Correlation study of lumbar proprioception and core strength in non-specific low back pain

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Abstract

Aim: Low back pain has become a global problem with increasing prevalence and affecting all age groups. An interplay of various factors results in the causation and persistence of non – specific low back pain. Therefore, finding out the relationship between these factors is important as that will help in designing more effective treatment protocols. Therefore, the aim of this study is to find if a correlation exists between lumbar proprioception and core strength in university students with non – specific low back pain.

Method: 30 students with low back pain were recruited. Modified – Modified Schobers's test along with joint repositioning sense was used to calculate the RE (repositioning error) and study lumbar proprioception. Pressure biofeedback unit was used while performing the abdominal draw in manoeuvre to assess transverse abdominis (core muscle) strength.

Result: Spearman Correlation coefficient was calculated as the data was not distributed normally. The value of the correlation coefficient (r) was -0.174 and the *p* value was 0.356. The results are of no statistical significance.

Conclusion: No correlation was found between lumbar proprioception and core strength in university students with low back pain.

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I would like to sincerely thank all the participants of the study as I would not have been able to complete my study without their participation.

Introduction

Low back pain has become a global epidemic with increasing prevalence. Its prevalence across various age groups has drastically increased over the last few years and in a few years the prevalence is expected to be as high as 90% per year. A continuous increase in prevalence has been observed in industrialized countries, where the prevalence is as high as 60% to 70% per year for non-specific low back pain. Studies have also shown the increase in prevalence of low back pain with increase in age with increased susceptibility especially in the third decade of life (Ganesan et al, 2017). A lot of the recent studies funded and recognized by the World Health Organisation (WHO) have been focused on the implications low back pain has on the various facets of life, like social life, economy, occupation, mental health, family life. In both developed and developing countries alike, it is one of the major causes of living with disability. According to the 2010 Global Burden of Disease Study, low back pain ranks sixth worldwide when it comes to overall disease burden (Maher, Underwood & Buchbinder, 2016) (Hoy et al, 2012) (Hoy et al, 2014).

Analgesics are still the mainstay when treating low back pain. Conservative treatment approaches consisting of spinal manipulation, rehabilitation, acupuncture, electrotherapy and strength training to help improve function and reduce the pain are also mentioned in the WHO reports, but the various factors that play a very important role in low back pain patients in determining their quality of life are often not given due importance. Factors like, lifestyle factors: smoking, psychological factors like emotional wellbeing, mental health, stress and other individual factors that are work related, eg. heavy lifting, awkward static and dynamic postures need to be taken into consideration when treating low back pain. Previous trauma also needs to be considered.

The World Health Organisation has also recognised the need for further research in low back pain considering anthropometric risk factors and adapted rehabilitation.

(WHO .http://www.who.int/medicines/areas/priority_medicines/Ch6_24LBP.pdf)

Background and Literature Review

Non-specific low back pain is very prevalent in university students. A lot of factors including age, smoking (lifestyle factor), sitting upright during class (holding static posture for extensive periods of time), excessive use of computers play a role in causing low back pain and then helping it persist in university students (Taspinar et al, 2013). Various studies have been done over the years, demonstrating a relationship between smoking amount and chronic low back pain in university students (Alkherayf & Agbi, 2009) and between smoking and musculoskeletal ache (Wang et al, 2011). Various studies have drawn a link between non-specific low back pain and increased used of analgesics, decreased attendance and an affection on the health aspect of quality of life among university students (O'sullivan et al, 2012) (Ferkhanda et al, 2016). It has been observed that a trend has developed, where university students have developed non- specific low back pain before even entering the work force. This is a cause for alarm and concern (Smith and Leggat, 2007). A cross sectional study by Panahi et al,(2018) consisting of 200 participants found that 60.3% of the university students suffered from low back pain. The study collected demographic data and also used the Roland – Morris Disability Questionnaire and the SF – 36 form to collect data and analyse it to reach this conclusion. It showed a significant relationship between the disability that stems from low back pain and its effect on the students' mental and social well being

A multitude of factors have been shown to play a role in the development and maintenance of low back pain cases. Abundant research has been done on the topic and numerous studies have found a relationship between low back pain and lumbar proprioception (Gill and

Callaghan, 1998) (Tong et al, 2017) as well as low back pain and core strength (Chang et al, 2015) (S et al, 2014) (Hu et al, 2017).

Proprioception is a complex interaction of information between the afferent and efferent pathways and is regulated by the mechanoreceptors in the joints and the muscles (Gandevia et, 1992). Proprioception is required to maintain stability, mobility and for normal movement control of the body (O'Sullivan et al, 2002). In spine, proprioceptive information is provided by structure present in ligaments, paraspinal muscles, intervertebral disc and facet joints. Muscle spindle in deep paraspinal muscles acts as kinaesthetic sense for trunk positioning and movements (Panjabi, 1992). Research shows that the paraspinal muscles and golgi tendons form an important part of the sensory motor system that functions to control spinal muscles and provide the sensory cortex with proprioceptive feedback (Olm et al, 2002). As a result of this, researchers believe that if lumbar proprioception is altered, the ability to exert any sort of control over spinal posture and coordination of muscle activation is also negatively affected (Dankaertas et al, 2006) (Reeves, Narendra & Cholewicki, 2011). This will result in an alteration of trunk muscle activation also resulting in an imbalance in the stress experienced over the spine (Panjabi, 2003). The interaction of these factors results in low back pain which will result in further deterioration of lumbar proprioception and the formation of an endless feedback loop (http://www.crd.york.ac.uk/PROSPERO/) (Tong et al, 2017).

According to a cross sectional study undertaken by Gregory in 2011, there is altered lumbar proprioception in individuals with low back pain, irrespective of the causative factors. The study consisted to 45 participants divided in 3 groups of 15 each. Group one consisted of participants who did not have any low back pain, group two consisted of participants with non-specific mechanical low back pain and group three participants had discogenic back pain. Participants were screened using VAS and they were required to have at least 50% of

the normal range of motion. A Biodex System 3 Pro Isokinetic Dynamometer was used for the purpose of this study where participants were guided to and then expected to replicate lumbar flexion to 30 degrees. Three trials were given and the mean of the RE (repositioning error) was used for the calculations. The study was successful in proving that lumbar proprioception is affected in low back pain. The value of the repositioning error was significantly greater in group two and three participants compared to group one. One of the shortcomings of this study was that the researcher failed to provide the reader with any information about the blinding of the researcher or the participants. Another shortcoming mentioned was the use of the Biodex System 3, as it only allows the researcher to study lumbar repositioning in the sagittal plane. Numerous straps were used to hold the participant in position, which may have inadvertently provided them with extensive sensory input, thus providing cutaneous feedback and affecting the data collected. A positive aspect of the Biodex System 3 is that it is more accurate than other manual methods. The legs of participants were not in contact with the floor, thus reducing the proprioceptive feedback from the lower limbs.

A systematic review and meta-analysis conducted by Tong et al (2016), also concluded that a relationship exists between low back pain and altered lumbar proprioception. The review consisted of twenty-two studies that were shortlisted by two researchers after going through numerous data bases. This allowed for consensus and in case of a disagreement, a third researcher's opinion was also taken into account. A Critical Appraisal Skills Programme checklist (CASP) along with other relevant criteria framed for the selection purpose were used to check for the quality of the study. The review included twenty-two studies of which twenty-one were cross sectional. They compared lumbar proprioception in low back pain patients against a control group. One study checked for a relationship between low back pain and lumbar proprioception. Joint repositioning sense was the method used to study

proprioception in twenty-one studies with the use of different equipments and one used threshold to detect passive motion (TTDPM) to measure proprioception. The review took into account the various equipments used, the different subgroups of patients considered without any apparent discrimination of bias. Different types of low back pain patients were considered and the results showed that the lumbar proprioception was affected in almost all these cases, thus establishing the fact. It also showed that proprioception is affected in both, sitting and standing positions.

McCaskey et al (2014) conducted a systematic review about the effect of proprioceptive training in case of chronic neck pain and chronic non-specific low back pain. Eighteen randomised control trials were included after extensive screening, but the findings were very inconsistent across the studies. All but one study was considered free of risk of bias. All the other studies presented with moderate or high risk of bias due to lack of information about allocation, concealment and blinding. Most of the studies did report a decrease in pain but the improvement following proprioceptive training did not differ significantly from other methods of treatment like, normal physiotherapy, patient education and strengthening. Hence the findings of the study could not be used as a basis for any treatment recommendations regarding proprioceptive training, even though participants who underwent proprioceptive training showed decreased pain. Majority of the studies failed to measure a baseline proprioception and check for proprioceptive changes after the intervention. A need for further research in the field was expressed.

Joint repositioning sense is going to be the method adopted to measure proprioception in this study. One of the main reasons is that it requires minimal equipment. Modified-Modified Schobers' test will be used to measure the lumbar range of movement, which will then be employed to study the proprioception. Also, almost all proprioception studies, including those on lumbar proprioception have used Joint repositioning sense as the method and it is

considered a reliable method for the same (Gill & Callahgan, 1998) (Gregory, 2011, Peterson et al, 2008).

The core muscles are responsible for maintaining spinal stability and normal posture. Proper co-contraction of these muscles is required to obtain this. Counteracting external forces by engaging in hip and ankle strategies to maintain this control is a part of their function (Panjabi, 1992, Panjabi, 2003, Reeves, Narendra& Cholewicki, 2002). A study conducted by Lee et al (2014) used PNF (Proprioceptive Neuromuscular Facilitation) pattern and ball exercises randomly on forty participants. Baseline data was collected and they were evaluated periodically over the course of the study. VAS (Visual Analogue Scale) and EMG activity was recorded and it was concluded that the EMG activity increased significantly for participants in the PNF group. It also concluded that weakness of trunk and abdominal muscles is a major causative factor for low back pain.

Kumar and Kumar (2014) conducted a study with 30 participants suffering from chronic low back pain. Each group had 15 participants divided according to the chronicity of their pain. Participants of one group had pain for over twelve months and those of the other group had pain for less than twelve months but more than three. A systematic intervention was given to both the groups. It consisted of warm up exercises, flexibility training and core strengthening exercises. The core strengthening exercises were administered in three stages. Stage one – control and activation of the transverse abdominis with the help of a pressure biofeedback unit. Stage two - exercises aimed at improving close chain segmental control, close chain exercises for the upper quadrant, weight bearing and forward leaning exercises for the trunk and exercises performed in flexed posture. Stage 3 - this consisted of open chain segmental control exercises, training lumbar spine stability with the help of a pressure biofeedback device, lower limb activities including strengthening the gluteus maximus via single leg squats and dead lifts. Numerous outcome measures were used including Numerical pain

rating scale, Oswestry Disability Index, Sorensen test, Gluteus Maximus Strength test, Transverse abdominis activation and Modified-Modified Schober's Test. One of the positives about the study is that baseline data was recorded for all these measures on day zero and the measurement was done again after six weeks to check for improvements. Also, the data was collected at the same place and at the same time of the day during both the data collection phases. The inclusion and exclusion criteria for the study was very stringent, thus proving reliable results. The limited number of participants was a limitation for the study, as was the small duration of participant follow up. It was concluded that a relationship between core strength and low back pain exists and therefore, strengthening the core muscles has a positive impact on low back pain.

There is no universal method of measuring core strength, but the most widely used method is the use of a Pressure Biofeedback Unit placed underneath the lumbar spine, while encouraging the participant to perform an abdominal draw-in manoeuvre. It engages the deep spinal muscles including transverse abdominis, internal obliques, external obliques, lumbar multifidus, with transverse abdominis being the main muscle. The co-contraction of all these muscles plays a role in maintaining the spinal stability. If the muscles lack strength, then the stability of the core is affected, hence affecting the spinal stability (Kaping, Äng & Rasmussen-Barr, 2015),(Kim, Seok & Jeon, 2017).

It has been established that both, core strength and lumbar proprioception are important factors that play a role in low back pain. Enough evidence is present that shows their relationship with low back pain, but no study has been done with the aim of studying and establishing a relationship between these factors. To add to the knowledge we have about low back pain and to help device new methods and treatment approaches for this prevalent problem, continued exploration is required, which helped establish the need for this study. A correlation study will check if a correlation between these factors is present and the results

from this study can form the basis of future randomised controlled trials to determine the type of relation and its implementation in rehabilitation practice.

Aim

The aim of this study is to check if a correlation exists between lumbar proprioception and core strength in university students suffering from non-specific low back pain.

Objectives

- To check the proprioception with the aid of the joint repositioning sense and Modified – Modified Schober's test
- To check the core strength using the pressure biofeedback unit and abdominal draw-in manoeuvre
- To check for a correlation between these two factors

Method

Study Design

A positivist/ postpositivist paradigm was considered for this study as all the data gathered was definitive, observable and could be measured using suitable outcome measures. (Mertens, 2005), (Creswell, 2003), (O'Leary, 2004). (Mackenzie and Knipe, 2006). The study was quantitative since the question sits in the positivist/ postpositivist research

paradigm. Quantitative studies give us immediate answers which are facts and the data can be measured using universally validated methods and devices. (Bryman and Bell, 2007), (Fellows and Liu, 2008).

Research Method

The research method chosen was a correlational study. The absence of any previous study aimed at studying the correlation between lumbar proprioception and core muscle strength in non-specific low back pain dictated the necessity of using this research method. Studying the relationship between these variables is necessary and is the first step, if future quantitative studies like randomized controlled trials are to be considered for these factors of non-specific low back pain. Correlational studies are relatively straightforward and less time consuming as well as quite economical (CIRT). The data collected for various variables in this study was numerical. The data was collected from university students with non-specific low back pain.

Sample Size Calculation

Usually g*power software is used to calculate the sample size for a correlational study. For this purpose, the *p* value from a previous research needs to be available for use. Due to a lack of research in this research topic, the researcher was unable to find a reliable article to obtain a *p* value. Thus, the g*power software was not used in sample size calculation. According to Roscoe, J.T (1975) a sample size ranging from 30 to 500 participants is sufficient to conduct a correlational study. According to the paper, this range suffices for most research topics, depending on how many categories the researcher intends to break the data into. Since the data for this study was not divided into various subsamples, a sample size of 30 participants

was considered sufficient, and therefore 30 students with non-specific low back pain were recruited.

Recruitment

Participants were recruited via word of mouth and by using snowball sampling. Social connections established by the researcher via their place of employment aided the researcher in the recruitment process. Interested people who contacted the researcher, were given minimum data about the study. Social media was also used to contact probable participants. Once the students demonstrated an interest and willingness to participate, they were emailed details about the study and a participant information sheet was also sent. Following this, an email exchange ensued where participants were screened based on the inclusion and exclusion criteria. They were encouraged to ask any questions they may have regarding the study. A suitable time was decided upon by the participant and the researcher to meet for the process of data collection.

Study Setting

The data collection process was conducted at the researcher's place of employment, as it was easily accessible to the participants as well.

Equipment Required

- Inch tape and pen to measure proprioception error using Modified-Modified Schober's test

- Pressure biofeedback unit to measure abdominal muscle strength (Tr A)
- Weighing Scale
- Height measure

Inclusion Criteria

- University students suffering from non-specific low back pain – students who have had recurrent low back pain problem in the past few months with no specific structure being held accountable for it through tests.
- Are not undergoing treatment currently. Past treatment is accepted.
- Occasional use of analgesics in the past is acceptable.
- Do not have orthopaedic conditions like scoliosis, club foot, etc, disc herniations or other systemic conditions like diabetes, inflammatory diseases, etc

Exclusion criteria

- Low back pain from established causes eg, intervertebral disc prolapse
- Have structural or systemic issues, eg scoliosis, inflammatory diseases, diabetes, etc as they may alter the results
- Undergoing treatment for non-specific low back pain
- On regular medications for non-specific low back pain
- Chronic low back pain (persistent pain for more than 3 months)– as this includes an increased psychological aspect to the pain which may negatively affect the data
- Are athletes – because the physical limitations and capacities of athletes supersede those of non-athletic individuals, which would affect the uniformity and reliability of data collected

Reliability and Validity

The Modified-Modified Schober's test has shown moderate validity of 0.67 and excellent reliability (inter rater reliability of 0.83 - 0.96, intra rater reliability of 0.89 - 0.97) (Tousignant et al, 2005). This was used to measure lumbar proprioception to calculate the absolute error. A BROM 2 device (back range of motion device) is better suited for this, but due to lack of availability, the Modified-Modified Schober's test was used. The data will be in centimetres.

The pressure biofeedback unit has moderate to excellent reproducibility (0.47 – 0.82) and acceptable construct validity (0.48 – 0.90) (Lima et al, 2011). This was used to measure the pressure exerted by the transverse abdominus muscle while performing the abdominal draw in manoeuvre. The data will be in mmHg (pressure).

Procedure

- Participant information sheet was provided to the interested candidates. Following this, if they were comfortable with participating, they were recruited for the study and informed consent was taken.
- Gender, age, height and weight was collected for demographic purposes
- In accordance with the Modified-Modified Schober's test, the posterior superior iliac spine was palpated and the points of measurement were marked.
- Following this, the participants were asked to spread their feet shoulder width apart and close their eyes. They were then guided to 5 cm of lumbar flexion. This point was

then marked on their back. An inch tape was used for this purpose as is used in the Modified-Modified Schober's test.

- The participants were asked to remember this position of lumbar flexion and then return to neutral standing position.
- They were then asked to replicate the movement thrice with the aim of reaching the same extent of lumbar flexion. Measurements were taken all three times and the mean of the absolute error was calculated.
- To measure the core strength, the participants were initially taught the abdominal draw-in manoeuvre and asked to practice it.
- They were then asked to lie supine and the pressure biofeedback unit was placed under the lumbar curvature and inflated to 50mmHg. Following this, they were asked to perform the abdominal draw in manoeuvre and the reading from the pressure biofeedback unit was taken. This was done thrice and the mean was calculated.

Data collection

Demographic data of the participants was collected first. This was recorded and stored by the researcher. The data obtained for the proprioception measure was in centimetres and the data obtained from the pressure biofeedback unit which measured the core strength was measured in mmHg.

Following the data collection, all the data was electronically stored on a password protected personal laptop that is accessed only by the researcher.

Ethical Considerations

Before participation in the study, the prospective participants were given an information sheet and an informed consent form. Only after they read the information sheet, asked the researcher any questions they wanted answers to and signed the informed consent form, were they considered a part of the study. The participants volunteered to participate in the study and this is mentioned on the forms they signed prior to the study. They were made fully aware that they are free to withdraw from the study till the stage before data analysis begins. All the potential risks, requirements were mentioned in the forms before informed consent was obtained. A time convenient for both the participant and the researcher was agreed upon to conduct the research and collect data. All personal data obtained, will be safeguarded. The identity of the participants will be heavily safeguarded and removed from the data at the earliest possible convenience.

A risk assessment was done before obtaining ethical approval. The level of risk was low and necessary steps were taken to prevent any harm.

Data Analysis

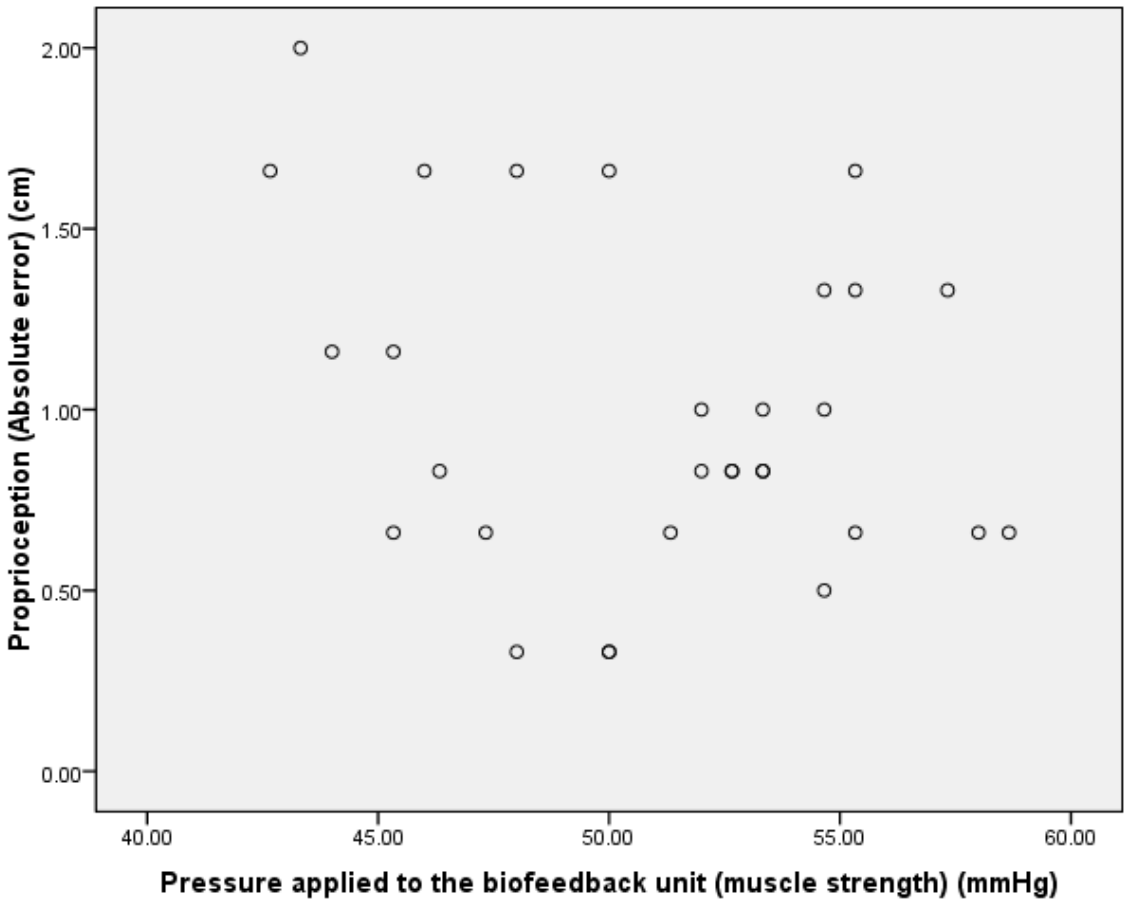
Data was analysed using Statistical Package for the Social Sciences (SPSS) version 26.0 software. Descriptive statistics were also used to analyse the data obtained (mean, standard deviation etc)

Absolute error (AE) was calculated from the proprioception readings and their mean was calculated. The mean for the readings from the pressure biofeedback unit were also calculated. The data was checked for normality and the results showed that the data was not normally distributed. The Shapiro–Wilk test was taken into account as it is used for most data where the

sample size is 50 or less. The sig. value for the Modified-Modified Schober's test was 0.052 and that for the core muscle strength was 0.275. The data is considered normal for sig. value of >0.05. In this case, the data was not considered to be normally distributed as one value is too close to 0.05. As the data is not normally distributed, a non-parametric test, the Spearman test to find the Spearman correlation coefficient (r), was used.

Result

30 participants were recruited for the purpose of this study. Of these 17 were females and 13 were males. The mean age was years and the mean weight and height of the participants was kgs and cms. The Spearman correlation coefficient was calculated and a minimal negative correlation was found. The value of r obtained was -0.174. The value of *p* was calculated to be 0.356, which makes the results obtained statistically insignificant. Therefore, no correlation was found between lumbar proprioception and core muscle strength in university students with non-specific low back pain.



SCATTER PLOT GRAPH OF THE PROPRIOCEPTION (ABSOLUTE ERROR) AND MUSCLE STRENGTH (mmHg)

It was also observed that 10 participants out of 30, were unable to put pressure on the pressure biofeedback unit. Therefore, data for the remaining 20 participants was reanalyzed to check for a possible correlation. The resulting calculation showed that there is no correlation in these 20 participants as well. The value of the Spearman correlation coefficient obtained was 0.182. Therefore, it has been demonstrated that no correlation exists between lumbar proprioception and core strength in university students with non-specific low back pain.

Discussion

The purpose of this study was to check if a correlation exists between lumbar proprioception and core strength in university students with non-specific low back pain. Modified-Modified Schober's test was used to measure the proprioception using joint repositioning sense. The absolute error was calculated for further calculations. The pressure biofeedback unit was used to measure the core muscle strength as transverse abdominis is one of the main muscles here and with the increased pressure it will apply during the abdominal draw-in manoeuvre, The increase in pressure will be an indication of the strength of the muscle. No correlation was found with a sample size of 30 participants. Another correlation calculation was done after removing 10 participants from the sample size as they were unable to maintain the baseline measure of 50 mmHg on the pressure biofeedback unit while performing the abdominal draw in manoeuvre. This calculation also showed no correlation between core strength and lumbar proprioception in the participants.

Low back pain has many factors that influence it psychological factors, core strength, core stability, proprioception, decreased flexibility, life style factors like smoking, etc. The interplay of these factors causes low back pain and low back pain also aggravates some of these factors in turn. There is extensive research that shows a relationship between low back pain and decreased lumbar proprioception (Gregory, 2011). Similarly previous research also draws a relationship between low back pain and decreased core strength. It has also been established that the core muscles play an important role stabilising the spine. In order for the muscles to perform this function they need to be strong. If the strength is affected, their ability to stabilize the spine is also affected. Therefore, research has concluded that in the case of low back pain, the strength of the core muscles is also affected.

It was found in this study that no relationship exists between these two factors, core strength and lumbar proprioception in low back pain in university students. It is possible that the researcher was unable to find a correlation because of the sample size taken. According to Roscoe (1975), a sample size of anything from 30 to 500 participants is deemed sufficient for the purpose of conducting a correlation study if the participants are not divided into various subgroups. Since in this study, there was no subdivision, the researcher decided to go with the minimum possible sample size. It is quite possible that if the sample size taken was larger, a correlation may have been found. It was also observed that within this small sample size, one – third of the participants were unable to perform the proper abdominal draw-in manoeuvre, thus affecting the readings obtained using the pressure biofeedback unit. Since 10 participants were unable to perform properly, this too may have affected the results obtained.

It is also worth considering that joint repositioning sense was used to measure proprioception here. Though joint repositioning sense has been proven to be a valid and reliable way to measure lumbar proprioception, the methods of measuring it differ greatly. Researchers have used Biodex System 3 Pro Isokinetic Dynamometer (Gregory, 2011), BROM II device (Back Range of Motion) (Breum et al, 1995) and various other devices to measure spinal mobility and deduce proprioception. Research has been conducted about the validity and reliability of the devices and found to be very good. The researcher came across only one other article where an inch tape and Modified-Modified Schober's test was used to check the proprioception in the lumbar spine (Kara, B et al, 2011). The study deemed it valid and reliable with good results but no validity and reliability values were found for this method. It is possible that the use of this method may have led to an error in measuring the joint repositioning sense.

The pressure biofeedback device while performing the abdominal draw in manoeuvre primarily measures the pressure applied by the transverse abdominis. It is quite possible that

no relationship was found because transverse abdominis may not be relevant to lumbar proprioception during lumbar flexion in standing position. One of the other muscles that form a part of the core muscle group may have a more significant relationship to lumbar proprioception. According to Panjabi (1992) it is the muscle spindles of the deep paraspinal muscles that play an important role in proprioception for trunk proprioception and movement. The lumbar multifidus is another prospective muscle that may be affecting the proprioception. An increase in fat infiltration, muscle atrophy and a deficit in activation of the lumbar multifidus muscle in low back pain patients has already been reported through various studies. Also, low back pain intensity has been proven to be related to abnormal morphology and decreased activation of lumbar multifidus, although the findings from various studies have been inconsistent. This seems to be a relatively new area of research with limited studies. The diaphragm also has a relationship with lumbar proprioception. Research shows that following high intensity inspiratory muscle training (IMT) promotes muscles involvement in lumbar proprioception in posture control in people with low back pain (Janssens, K et al, 2015). This knowledge can be used to design rehabilitation protocols accordingly. Measuring strengths of muscles other than that of transverse abdominis may have yielded a relationship between lumbar proprioception and core strength in university students with non-specific low back pain.

Limitations

The research study undertaken here had several limitations, which may have adversely affected the results. No Visual Analogue Scale (VAS), Numeric Pain Rating Scale (NPRS) or any other method was used to record the intensity of the pain. Using this would have enabled the researcher to recruit participants with wide ranging severity of non-specific low back

pain. The lack of use of a pain scale has resulted in no knowledge about the pain levels of individual participants. Most of the studies do use a pain scale to categorise and keep record of the range pain levels of the participants.

Another limitation was the use of an inch tape and the Modified-Modified Schober's test to determine the joint repositioning sense. The reliability and validity of a different instrument like the BROM II device may have improved data accuracy. Also methods of testing proprioception other than joint repositioning sense could have been used additionally. The threshold to detection of passive motion (TTDPM), if the equipment were available, would add to the quality of data. Active movement extent discrimination assessment (AMEDA) has been recently adapted for lumbar spine proprioception test and is considered the most ecologically valid as it does not attempt to alter the other senses or the environment of the testing area for the participant (Han, J. et al, 2016).

The lack of a proper and standardized method to measure the strength of the core muscles, significantly affected the study. The pressure biofeedback unit does not have a very good reliability or validity. Use of a standardized method to measure core strength may have altered the results and also enabled the researcher to check for the strength of every relevant core muscle that plays a significant role in spinal stability.

Future Implications

It was found that no correlation exists between core strength, measured using pressure biofeedback unit for transverse abdominis and lumbar proprioception, measured using Modified-Modified Schobers's test in non-specific low back pain in university students. The absence of a correlation might compel clinicians to think about altering strength training protocols for low back pain if they focus on strengthening only the abdominal muscles. Focus will shift towards the lumbar multifidus muscle and paraspinal muscles. Recent research has

shown that the lumbar multifidus muscle plays a very important role in maintaining stability of the spine. It the strength of the lumbar multifidus is affected, then its ability to stabilize the spine will also be affected. This will result in aggravation of pre-existing low back pain or cause low back pain.

Low back pain is a predominant condition all over the world and has a lot of factors that influence it and cause it and it is a recurrent condition. Even after extensive research into non-specific low back pain, there still is a lot about the condition that is unknown. Any new information about its factors or any relationship between its factors should be a welcome knowledge as it helps us understand the condition better.

When undertaking future research in this area of study, it must be kept in mind that the researchers should consider focusing on core muscles other than the transverse abdominis when checking for a correlation to other factors of low back pain, like proprioception, strength and stability. In accordance with recent studies and ongoing studies, it seems more prudent to focus on the lumbar multifidus muscles, deep paraspinal muscles and the diaphragm when trying to study spinal proprioception and muscle strength and core stability as the research surrounding low back pain seems to be moving in this direction.

Conclusion

Low back pain is a recurrent condition and its cost on the healthcare system is increasing every year. Therefore, understanding and treating it is of the utmost importance. According to Panjabi (1992)(Comeford and Mottram, 2000), low back pain occurs if the stability of the spine is altered. According to the spinal stabilization model, there are three components to it which balance each other out to maintain stability, The passive subsystem consisting of

articular structures and connective tissue like ligaments, the active subsystem, consisting of the muscles and tendons, which function to maintain the stable position and the Control system, the neural system that receives sensory information and the other two systems respond accordingly. According to this model, all three systems are interdependent and compensate for each other. When they are unable to compensate for each other, it leads to low back pain. So, to maintain the stability of the spine, the muscle strength needs to be good as well as the proprioception which allows them to change positions to compensate. This research study aimed to find a correlation between lumbar proprioception and core muscle strength in university students with non-specific low back pain. The results obtained in this study showed the presence of a minimal negative correlation which was not of a statistically or clinically significant value to induce. Therefore, no correlation was found between these two variables. Lumbar proprioception and core strength are important factors of non-specific low back pain and future research of good quality must be conducted focusing on other lumbar muscles, especially lumbar multifidus as recent research has shown that it might be playing an important role in spinal stability, proprioception as well as core strength.

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