e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(9); 1154-1159

Original Research Article

Evaluating Probable Predictors for Fall Related Wrist Fracture among the Elderly Population

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Received: 01-07-2025 / Revised: 15-07-2025 / Accepted: 21-08-2025
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Conflict of interest: Nil

Abstract

Background: One of the most frequent injuries among the elderly is a fractured wrist, which, if left untreated, can result in diminished functionality and a lower quality of life. Fall-related wrist fractures in the elderly population have been more frequently linked to factors such as unsteady posture, diminished plantar sensation, asymmetry of vestibular function, and functional handicap. Preventive measures like enhancing balance, inner ear function, and foot sensation can be promptly implemented because wrist fractures are thought to be a predictor of future fracture incidence, particularly for hip fractures. These measures may also aid in the rehabilitation of patients who have suffered wrist fractures. Aim of this study to determine effect of multi-sensory training (MST) on posture (muscle strength), vestibular function, vibration perception, tactile sensation and functional ability compared to wrist stabilization training (WT) among elderly with fall related wrist fractures.

Methods: This study design was carried out for the 130 wrist fracture follow-up cases, with 42 participants receiving wrist stabilization training and 88 individuals randomly assigned to multisensory training from July 2024 to June 2025. A physiotherapist supervised four sessions during the 12-week training period, and both groups completed at-home exercises. Measures used before and after training included the Dizziness Handicap Inventory Scales (DHI), Activities Specific Balance Confidence (ABC), Vibration Perception Test, Semmes-Weinstein Monofilaments (SWM), Head Shake Test (HST), 10m Walk Test (10MWT), and Five Times Sit to Stand Test (FTSTS).

Results: Between the two groups, FTSTS, ABC, and DHI were determined to be statistically significant. MST was more beneficial in enhancing HST than wrist stabilization training (p=0.001).

Conclusion: Multisensory training improved vestibular function in wrist fracture sufferers. Following fracture treatment, it could be used as a regular training intervention. Its effectiveness can be generalized by using a large sample size.

Keywords: Wrist Fracture, Sensory Function, Postural Stability, Vestibular Function, Vibration Perception.

Introduction

Elderly people frequently sustain wrist fractures, which can lower their quality of life and limit their functionality if they are not properly treated and repaired. [1] Fall-related wrist fractures in the elderly population have been more frequently linked to factors such as asymmetry of vestibular function, diminished plantar sensitivity, and unstable posture, decreased lower extremity strength, and functional disability. [2]

Since wrist fractures are thought to be a predictor of future fracture incidence, particularly for hip fractures, preventive measures such as enhancing balance, inner ear function, and foot sensation can be promptly implemented. These measures may also aid in the rehabilitation of patients who have suffered wrist fractures. [3,4]Age-related degenerative changes impact not only posture control, bodily strength, and reflexes, but also multisensory activity. The fact that one-third of those over 60 are more likely to fall is supported by this.[5,6] Dizziness, diminished lower extremity mechano-receptive sensitivity, psychological factors, etc., can all contribute to falls. [7, 8] Physical activities that build muscles and stimulate the senses may help lower the risk of falls. [9]

Material and Methods

This study designed for 130 follow up cases of wrist fracture (DRF) who had undergone surgical management from July 2024 to June 2025. The sample size and population was with reference to previous study which was followed by this exercise.10

The participants had to be ≥ 50 years old, having fracture of distal end radius of either side or both side (closed type) that was surgically managed within a year, irrespective of their gender. Exclusion criteria were if wrist fracture was of compound/pathological type, history of any degenerative disease of either bones or CNS which could be a challenge in the healing of fractured bone and cognition, respectively. The cases were randomly assigned to one of the groups, either multi-sensory training group (n=88) or to the wrist stabilization training group (n=42) using a computer generated random number list. The training period was for 12 weeks, with 4 supervised sessions by a physiotherapist and home exercises for both groups.

The exercises that were used in this study are common and widely accepted:

Multi-sensory Training (MST): This method is also referred to as "The Reykjavik model. [11] The exercises were performed barefoot on firm and soft surfaces, during movements.

Attention of the subject was kept directed at distribution of weight on soles of both feet. No use of external support was allowed. This was done to control the body's movement along with its position.

Moreover, they were encouraged to know their body posture control pattern and trained to correct their posture with motions at ankles. Control of posture was practiced during head movements in various directions, with eyes open, closed and during fixation of gaze. The subjects were taught how to react to sudden balance disturbances by taking a step to hinder falling and use stepping reactions when their stability was challenged by a manual push indifferent directions. [10,11] With respect to the type of weakness in balance, the subjects were given different exercise, which were taught to them during the sessions under supervision of ENT and Orthopedic specialist. The subjects were instructed to perform the exercise at home and focus on distribution of weight on the soles. The exercise had to be continued after taking some rest, if nausea or dizziness was experienced during the exercise.

Wrist Stabilization Training (WT): The exercises for strengthening fractured wrist post-surgery were to be done while seated so that the control over body position is also stimulated. The exercises include elastic resistance bands, sponge ball and ball over a plate which were taught under supervision of the experts. This training was referred to from a similar study. [10] All measurements conducted to judge the gait, vestibular function, muscle strength, posture stability and sensations were conducted at baseline and completion of the study, in addition to recording of weight and height:

FTSTS test was applied to test the strength of lower limb muscles which has been proved to be very reliable. [12,13] The gait speed was assessed by the10 m Walk Test (10MWT) where measurements were taken twice, first when the subject walked at normal pace and second when the subject walked at the fastest speed. [14,15]

Vibration perception test over plantar surface of feet was done using a biothesiometer which produced a120 Hz vibration. [16] Whereas, a tuning fork producing 128 Hz vibration was used to check perception over lower extremities. These sensations were graded from 1-3; 1 if vibration perceived over base of 1st metatarsal, tibial tuberosity and medial malleolus, 2 if vibration perceived over tibial tuberosity and medial malleolus and 3 if vibration was detected only over tibial tuberosity. [17–19]

The Semmes Weinstein pressure aesthesiometer (SWM) having nylon filaments was used to measure tactile sensitivity. This was done and interpreted in accordance to previous studies. [16] Normally, it ranges from 0.4 to 4 g. [16] Monofilament and biothesiometer; measured on plantar surface of heel, caput of the 1st and 5thmetatarsal bones, bilaterally.

Head Shake Test (HST) was done to evaluate the vestibular function where the eye movements of patient were recorded in supine position while using infrared goggles. [20,21] Nystagmus was recorded.

After head shake, 2 or more beats of nystagmus was asymmetry. [2,20]

The questionnaires for Activities Specific Balance Confidence (ABC) [22,23] and Dizziness Handicap Inventory scales (DHI) [24,25] were used as research tool which were self-administered.

Results

Interestingly, all wrist fractures were caused due to fall.25% patients reported fall due to sudden black out while head movement while 13.1% reported fall due to accidental tripping. Wrist fracture was reported by 91(73.4%) male while 33(26.6%) were female. Among them, 38.6% were diabetic and 51.2% reported to be hypertensive. On baseline assessment, 85.5% patients had reduced lower limb strength, 71.2% had decreased plantar vibration sensitivity and 90% had complaints of discomfort/

nauseaon movement of head. 25.4% of the patients had reduced tactile sensation both the lower limbs while 47.8% reported the deficit on either of the lower limbs. Moreover, 70.1%patients reported history of experiencing dizziness and 65%had reduced activities specific balance control. Table 1 depicts the baseline characteristics information of patients who were randomized and divided into 2 groups receiving different training- MST and WT. Body mass index, history of wrist fracture, vibration sensation over feet (Biothesiometer) and head shake test was found to be statistically significant.

Table 1: Baseline characteristics of the patients receiving MST and WT, N=130

Parameter	**MST(n=88)**	**WT(n=42)**	**p-value**
	Mean±SD	**Mean±SD**	
Age (Years)	58.2±4.8	56.4±2.9	0.115
BMI (kg/m^2)	64.4±6.1	63.1±4.6	**0.023**
Alcohol abuse (%)	29.2	20.3	0.383
History of wrist fracture (within last 5 years) (%)	45.6	40.4	**0.045**
FTSTS test (s)	12.3±1.2	12.1±1.5	0.124
10MWT(m/s)-			
Normal speed	1.3±0.2	1.4±0.2	0.082
Fastest speed	1.8±0.3	1.8±0.1	0.349
Vibration perception-Biothesiometer(µ/m)	3.5±4.1	2.9±3.5	**0.012**
Tuning fork score	1**(Median)**	1**(Median)**	0.111
SWM(g)	1.6±2.1	1.6±1.4	0.212
HST*(%)	92.2	86.5	**0.001**
ABC score	85±12.5	86±12.2	0.121
DHI score	12±12.1	11.3±10.9	0.485

BMI-body mass index, 10MWT- 10 m Walk Test, FTSTS - Five Times Sit to Stand Test, DHI- Dizziness Handicap Inventory, ABC- Activities specificBalance Confidence, *Positive HST:≥2 fast eye beats

Table 2 shows difference in the pre and post training assessment of the patients treated for wrist fracture for strength, gait, vibration, tactile sensitivity, vestibular function, balance confidence, dizziness and functional abilities. The study reports that there was significant improvement witnessed in ABC, DHI and FTSTS in both groups whereas the MST group in addition reports developing better HST.

The observed effect sizes of significant parameters for both the types of training is shown in Table 3.

Table 2: Post training assessment of the patients treated for wrist fracture, N=130

Parameter	**MST(n=88) Mean change**	**WT(n=42) Mean change**	**p-value**
FTSTS test (s)	-1.8	-1.5	0.001
10MWT (m/s)-			
Normal speed	0	0	0.208
Fastest speed	0	0	0.089
Vibration perception-Biothesiometer(µ/m)	-0.4	-0.3	0.343
Tuning fork score	-1.9	-2	0.111
SWM(g)	-0.2	-0.31	0.212
HST	-16.2	0	**0.001**
ABC score	3.8	2.8	**0.002**
DHI score	-4.5	-4.1	**0.034**

Table 3: Observed effect size of significant parameters for both the types of training

Training Type	**Parameters**			
	FTSTS	**ABC**	**DHI**	**HST**
MST	r=-0.54	r=-0.41	r=-0.3	r=-0.32
WT	r=-0.52	r=-0.41	r=-0.24	-

Discussion

The main goal of this study was to assess the likelihood of wrist fractures in the older population following falls, as well as whether multisensory training or wrist stabilization training can improve these deficiencies. Fractures are more common in the senior population. [26, 27] According to the

current study, the majority of people with wrist fractures are men, which is consistent with findings from another study.[10, 14] According to one study, those with wrist fractures who were between the ages of 70 and 92 had substantial medical histories; in contrast, our study found that 51.2% of participants had hypertension and 38.6% had diabetes. [11]

At baseline assessment, poor lower limb strength, vestibular function, activity specific balance and dizziness was recorded among the cases of wrist fracture in both the groups.

While, the study by Baldursdottir et al. report poor balance control among the subjects at beginning of the study, 10 the findings of current study reports 90% patients to have vestibular asymmetry and 38.6% had impaired plantar vibration sensitivity of foot which is in line with the findings of another study that shows 83% patients having vestibular asymmetry and 35%having decreased vibration sensitivity over plantar surface of foot. [16] Whereas, another study on the elderly population reported the participants to be physically weak and less confident in performing daily activities (as per the interview based on ABC questionnaire) at baseline. [11]

After 12 weeks of training, in current study, a change of 1.8 second of lower extremity strength from the baseline was seen in the MST group while it was 1.6 seconds in the WT group. There was no difference observed post training in 10 meter walk test (for both normal and fast walk) while a study reported fast walking speed to have increased by 0.1m/s after MST among the participants. [10,28] A clinically significant improvement of 2.9 s in FTSTS in MST group was reported by Bohannon RW. [29]

Vibration perception test using Biothesiometer in MST group had improved by 0.4 μ/m while it was0.2 μ/m as reported by previous study. [10] Studies have shown that an improvement in muscle strength might prevent injuries related to fall. [30]

On assessing the tactile sensitivity using SWM, minimal difference in the improvement was noticed among the two groups whereas when compared to the baseline observation, an improvement of 0.2gand 0.31g was reported, respectively. Whereas it was improved only in the MST in previous studies.[10,20] A deficit in the tactile sensation makes a person prone to fall related injuries [20] thus, hinting on the fact that MST seems more effective than WT in elderly with decreased postural control.

Our study noticed statistical significant improvement in the vestibular asymmetry among patients in the MST group after 12 weeks of training and regular follow up. On head shake test, MST group showed clinically and statistically significant improvement in vestibular asymmetry (p=0.001) while WT group saw no change when compared to the baseline data. Similarly, participants of another study reported borderline significant (p=0.06)reduction of vestibular asymmetry in the MST group while there was no change in the WT group. 10 A study reports HST and monofilaments sensation to have the strongest association with wrist fracture due to fall. [20]

The group receiving multi-sensory training had better Sensory Organization Test after intervention in comparison to wrist stabilization training. 10

Dizziness has been reported as one of the factors for fall related fractures. [3,24] In accordance with this fact, our study reports 70.1% patients of fall related wrist fracture complaining of dizziness prior to fall.

Post training, a change of 4.5 and 4.1 in DHI score was seen in MST and WT group when compared from the baseline report. Similar finding was reported by another study where DHI score significantly improved in the MST group (p=0.01).[10] Thus, statistically significant improvement was witnessed in both the groups in terms of ABC, DHI and FTSTS. Whereas HST only in the MST group was found to be significantly improving. There are studies which report that even if the strength exercises are found to be beneficial for improvement of balance, its application alone is not effective.[9,30]

Conclusion

Asymmetric vestibular function, diminished lower limb muscle strength, diminished trust in one's ability to balance, and light headedness may be risk factors for fractures, particularly wrist fractures in the elderly. Increasing physical activity may help people with their posture and ability to control their balance.

The incidence of fractures in the elderly population may be decreased with early diagnosis and treatment to improve the aforementioned characteristics, resulting in higher quality of life. Stimulation of sensory system by multi-sensory training of an elderly individual might contribute to reduction in incidence of fall.

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