High-Risk Fall Rehabilitation With Modified Otago Exercises and Medicinal Nano Gel Phonophoresis for Symptomatic Relief in Osteoarthritis of Knee

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Abstract

Proprioception is a major affection faced by individuals who undergo lower limb injuries. Especially in the elderly population, this places a major role in increasing the risk of fall. We are reporting a case of an elderly female having severe pain in her lower limb and difficulties in performing activities of daily living. Post clinical assessment, a functional diagnosis of osteoarthritic knee was made. The patient was managed with proprioception exercises (Otago exercises) and phonophoresis. These exercises were also beneficial in improving the apprehension of patient towards daily activities, walking, stair climbing, and fall risk. The technique of phonophoresis helped in alleviation of pain when given with a beneficial adjunct, like a medicinal gel.

Categories: Physical Medicine & Rehabilitation
Keywords: case report, otago exercise, proprioception, osteoarthritis, knee pain

Introduction

Proprioception loss in elderly people creates a high risk of fall and a major problem under public health domain [1]. Physiological changes as a response of aging leading to the collateral damage to surrounding bone, soft tissue and ligaments contribute to the incident of fall. Since proprioception and lower limb strength is directly proportional to the balance, both static during standing and sitting and dynamic during transfers and walking, proprioception retraining and resistance training play an important role in the rehabilitation of elderly individuals [2].

Painful arthritic condition of knee is a major age-related change that damages the subchondral bone and synovial fluid, and creates an inflammatory response, a result of which there is persistent pain and reduced ability to perform functional instrumental everyday activity [3]. The growing sedentary lifestyle and unhealthy eating habits have also led to a higher increase in the rate of prevalence of obesity, with 46.51% in southern parts of Indian and lowest prevalence of 32.96% in eastern parts of the country, which is one of the major cause of arthritis painful knee condition.

The aim of physiotherapeutic rehabilitation in individuals with such risk of fall either secondary to osteoarthritis of knee, or primarily due to age-related changes and weakness, is symptomatic relief of pain and retraining for gaining lower limb strength and balance by using a modified supervised form of Otago exercise program [4].

We have utilized ultrasound in an electrotherapy modality for the purpose of symptomatic relief of pain [5]. Phonophoresis, an advanced form of ultrasound application that facilitates transdermal drug delivery has been administrated during the process. Diclofenac gel is most commonly used with the coupling medium for phonophoresis [6]. Since the patient was treated in a rural area of India, there was apprehension to use and unavailability of muscle relaxant gel. We have therefore combined ginger (Zingiber), a natural Ayurvedic medicinal herb with anti-inflammatory properties on topical application and oral intake, as an ingredient of the nano-gel phonophoresis [7,8]. The gel was formed by mixing aqua sonic gel and ginger gel in a ratio of 4:11 for therapeutic effect [9]. We thus report the effect of this medicinal nano gel phonophoresis in combination with Otago exercises as a single subject case report.

Case Presentation

A 62-year-old female retired professor presented with a history of persistent pain in right knee after standing for more than thirty minutes for last 4 months. The pain exaggerated after descending more than seven flights of stairs. There was no history of any trauma. The patient at the time had a BMI of 31.0 kg/m2 (grade I obese). On visual analogue scale, the intensity of pain on activity was seven. The pain had severely restricted the patient's participation in social activities, which included managing events in her locality requiring standing for a long time.
Clinical assessment

Physical examination revealed no decrease in active knee range of motion bilaterally. On manual muscle testing, the grade for knee extensors and flexors was three. Hip flexors and extensors were both graded three plus. Hamstring tightness was present bilaterally. Tenderness of grade one on the medial aspect of the right knee with mild swelling was revealed by a figure of eight methods of measuring when compared bilaterally. Joint mobility was intact with the presence of crepitus. Observational gait analysis revealed more weight bearing on the left lower limb and an increased stance time on the same side with hiking of the right hip. With the above physical examination and keeping in mind the patient's endomorphic built and hectic lifestyle, we concluded osteoarthritis to be a provisional diagnosis. This was correlated with an X-ray which revealed grade three osteoarthritis according to Kallegren and Lawrence scale.

Outcome measures taken prior to the start of treatment were as follows: Visual Analogue Scale for pain, on activity, has intensity 7.3/10, WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) has a total score of 46%, and all the ranges were within normal values for hip knee and ankle. Findings for Star Excursion Balance Test are given in Table 1.

| Stance on Affected | Stance on Unaffected |
|--------------------|----------------------|
| **Direction**      | **Average Distance** |
| Anterior           | Value on Examination (v) in cm | Normalized to limb length (v/Limb length) in % | 63 | 80.76 |
| Antero-Medial      | 65 | 83.33 |
| Medial             | 49 | 62.82 |
| 45 | 57.69 |
| Postero-Medial     | 57 | 73.07 |
| Posterior          | 62 | 79.48 |
| Postero-Lateral    | 60 | 76.92 |
| Lateral            | 61 | 78.20 |
| Antero-Lateral     | 57 | 73.07 |
|                    | 72.75 |                                         |
|                    | 63 | 80.76 |
|                    | 63 | 80.76 |
|                    | 62 | 79.48 |
|                    | 59 | 75.64 |
|                    | 74.83 | |

**TABLE 1: Pre-treatment findings for Star Excursion Balance Test**

Investigations

Correlation of symptoms to the radiological investigations and the confirmation of the stage of knee osteoarthritis (KOA) with X-ray (Figure 1) was done.
FIGURE 1: X-ray anteroposterior (AP) view

It shows osteoarthritis of knee with joint space narrowing, sclerosis of bone, and multiple osteophyte formation representing grade three of knee osteoarthritis (OA) according to Kellgren-Lawrence scale.

Physiotherapy rehabilitation

As the pain was the major limiting factor of the functional activities, therefore a total of 10 sessions were taken in two weeks where both electrotherapeutic modality (Table 2) and an exercise program were given to the patient (Table 3-4).

| Variable       | Duration/Intensity            |
|---------------|------------------------------|
| Frequency     | 5 times a week for 2 weeks    |
| Duration      | 40 minutes a week/2 weeks     |
| Intensity     | 1.2 w/cm²                     |
| Mode          | Continues                     |

TABLE 2: Dosage of ultrasound: medicinal ginger gel was used for ultrasound phonophoresis
### TABLE 3: Week one and two strengthening program

| Exercise type       | Week 1                                           | Week 2                                           |
|---------------------|--------------------------------------------------|--------------------------------------------------|
| Knee Extension      | 1.5 kg weight cuff 10 repetitions X 1 set        | 1.5 kg weight cuff 10 repetitions X 1 set         |
| Knee Flexion        | 10 repetition X 2 sets with support              | 10 repetition X 2 sets without support           |
| Hip Abductors       |                                                  |                                                  |
| Ankle Plantar flexors | 10 repetition X 2 sets with support              | 10 repetition X 2 sets without support           |
| Ankle Dorsiflexors  | 10 repetition X 2 sets with support              | 10 repetition X 2 sets without support           |

### TABLE 4: Balance re-training program

| Exercise type                      | Week 1                                           | Week 2                                           |
|------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Knee bending                       | 10 repetitions with support 2 sets               | 10 repetitions without support X 2 sets          |
| Backward walking                   | 10 steps, 4 times with support                   | 10 repetitions, 4 times without support          |
| Walking and turning around         | Walk and turn around (figure of 8) twice         |                                                  |
| Sideways walking                   | 10 steps X 4 sets with yellow resistance band    |                                                  |
| Tandem stance (heel-toe touch standing) | 10 seconds X 2 sets with support                | 10 seconds X 2 sets with support                |
| Tandem walk (heel-toe walk)        | Walk 10 steps 4 times hold support               | Walk 10 steps 4 times                           |
| One leg standing                   | 10 seconds with support                          | 10-second standing without support              |
| Heel walking                       | 10 steps 2 reps with support                     | 10 steps 2 reps without support                 |
| Toe walk                           | 10 steps 2 reps with support                     | 10 steps 2 reps without support                 |
| Sit to stand                       | 10 stands and two hands for support              | 10 repetitions without support                  |
| Stair walking                      | 4 flights ascend and descend thrice throughout day | 8 flights ascend and descend thrice throughout day |

Star Excursion Balance Test was also taken as an intervention where the patient performed clockwise reach-outs in all eight directions on the mat (Figure 2). Exercise was performed thrice daily only under supervision.
Follow-up and outcome measure

Post-treatment values for outcome measure are as follows: Visual Analogue Scale for pain, on activity, has intensity 2/10. WOMAC has a total score of 19%, and all the ranges were within normal values for hip knee and ankle. Findings for Star Excursion Balance test are given in Table 5.
TABLE 5: Post two-week treatment - outcome measure interpretation for Star Excursion Balance Test

| DIRECTION        | Stance on Affected | Stance on Unaffected |
|------------------|--------------------|----------------------|
|                  | Value on Examination (v) in cm | Normalized to limb length (v/Limb length) in % | Value on Examination (v) in cm | Normalized to limb length (v/Limb length) in % |
| Anterior         | 66                  | 84.61538             | 66                  | 84.61538             |
| Antero-Medial    | 51                  | 65.38462             | 51                  | 65.38462             |
| Medial           | 49                  | 62.82051             | 47                  | 60.25641             |
| Postero-Medial   | 63                  | 80.76923             | 63                  | 80.76923             |
| Posterior        | 69                  | 88.46154             | 69                  | 88.46154             |
| Postero-Lateral  | 68                  | 87.17949             | 68                  | 87.17949             |
| Lateral          | 69                  | 88.46154             | 68                  | 87.17949             |
| Antero-Lateral   | 64                  | 82.05128             | 64                  | 82.05128             |

**Discussion**

We present a case of a woman who developed degenerative changes early in her life indicated by pain but neglected the same which lead to the development of a faster progression of the condition. The patient now presented with grade three of osteoarthritis in the early stages of her life. A previous history of knee ligamentous injury had led to altered joint loading in this patient.

Physiotherapy was implicated specifically to avoid fall risk as the patient had an initial apprehension towards even walking for 100m. A holistic approach that involved patient counselling, flexibility, strengthening and proprioception exercises was fabricated. A significant increase in the isotonic and isometric muscle strength for quadriceps, hamstrings, gastrocnemius and soleus is found to be effective in reducing the fall risk and improvement in functional activities. Gained strength also improved patient’s self-confidence [10].

Star Excursion Balance Test activity was initially difficult for the patient to perform in a rhythmic fashion. By the end of a week, movement in all eight directions could be performed without the affected leg touching the floor in between a single cycle could be performed, indicating an overall increase in strength. These findings are in accordance with other research where Star Excursion Balance Test, functional strength, and fall risk have been used as outcome measures [11,12].

**Conclusions**

This case report provides a clinical framework for improving and managing motor functions in geriatric patients. This exercise program can be used in clinical settings for all patients under the same category as in the case report and for those who are rehabilitating post injuries, with modifications in the amount of weights used for strength training. Further studies are required to evaluate the beneficial effects of modified application of ultrasound and for their long-term follow-up.

**Additional Information**

**Disclosures**

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1. Al-Aama T: Falls in the elderly. Can Fam Physician. 2011, 57:771-6.
2. Pitchai P, Dedhia HB, Bhandari N, Krishnan D, D’Souza NR, Bellara JM: Prevalence, risk factors, circumstances for falls and level of functional independence among geriatric population - a descriptive study. Indian J Public Health. 2019, 63:21-6. 10.4103/ijph.UPH_332_17
3. Kloppenburg M, Bereribaum F: Osteoarthritis year in review 2019: epidemiology and therapy. Osteoarthritis Cartilage. 2020, 28:242-8. 10.1016/j.joca.2020.01.002
4. Chiu HL, Yeh TT, Lo YT, Liang PJ, Lee SC: The effects of the Otago Exercise Programme on actual and perceived balance in older adults: a meta-analysis. PLoS One. 2021, 16:e0255780. 10.1371/journal.pone.0255780
5. Devrimsel G, Metin Y, Serdanoglu Beyazal M: Short-term effects of neuromuscular electrical stimulation and ultrasound therapies on muscle architecture and functional capacity in knee osteoarthritis: a randomized study. Clin Rehabil. 2019, 33:418-27. 10.1177/02692155198117807
6. Fernández-Cuadros ME, Bocanegra LO, Albaladejo-Florin MJ, Alava-Rabasa S, Perez-Moro OS: Effect of diclofenac gel phonophoresis on temporomandibular joint disorders: a prospective quasi-experimental study. Middle East J Rehabil Health Stud. 2020, 7:e102928. 10.5812/mejrh.102928
7. Balkrishna A, Sakat SS, Joshi K, et al.: Anti-inflammatory and anti-arthritic efficacies of an Indian traditional herbo-mineral medicine “Divya arnivatari ras” in collagen antibody-induced arthritis (CAIA) mouse model through modulation of IL-6/IL-1β/TNF-α/NFκB signaling. Front Pharmacol. 2019, 10:659. 10.3389/fphar.2019.00659
8. Mashhadi NS, Ghiasvand R, Askari G, Hari M, Davishi L, Mofid MR: Anti-oxidative and anti-inflammatory effects of ginger in health and physical activity: review of current evidence. Int J Prev Med. 2013, 4:536-42.
9. Decha P, Kanokwan K, Jiraporn T, Pichaya J, Pisittawoot A: Phosphonate associated with nanoparticle gel from Phyllanthus amarus relieves pain by reducing oxidative stress and proinflammatory markers in adults with knee osteoarthritis. Chin J Integr Med. 2019, 25:691-5. 10.1007/s11655-019-3202-8
10. Fatima I, Hassan D, Perveen W, Ali MA, Bhatti ZM, Ashraf A: Kinesophobia and Outcomes of Lower Extremity Exercise Regime in Subjects with Knee Osteoarthritis: A Case Series. Pakistan J Medical Health Sci. 2021, 15:2631-2. 10.03350/jphmhe2115102631
11. Gribble PA, Hertel J, Plisky P: Using the Star Excursion Balance Test to assess dynamic postural-control deficits and outcomes in lower extremity injury: a literature and systematic review. J Athl Train. 2012, 47:339-57. 10.4085/1062-6050-47.3.08
12. Abdelraouf OR, Abdel-Aziem AA, Ahmed AA, Nassif NS, Matar AG: Backward walking alters vastus medialis oblique/vastus lateralis muscle activity ratio in females with patellofemoral pain syndrome. Turk J Phys Med Rehabil. 2019, 65:169-76. 10.5606/tfmed.2019.2445