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ASSESSMENT OF LUMBER MULTIFIDUS AND TRANSVERSE ABDOMINIS MUSCLE THICKNESS OR CROSS-SECTIONAL BY REHABILITATIVE ULTRASOUND IMAGING-A META-ANALYSIS

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Abstract:
Objective: The purpose of this study was to evaluate the reliability of RUSI for the measurement of cross sectional areas or thickness of multifidus and transverse abdominis muscle with the symptoms of low back pain.
Method: The electronic searches were used to identify the articles from 2006 to 2016. Two reviewers independently selected the relevant studies and then extracted data to investigate the effects of RUSI.
Results: From 12 potentially relevant trials, the totals of 5 studies involving 244 participants (18 to 60 years) were included in this present analysis. The collective results revealed that RUSI is a reliable method as the intra-rater reliability was high at the vertebral level of L2-3 (ICC=0.81-0.96,95% CI=0.84 to 0.99) and L4-5 (ICC=0.85-0.97, 95% CI=0.87 to 0.99) with no difference in muscle size across the operators (SEM=0.05-0.06).
Conclusion: RUSI is an effective method to investigate the cross-sectional area or thickness of both muscles.
Keywords*: Rehabilitative Ultrasound Imaging, Low Back Pain, Multifidus, LM, Transversus Abdominis, Muscles of Lumbar Region and Stabilizing Muscles.*

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INTRODUCTION:
Low Back Pain (LBP) is one of the most common musculoskeletal problem that affects about 60-80% of the population throughout their life expectancy. The lifetime prevalence of low back pain is reported to be 84% with 11-12% of the population being disabled by this condition [1,2]. In 2010 a Global Burden of Disease conducted a study and estimated the global age standardized point prevalence to be 9.4% [3,4]. It is a self-limiting condition that can commonly be found in middle age ranging between 35 to 65 years in which 90% of the people can be cured within 3-4 months without any treatment [5]. The inner abdominal muscle thickness that includes multifidus and transverse abdominis show high correlation with the stability of the lumbar spine. When the activity of these inner muscles decreases it causes the outer muscles (erector spinea, abdominal oblique and rectus abdominis) to compensate for the movements and stability of lumbar region which in turn leads to low back pain. According to several studies the multifidus muscle of the patients suffering from low back pain was atrophied and replaced by adipose tissue [6].

The ultrasound imaging has been advocated as a noninvasive method to quantify the morphology and behavior of multifidus muscle. It is getting popular among physiotherapist for clinical and research purposes. Clinically it has a dual application: i) A tool for objective assessment for detection of abnormality and monitoring of changes during the recovery ii) A tool for biofeedback, during the re-education of muscular contractions. As normal data is available for the multifidus characteristics such as cross sectional area (CSA), shape and size therefore with the help of ultrasound imaging accurate assessment of muscle size can be obtained, which in turn serves as the assessment of muscle wasting in different muscles.

It is important to ensure that the determination of most effective method for the measurement of multifidus and transverse abdominis muscle in patients of low back pain is based on scientific evidence. Therefore, the purpose of this study was to evaluate the efficacy of ultrasound imaging in measuring the thickness and cross-sectional area of multifidus and transverse abdominis muscle in the patients of low back pain.

MATERIAL AND METHODS:
The RCT'S (Randomized controlled trials) were identified through electronic searches from the following databases: NCBI (2006- December 2016), PubMed (2006- December 2016), Med-line (2006- December 2016) and Cochrane library (2006- December 2016). The detailed explanation of search strategies and approaches are described in Fig. 1.The medical headings that were included in the searching strategy are as follows: low back pain, abdominal muscles, multifidus muscle and ultrasound imaging. The following keywords were included: single- blind, double- blind method, multifidus muscle, cross-sectional area, stability, lumbar region, RUSI and physical therapy. Any duplication that were identified during the searching process was removed.

INCLUSION CRITERIA
1. **Type of studies:** The RCT'S assessing the efficacy of ultrasound imaging in measuring the cross-sectional area or thickness of multifidus and transverse abdominis muscle were included. According to the criteria selected only those articles were selected that were published in English.
2. **Type of participants:** In this analysis both male and female participants (over 18 years of age) were included who were suffering from acute, sub-acute and chronic low back pain. The articles that involved individuals suffering from low back pain with any specific condition or pathology were excluded.
3. **Type of interventions:** Only those studies that had used ultrasound imaging for the measurement of cross-sectional area or thickness of multifidus and transverse abdominis muscle in patients of low back pain were included. The readings were taken bilaterally at rest and during contraction.
4. **Type of outcome measures:** The major outcome of interest was the severity of pain, muscle thickness, stability of spine and quality of life. The outcomes were recorded for two time periods that includes: short term (less than 3 months) and long term (1 year).

Table 01: Inclusion Criteria

Study	Study population	Study design	Treatment	Outcome measure
Jeffrey J et al. 2016	32 individuals with the age b/w 18 to 60 years with the complain of low back pain.	RCT	Examined the interrater reliability and concurrent validity of the TrA/MF muscle by Ultrasound imaging	Modified Oswestry disability score and Ultrasound imaging.
Muhammad H. et al. 2015	Fifteen healthy subject with the age between 22 to 42 years.	RCT	Measured Intra-class correlation coefficient (ICC) , TrA/MF muscle CSA, thickness and BMI at rest and during contraction by ultrasound imaging.	B-mode of ultrasound imaging
Qiuchen Huang. Et al. 2014	15 participants with chronic LBP on one side of the spine for more than 6 months.	RCT	Evaluated inter-class correlation coefficient of TrA/MF muscle thickness at rest and during contraction by B-mode and M-mode of RUSI.	VAS scale(0-10) and B-mode of RUSI
Maria Strokes et al. 2013	Healthy participant with the age b/w 18 to 69 years.	RCT	Measurement of TrA/MF muscle thickness by B-mode of RUSI.	RUSI used as evaluation and treatment tool.
Deydre S. et al. 2012	96 female and 244 male with the age b/w 18 to 35 years.	RCT	The thickness of MF, Transversus abdominis, internal oblique, external oblique and ractus abdominis was measured by B-mode of RUSI.	RUSI and BMI

SELECTION OF STUDIES

The two reviewers (kazmi, Siddiqui) independently used pre specified criteria to screen for the appropriate trials and abstracts. The articles that did not matched the subject were rejected on the basis of specific criteria. If the final decision was different then the third reviewer (Ansari) was consulted.

DATA EXTRACTION

The information obtained from selected studies include design of the study, description of intervention, participant information (gender, age, duration and type of low back pain), sample size, prognostic features, clinical results, statistical analysis, outcome measures and follow-up period. The extracted data was then compiled in to a standard table and the reviewers evaluated the risk of bias.

ASSESSING THE RISK OF BIAS

The Cochrane collaboration recommendations was used to evaluate the risk of bias by extracting the following information: random sequence generation, allocation concealment, blinding of participants and personal, blinding of outcome assessors, incomplete results, selective reporting and other bias. The two reviewers evaluated the quality of methodology process in the selected articles while the arbiter was used to reconcile any disagreements.

STATISTICAL ANALYSIS

The data was managed and analyzed through SPSS while ICC (interclass correlation coefficient) determined the reliability of the ultrasound imaging in measuring the cross-sectional area of muscles. All variables involved in the analysis were continues so mean difference (MD) and 95% confidence interval (CI) was used to evaluate the articles. The P value >0.05 was considered to be statistically significant.
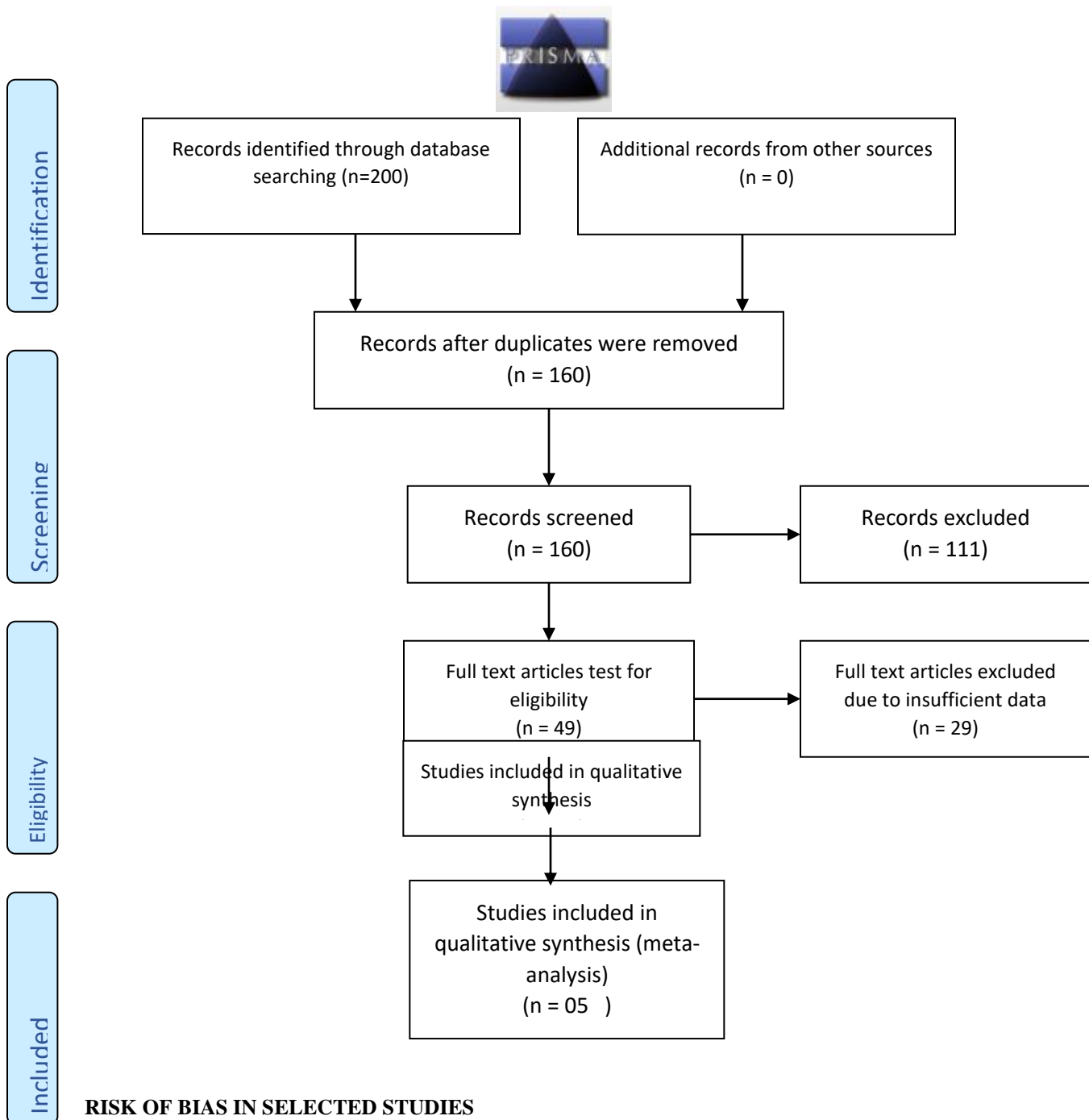
RESULTS:

Search Results

The method of finding suitable articles is described in fig 1. Initially 200 articles were selected through NCBI, PubMed, Med-line and Cochrane Library and after reviewing 85 articles were omitted due to replication and irrelevant title of the study whereas approximately 111 articles were disqualified on the basis of study design, absence of morphometry assessment, activation of TrA/LM and lack of clinical outcomes. Only five articles out of 200 were selected on the basis of inclusion criteria[i], [ii], [iii], [iv], [v]. The characteristics of each selected study are described in table 1.

Figure: 01: PRISMA Flow Diagram


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Identification

  Records identified through database        Additional records from other sources
       searching (n=200)                                (n = 0)

                          Records after duplicates were removed
                                      (n = 160)

Screening

       Records screened                         Records excluded
         (n = 160)                                 (n = 111)

Eligibility

    Full text articles test for              Full text articles excluded
          eligibility                         due to insufficient data
           (n = 49)                                 (n = 29)

     Studies included in qualitative
                synthesis

Included

       Studies included in
   qualitative synthesis (meta-
            analysis)
          (n = 05   )
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RISK OF BIAS IN SELECTED STUDIES

According to the Cochrane collaboration recommendations the articles were not at a high risk of bias. All articles were described as randomized, the mode of allocation concealment was clear, outcome data was complete and the participants and outcome assessors were blinded in all five trials. The detail explanation of risk of bias assessment is described in in table 2.

Table: 02.

	Jeffrey J et al. 2016	Muhammad H. et al. 2015	Qiuchen Huang. Et al. 2014	Maria Strokes et al. 2013	Deydre S. et al. 2012
1. Adequate randomization	Y	Y	Y	Y	Y
2. Allocation concealed	Y	Y	Y	Y	Y
3. Patient blinded	Y	Y	Y	Y	Y
4. Care provider blinded	Y	Y	Y	Y	Y
5. Outcome assessor blinded	Y	Y	Y	Y	U
6. Dropout rate described	Y	Y	Y	Y	Y
7. Was the treatment allocation adequately concealed	Y	U	Y	Y	U
8. Are report of the study free of suggestion of selective outcome reporting	Y	Y	Y	Y	Y

PHYSICAL TESTS FOR TRA AND LM

This review intended to incorporate only those studies that had used different methods of muscle assessment to investigate the muscle integrity through rehabilitative ultrasound imaging. The results of this review was only limited to TrA/LM because other studies had not used electromyography to assess the activation of muscles. The B-mode of USI was used to evaluate the voluntary contraction ratio and lateral sliding of TrA/LM during abdominal draw in maneuver while M-mode of USI and tissue Doppler imaging determined the predictive inception of lateral abdominal muscles during contra lateral rapid arm movement.[vi] The voluntary contraction of lumbar multifidus muscle during two types of contra lateral arm lifting was assessed by B-mode of USI[vii] whereas the dynamic morphometry of LM during contraction was expressed by the percent change in the thickness of LM muscle[viii].

CLINICAL OUTCOME MEASURES

All included studies evaluated the severity of pain by visual analogue (0-10) and numeric pain rating scale (NPRS). The measurements of the cross-sectional area of bilateral multifidus and tranversus abdominis muscle during rest and contraction were obtained through different modes of ultrasound imaging. The modified Oswestry disability index was used for

functional assessment while Fear-Avoidance belief questionnaire (FABQ) for participant's beliefs regarding LBP and general physical activities.

THICKNESS OF MULTIFIDUS MUSCLE
In all five trials the ultrasound imaging produced high inter-rater reliability scores for the level of L2-3 (ICC=0.81-0.96, 95%CI=0.84-0.99, SEM=0.06) and L4-5 (ICC=0.85-0.97, 95% CI=0.87-0.99, SEM=0.05). The value of P>0.05 indicated no systemic error between the scores of muscle thickness.

FOLLOW-UP
The follow-up time of the articles that were included in this analysis ranged from 1 week to 1 year. About four studies displayed less than 80% of attrition when assessed immediately after the treatment while the study involving 1-year follow up presented with 79.8% of attrition from 56.8% to 62.4% of the total number of participants recruited[2, 3, 4, 5, 6].

DISCUSSION:
In this analysis 5 RCT's were selected that investigated the efficacy of ultrasound imaging in measuring the cross-sectional area of multifidus and transverse abdominis muscle in the patients of acute, sub-acute and chronic low back pain. The Cochrane Collaboration recommendations was used to assess the risk of bias. No serious complications were reported in any of the five articles that investigated the adverse effects. However, the quantity of selected participants was not enough to assess the accuracy of ultrasound imaging. According to the results of this analysis ultrasound imaging is an effective tool to measure the muscle thickness or cross-sectional area of multifidus and transverse abdominis muscle in the patients of low back pain.

According to the included articles the patients with acute or chronic LBP have amplified fat infiltration and abnormal changes of type I and type II fibers in LM,[ix] while patients with unilateral LBP presents with localized asymmetrical LM atrophy at the painful vertebral level.[4] Functionally, patients with LBP exhibited considerably less TrA/LM thickness changes than asymptomatic individuals during voluntary tasks as measured by B-mode ultrasound imaging (USI)[x] . In all five articles the changes in muscle thickness during relaxation period and contraction while performing tasks were easily recorded by RUSI whereas the 95 % confidence interval and p value>0.05 indicated the absence of any measurement error between the scores of muscle thickness.

When the comparison was made between previous reviews almost all of the studies encompassed in this analysis were original that considered the patients suffering from acute, sub-acute and chronic low back pain. Along with this it investigated the effects of that method which is safe, reliable and cheap as compared to the other techniques.

LIMITATIONS
There were several limitations in this analysis that should be taken in consideration. The first limitation was that readings were based on low quality data. Although several articles involved in this analysis were published in last five years but methodologically rigorous articles were still deficient. Second, the total number of subjects involved in this analysis was too small to identify the efficacy of ultrasound imaging whereas the third limitation was that several articles did not contain necessary information for evaluating the quality and clinical relevance of the data. There was a probability of one other limitation known as publication bias which was overcome by substantial database search.

IMPLICATIONS FOR PRACTICE
RUSI is an effective tool to measure the cross-sectional area or muscle thickness of the multifidus and transverse abdominis muscle in patients of low back pain. However, this conclusion is not based on high quality data so more definitive studies are needed to conform the outcomes.

IMPLICATIONS FOR RESEARCH
The studies that are methodologically sound and have powerful data are required to investigate the efficacy of ultrasound imaging in measuring the cross-sectional area or muscle thickness of multifidus and transverse abdominis muscle in patients of acute, sub-acute and chronic low back pain. The effects of RUSI should be evaluated for long term (more than 1 year) whereas the theory regarding the connection of low back pain and multifidus cross-sectional area should be explored more.

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