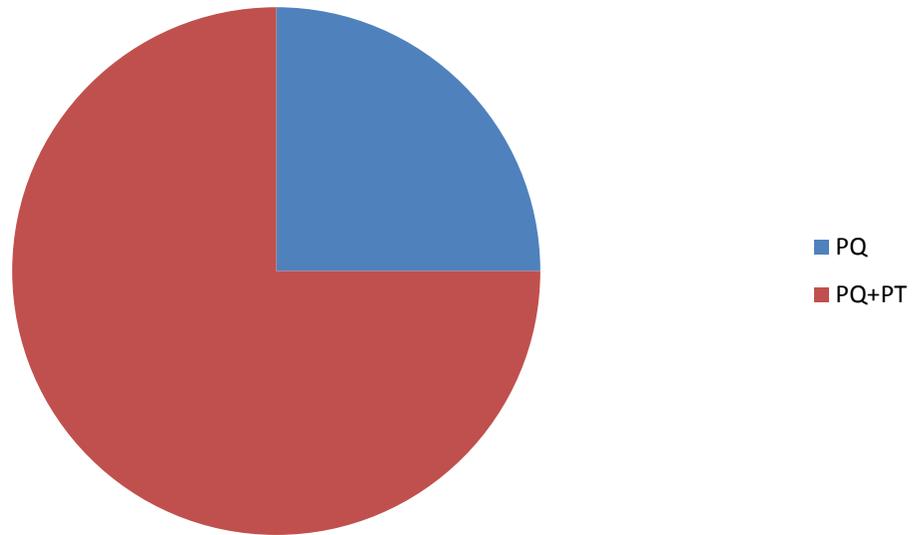


Fig (4.19): The incidence of PQ with or without PT association

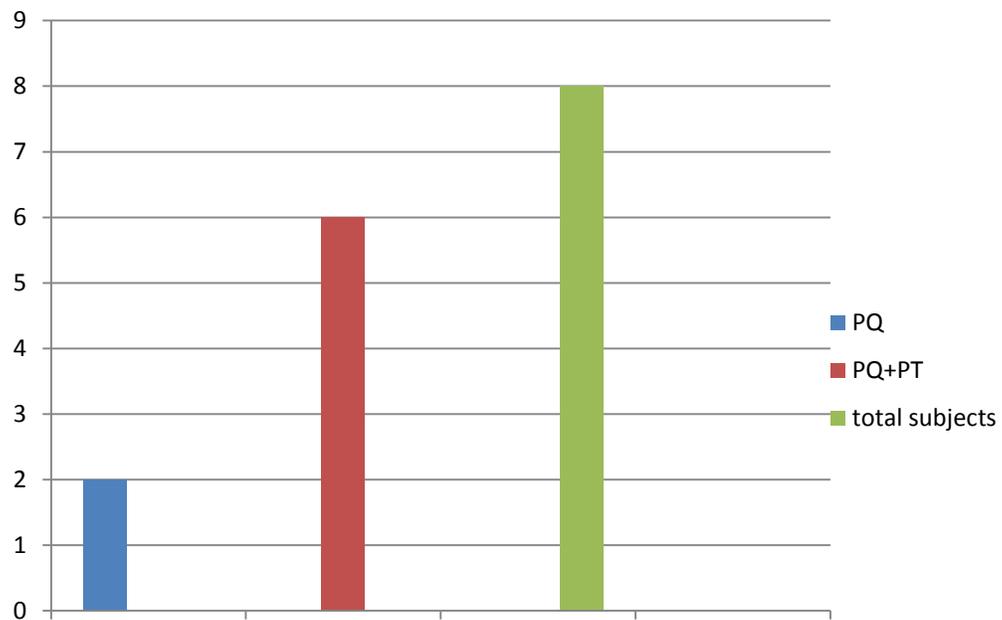


Fig (4.20): The incidence of PQ only & PQ + PT in all subjects

In 3 (37.5%) of the 8 ankles of the subjects in which confirmed the presence of the PQ were found on the right side, and the rest 5 (62.5%) on the left, as shown in table (4.9) and figs (4.21), (4.22).

Table (4.9): Side distribution of PQ muscle

Side	Frequency	Percentage
Right	3	37.5%
Left	5	62.5%
Total	8	100%

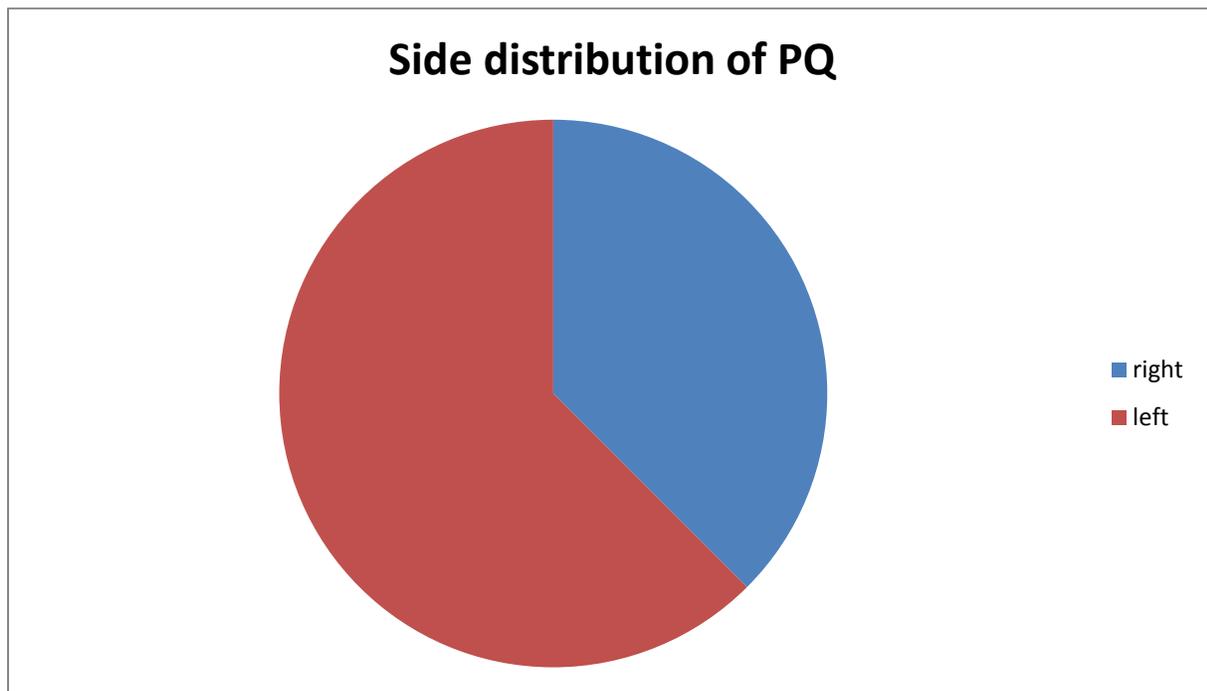


Fig (4.21): Side distribution of PQ muscle

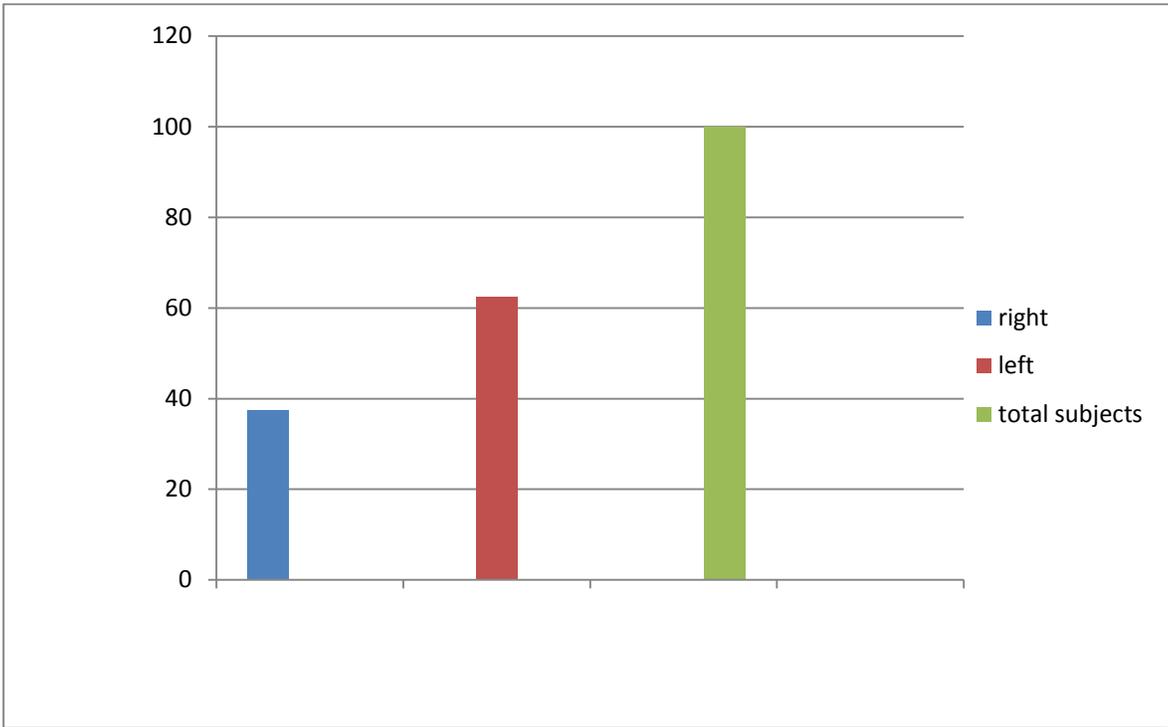


Fig (4.22): Side distribution of PQ muscle

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Chapter V

Discussion

5. Discussion

Many researches on PQ muscle muscle since its discovery in all studies considered it's variation in (origin, insertion site and even nomenclature).

Goss⁽¹⁰⁾ assuming it originates at the back of fibula between the peroneus brevis and flexor hallucis longus and inserts on the fibular trochlea.

Gruber's work of dissection, ⁽¹²⁾ assuming that its insertion can vary and may be in the calcaneu or in the cuboid.

Le Double⁽¹³⁾ however, states that the peroneus quartus muscle, when fully developed, has origins in the lateral distal quarter of fibula, inserting on the base, the proximal phalanx, or middle phalanx of fifth toe.

The presence of fully developed peroneus quartus muscle is very rare and because of that the muscle has different names, according to the author who describe it, named by: Chudzinski; accessoris fibularis muscle, Henle; fibulocalcaneus muscle, Wood, Thiele, and Macalister; PQ muscle, Otto; fibulofibularis muscle, Macalister; fibulocuboid and fibulocalcaneus externum. Poirier and Charpy;⁽¹⁾ one of the fifth finger fibularis muscle variant, Testut,⁽¹⁴⁾ Le Double;⁽¹³⁾ explain that the absorption of this muscle by the other fibularis muscles brevis and longus, their theory depend on; low incidence of fibularis quartus muscle, the lateral muscles of the lower limb have same function and action, studied lead to increased incidence of peroneus quartus muscle.⁽⁶⁾

The presence of this muscle together with the peroneus tertius muscle already however increase the usage of US and MRI, in addition to increase number of cases well established,⁽¹⁶⁾ presence of these two muscle together have important function in stabilization of foot, saving energy during movements, ⁽¹⁵⁾ lateral support to the foot during gait.^(16, 17) Other authors investigated the presence of PT muscle only and didn't mention the peroneus quartus.⁽¹⁸⁾

In the present study the origin of PQ muscle from the back of distal fibula and the insertion was varied from talus, cuboid and calcium.

No significant relationship between the gender and the presence of PQ muscle, the chance of the individual to have the peroneus quartus muscle and peroneus tertius muscle to individual which the peroneus quartus only is two to one (2:1), therefore, the presence of peroneus tertius does not depend on the presence of peroneus quartus muscle, in contrast, the presence of peroneus quartus muscle increases the chances that the peroneus tertius muscle is present.

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Chapter VI

Conclusion and Recommendation

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6.1. Conclusions

The peroneus quartus muscle was found in 8% of the population, most was found in the left side (62.5%), in 75% of them have both peroneus tertius and quartus together regardless the gender.

However, the chance of an individual who has peroneus tertius muscle is three times when also has the peroneus quartus muscle.

The presence of peronus quartus muscle is asymptomatic in most case, but it's presence is an important source of tissue for reconstruction procedures of fibular retinaculum, therefore it must be evaluated carefully, and to be considered as a differential diagnosis in case of suspect of longitudinal rupture or tear of peroneus brevis tendon.

6.2. Recommendations

The present study highly recommends to put the followings in the consideration:

- Ankle pain without obvious cause may be due to presence of peroneus quartus muscle.
- Presence of peroneus muscle may simulate tear or longitudinal rupture of peroneus brevis tendon.
- Presence of the muscle is an important source of tissue reconstruction for inferior fibular retinaculum in surgical repair.
- Absence of this muscle leads to defect in lateral support of the foot during gait (abnormal gait).
- The presence of this muscle in human leg may indicate a descent from certain species, and the effect of environments that need it's action, for that this muscle must further study in depth to give clue for human evolution.

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Chapter VII

Reference

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Appendix

The National Ribat University
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Data collection sheet

Detection of presence of peroneus quartus muscle in Sudanese people
using MRI

Date: No. :

Sex : Male Female

Age : years

Address:

Ankle side examined: right left both

Peroneus quartus muscle: present absent

Peroneus tertius muscle: present absent

Note -----

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