Rehabilitative Ultrasound Imaging in Multifidus - A Review

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Abstract

The main objective of this paper was to estimate the use of Rehabilitative Ultrasound Imaging (RUSI) in multifidus, obtaining the all-cross-sectional view of muscle, and to measure muscle morphology. Learning the different categories of US, techniques, modes while application. Effectiveness of the RUSI over other imaging technologies. Several articles were used as reference for the study. Research done by various authors are been compared to know the benefits and extent of USI. Also, use of Ultrasound imaging on cervical multifidus has been studied under this article. Muscle thickness of multifidus has been measured at different cervical level. It is found out that patients with LBP and neck pain have smaller cross-sectional area compare to normal subjects. The study concludes that use of RUSI in LBP, chronic neck pain patients and even on healthy subjects for comparative study. Use along with EMG and some types of manipulation for better outcome.

Keywords: Rehabilitation, Ultrasound, Lumbar, multifidus, imaging.

I. INTRODUCTION

Ultrasound imaging provides visual feedback of muscle function to aid the physiotherapist for clear diagnosis and advice a specific treatment for musculoskeletal condition such as low back pain, carpal tunnel syndrome, trigger finger etc. US images are laminographic i.e., provide visualization of internal structure. This method provides visual guide during regional anaesthesia and pain management. US imaging of strain in soft tissue and tensile strength provides information about the biomechanism of tissues and also about stiffness (tightness) and hardness.

Ultrasound imaging can easily between healthy individual and one with low back pain or chronic neck pain. As adults with pain have decreased muscle diameter, atrophy, asymmetry, disproportion and decrease in ability to thicken the muscles during any type of contraction.

There are three clinical categories of USI i.e., (rehabilitative, diagnostic and intervention US) (table.1) use to provide visual guidance that helps in improving the success and safety rate of procedures in both acute and chronic care, specifically in quick diagnosis or when therapy is critical. Within each of the four USI categories there are variety of US based technique (fig.3) i.e. A-mode (amplitude), B-mode(brightness), M-mode(motion) which can be use depending upon patient’s condition & research goal. The US imaging used in rehabilitation of neuromuscular disorders is called as rehabilitative ultrasound imaging (RUSI) which is also defined as application of ultrasound to study about muscle morphology, soft tissues and their function during physical exercises. It plays very important role as it provides the feedback to patient as well as therapist [1-10].

This help to measure normal muscle morphology; or any changes in muscle morphology over time (with ageing), with events like (e.g. contraction, injury, surgery,). The main role of use of RUSI is to evaluate muscle size, thickness and shortening to visualize any injury it also provides feedback to patient & therapist and measure muscle size while treatment.
The ultrasound imaging in the clinics is used to amplify the muscle activity by providing the feedback and documentation of specific therapy. Rehabilitative Ultrasound Imaging (RUSI) has been very effective for measuring activation of selected muscle. Use on lumbar multifidus muscle, bipolar fine wire electrode is inserted into the LM at the level of L4.

RUSI data is collected while the patient is asked to perform voluntary action to activate the muscle.

Estimation of thickness change in muscle by use of RUSI is a reasonable and efficacious method to document the activation of lumbar multifidus muscle in an asymptomatic patient. (fig. 1)

II. BENEFITS

Ultrasound has been very effective in imaging the human body. It has many benefits i.e., portability, free of radiation risk, and in expensive among other imaging technologies. This is concise and effective work for physical therapist available on science and working of advanced digital imaging system. Ultrasound images give clear picture of any soft tissues that cannot be obtained by using x-rays. Some arising alteration in US, such as application in app-based ultrasound technology, 3d imaging, fusion of CT/MR, shear wave elastography, development of wireless transducer, laparoscopic ultrasound etc. make use of US reliable. It is based on unionized radiation which makes it less hazardous than x-rays and other types of imaging technologies that works on ionizing radiation [11-18].

III. DISCUSSION

Some researchers applied Bipolar fine wire electrode on the LM at L4 in 5 subjects. Simultaneously electromyography and ultrasound imaging data (i.e., morphology) were acquired, while subjects were asked to perform higher demanding task to activate multifidus muscle, for determining the relationship between thickness change in muscle & data collected by EMG, then both EMG & RUSI data were compared. This helps in understanding the increase demand on lumbar multifidus.

According to case report of Alexandra K. Brenner and colleagues, a patient 33yr old with low back pain, during clinical analysis, patient was asked to lift upper extremity (trunk) in prone position to activate lumbar multifidus then the therapist palpate the LM and found out, decreased contraction of left LM. Further decided to apply RUSI which helped to verify the activation of multifidus during palpation. Manipulation on lumbar region was performed in order to reduced hypomobility of spine. Imaging at the L4-L5, S1 level of multifidus were acquired 1. pre-manipulation, 2. immediately post-manipulation, and 3. day after manipulation. Increase in ability to contract the multifidus while lifting task of upper extremity in prone was documented immediately after manipulation and a day after manipulation. Average of changes in thickness was 3.6% pre-manipulation, 17.2% immediately post-manipulation and 20.6% 24hr after post-manipulation.

According to Wendy J Herbert & colleagues, performed a clinical trial on 30 subjects randomly assigned them to two different groups constant (CONS) and variable (VAR) feedback. 28 subjects accomplished training and rest 23 finished their retention testing. They planned 8 training sessions in 4 weeks with muscle exercises by the use of RUSI. Retention was evaluated at 1 week and >1 month. The outcome of this experiment, at start both groups had similar performance of LM. Early in session 1 CON has success rate of 80% that was maintain till 8th session (84%). There was very less difference between session 1 and 8, VAR group moderately increased their success rate between first and eighth session. When testing was done for temporary retention of 1 week there was greater success in CON group. For the permanent retention testing the VAR group indicated superior motor learning. Conclusion of this study by them was that, VAR group had better success rate than CONS group in the recruitment of LM after couple of months of training [19-25].

Julie Hides, Carolyn Richardson & others did the pre-treatment and post-treatment assessment young cricketers with LBP. They measured the CSAs of multifidus at rest on lateral sides for four vertebral level at start of session and then after 13-week cricket training camp. People with past history of LBP and current LBP were placed in rehabilitation group. When RUSI was applied to this patient. The amount of muscle dissociation in those with low back pain were found to be decreased and become almost equal to the patients without LBP. There was also 50% reduction in pain magnitude reported by patient earlier [26-30].
In some articles it is found out that video method of RUSI is very efficient and reliable. They tested intra-rater reliability of two methods on lumbar multifidus i.e. the traditional method (static images) and the video method. Images and video of LM thickness in 15 healthy subjects were capture. Intra class correlation (ICC) with 95% confidence interval, stand error of measurement, and very small changes were calculated to determine the reliability and precision of the LM thickness measurement. Excellent intra-rater reliability was demonstrated measuring LM muscle thickness using both method with ICC ranging from 0.75 to 0.95. (fig.2) The reliability of LM thickness measured in video ultrasound similar to that with static images in fit subjects.

Researchers have demonstrated decrease in muscle thickness & wasting of LM in population complaining of low backpain, some articles based on the use of RUSI in cervical multifidus in neck pain. US imaging of multifidus muscle from the 3rd and 6th spinal level of cervical vertebrae were captured in 20 patients with severe neck pain and in 20 fit subjects. The subjects having neck pain is suspected of decreased CSAs of the cervical multifidus at each level compare to normal. It is found that wider ovoid shape compared to control, multifidus at C4 has a smaller shape compared to C6 but has not much difference from C3 and C5.

An article in which pattern and sequence of the morphology of (CM) cervical multifidus in normal patients were studied, which is described mathematically and use to do comparative study among different level of barriers (resistance) and at different cervical levels by use of rehabilitative ultrasound imaging (RUSI). 20 healthy subjects were enlisted for this study. US with synchronised recording of force was utilize to measure muscle morphology of CM during isometric contraction while performing extension against resistance force. The two Linear and Quadratic model was used. The changes in morphology (thickness) of muscle was better fitted in quadratic model \(y = ax^2 + bx + c\) than the linear model \([31-36]\).

(Fig.1) Ultrasound imaging of multifidus
- Mode A
  - One transducer
  - Linear image

- Mode B
  - Set transducers aligned
  - 2D image

- Mode M (Movement)
  - Consecutive B-mode images

- Mode Doppler
  - View and measures blood flow
  - Pulsed Doppler “power Doppler” (non-directional)
  - Color Doppler (directional)
  - Red: approaches the transducer
  - Blue: away from the transducer

(fig.4) working of ultrasound imaging
Table 1: Clinical categories of US

<table>
<thead>
<tr>
<th>Clinical categories of Ultrasound imaging</th>
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<tbody>
<tr>
<td>Diagnosti cUS</td>
</tr>
<tr>
<td>RehabilitationUS</td>
</tr>
<tr>
<td>InterventionalUS</td>
</tr>
<tr>
<td>ResearchUS</td>
</tr>
<tr>
<td>Diagnosis and monitor pathology</td>
</tr>
<tr>
<td>(healing stage, sprain, strain, lesions)</td>
</tr>
<tr>
<td>Work as a biofeedback</td>
</tr>
<tr>
<td>Evaluate soft tissues and muscle morphology</td>
</tr>
<tr>
<td>Guide percutaneous procedures involving dry or wet needling (injection)</td>
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<tr>
<td>Measurement explore muscle and soft tissue structure and function develop and evaluate screening tools and interventions</td>
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POINT OF CARE ULTRASOUND

IV. CONCLUSION

This study concludes that RUSI can be very effective in population with LBP, acute and chronic neck pain and even cricketers for measuring the morphology of multifidus. Also been used in healthy individuals for comparative study. It is use along with EMG and manipulation technique which is proven to be much effective. In clinics US imaging is also use for measurement and as feedback to patient as well as therapist that can help for improving the treatment method. Outcome of this paper was to see the efficacy of rehabilitative ultrasound imaging on multifidus. It is also found out that there was 50% decrease in pain and increase in muscle thickness after RUSI is been use along with other modalities, on various modes.

REFERENCES


