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THEME OF THE ISSUE

GERIATRIC REHABILITATION

IN THIS ISSUE

PEER REVIEWED
OPEN ACCESS JOURNAL

ADVANCING KNOWLEDGE
IMPROVING LIVES

EVIDENCE BASED
PATIENT CENTERED

Kerala Journal of Physical Medicine & Rehabilitation

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KJPMR CALL FOR SUBMISSIONS

KJPMR invites submissions from physiatrists, residents, researchers, and medical practitioners who are interested in rehabilitation medicine. We welcome:

- Original Articles
- Review Articles
- Case Reports / Clinical Insights
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- Innovation & Technology Briefs
- Humanities & Reflections
- Resident Forum Articles
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From the Editor's Desk

Ageing, Function and the Art of Rehabilitation

Dear Readers,

It is a pleasure to bring you the second issue of the Kerala Journal of Physical Medicine & Rehabilitation (KJPMR) under the new editorial team. The first issue was an important step for the journal, building on the work of earlier editorial teams and continuing our effort to create a useful academic platform for the PM&R community in Kerala. We are grateful to our contributors, reviewers, office bearers of IAPMR Kerala, and readers for their continued support.

The Theme: Geriatric Rehabilitation

The theme of this issue is Geriatric Rehabilitation, an area that is becoming increasingly important in Physical Medicine and Rehabilitation.

Ageing is not simply about the number of years lived. It brings changes in function, independence, participation, and social roles. Healthy ageing, therefore, is not only about longevity, but also about being able to remain mobile, independent, socially connected, and involved in activities that matter. This is where rehabilitation has an important role.

Geriatric rehabilitation extends beyond individual diseases. Frailty, sarcopenia, falls, multimorbidity, cognitive impairment, polypharmacy, deconditioning, and caregiver burden often occur together. A seemingly minor illness or injury can sometimes lead to a significant loss of function. Rehabilitation must therefore look beyond the impairment and consider the person, their circumstances, and what they want to continue doing.

The goal is not to reverse ageing, but to help people age with function, dignity, and agency.

Highlights of This Issue

This issue brings together scientific, clinical, educational, and reflective perspectives across PM&R, from impairment and function to participation and quality of life.

We are pleased to continue our Humanities and History section. Rehabilitation is closely connected to the lived experience of illness and disability, and medicine can learn much from history, literature, culture, and human narratives. Our Resident and Community sections also provide space for the ideas and experiences of colleagues across the PM&R community.

Looking Ahead

Our aim is for KJPMR to be more than a repository of scientific articles. We hope it becomes a space where the Kerala PM&R community can share ideas and think about the future of rehabilitation. Our specialty is changing rapidly, with advances in neuroscience, technology, pain medicine, assistive technology, digital health, artificial intelligence, and global health. At the same time, ageing, disability, climate change, health inequities, and chronic disease bring new challenges.

We welcome contributions that are scientifically sound, clinically useful, innovative, and relevant to rehabilitation practice in our region. We particularly encourage residents and early-career physiatrists to contribute alongside experienced clinicians and researchers. A journal grows through its community. We invite our readers not only to read KJPMR, but also to contribute to it and help shape its future.

We hope you enjoy this issue and find something that informs your practice, makes you think, or inspires you to contribute.

With warm regards,

Dr Anand Raja D S
Editor, KJPMR
(On behalf of the Editorial Team)

The President's Message

Dear Esteemed Members, Colleagues, and Friends,

It gives me immense pleasure to extend my greetings to you all through this September issue of the Kerala Journal of Physical Medicine and Rehabilitation (KJPMR).

As we mark another milestone in our academic calendar, I extend my heartfelt congratulations to the editorial board and the contributors who work tirelessly to ensure the regular quarterly publication of our prestigious journal. Maintaining this consistency is a testament to our collective commitment to academic excellence and scientific research.

The field of Physical Medicine and Rehabilitation is evolving at an unprecedented pace. Today, our role extends far beyond traditional therapeutic interventions; we are at the forefront of integrating cutting-edge technology, assistive devices, and multidisciplinary strategies to restore function and enhance the quality of life of our patients. As physiatrists, our unique perspective allows us to view health through the lens of functionality and independence, making our specialty indispensable to the modern healthcare ecosystem.

The Kerala Chapter of IAPMR has always been a beacon of academic rigour and clinical expertise. Through KJPMR, we provide a vital platform for sharing clinical insights, innovative research, and challenging case studies that reflect the unique demographic and healthcare challenges of our region. I encourage our young postgraduate students, researchers, and clinicians to make active use of this platform. Sharing your clinical experiences and research findings not only enriches our professional community but also contributes directly to improving patient care outcomes across the state.

As we move forward, let us continue to foster collaboration, embrace technological innovations in rehabilitation, and uphold the highest standards of empathetic, patient-centred care. I am confident that the articles in this issue will stimulate intellectual curiosity and inspire new avenues for clinical research.

I wish you all an enriching reading experience and a fulfilling quarter ahead.

Warm regards,

Dr. Selvan. P
President,
Kerala Chapter of IAPMR

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Editorial

The Future of Physical Medicine and Rehabilitation in Kerala: Time to Build a Rehabilitation-Centric Healthcare System

Roy R Chandran[1]

Rehabilitation is where medicine meets humanity,
science meets hope, and disability gives way to possibility.

The history of medicine is often described through breakthroughs in diagnosis and cure. Yet, one of the greatest achievements of modern healthcare is not merely helping people survive disease, but enabling them to live meaningful, independent, and productive lives thereafter. This is the essence of Physical Medicine and Rehabilitation (PM&R)—a specialty that focuses on restoring function, maximising ability, and improving quality of life.

At the outset, I express my sincere gratitude to Dr. Arun A. John, Editor of the Kerala Journal of Physical Medicine and Rehabilitation (KJPMR), for providing me with this opportunity to share my thoughts on the future of our specialty.

Kerala stands at a unique crossroads. It has some of the best healthcare indicators in India, an increasing burden of chronic diseases, and one of the country's most rapidly ageing population. These realities make rehabilitation medicine not an optional service, but an essential pillar of healthcare.

The demographic transition in Kerala is remarkable. According to government projections, nearly one in five Keralites is now above 60 years of age, and this proportion is expected to exceed 23% by 2036, making Kerala one of the most rapidly ageing populations in India. The recent establishment of a dedicated department and budget for senior citizens by the Government of Kerala further reflects the growing recognition of the challenges posed by population ageing.

With increasing longevity comes an inevitable rise in stroke, Parkinson's disease, osteoarthritis, osteoporosis, spinal disorders, frailty, dementia, falls, amputations, and multiple chronic illnesses. These conditions seldom require only medicines or surgery. They demand structured rehabilitation aimed at restoring mobility, independence, dignity, and participation in society.

This is where PM&R assumes immense importance.

Traditionally, rehabilitation has been viewed as the final stage of treatment. Modern medicine has decisively moved away from that concept. Rehabilitation now begins from the first day of illness. Whether it is acute stroke, spinal cord injury, traumatic brain injury, cancer, intensive care recovery, sports injury, or chronic musculoskeletal pain, early rehabilitation significantly improves functional outcomes, reduces complications, shortens hospital stays, and lowers long-term healthcare costs.

Perhaps the greatest opportunity before PM&R in Kerala lies in geriatric rehabilitation.

Healthy ageing is not merely about adding years to life but about adding life to years. Older adults require comprehensive assessment of mobility, balance, cognition, nutrition, continence, pain, and psychosocial wellbeing. Rehabilitation physicians are uniquely positioned to lead multidisciplinary geriatric rehabilitation teams comprising physiotherapists, occupational therapists, speech therapists, psychologists, prosthetists, orthotists, rehabilitation nurses, and social workers.

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Community-based rehabilitation programmes, fall-prevention clinics, osteoporosis management, frailty screening, home-based rehabilitation, cognitive rehabilitation, and caregiver education must become integral components of Kerala's healthcare delivery. Rehabilitation should extend beyond hospitals into homes, communities, and primary care settings.

Technology is also redefining rehabilitation. Robotics, functional electrical stimulation, virtual reality, wearable sensors, gait laboratories, musculoskeletal ultrasound, spasticity management, regenerative medicine, and telerehabilitation are rapidly transforming patient care. Kerala, with its established digital health infrastructure, is ideally positioned to become a leader in technology-enabled rehabilitation.

Despite these enormous opportunities, one major challenge threatens the future growth of the specialty—the shortage of trained rehabilitation physicians.

Kerala currently has fewer than 20 MD Physical Medicine and Rehabilitation training seats annually across its medical colleges, a number grossly inadequate for a state of over 3.5 crore people with rapidly expanding rehabilitation needs. This limited training capacity inevitably translates into shortages of specialists across government hospitals, teaching institutions, and community rehabilitation services.

Expansion of postgraduate seats should therefore become an urgent priority. Every government medical college should strive to establish or strengthen PM&R departments with adequate faculty, infrastructure, inpatient rehabilitation units, electrodiagnostic laboratories, prosthetic and orthotic services, and multidisciplinary rehabilitation teams. Simultaneously, greater exposure to rehabilitation medicine during undergraduate medical education will encourage more young doctors to appreciate the scope and scientific depth of this specialty.

Equally important is strengthening rehabilitation research. Kerala possesses enormous clinical material in stroke, spinal disorders, neurological diseases, musculoskeletal conditions, ageing, disability, and community-based rehabilitation. High-quality multicentric research can position Kerala as a national leader in rehabilitation science while generating evidence relevant to our own population.

The future of PM&R also lies in collaboration rather than isolation. Rehabilitation physicians must increasingly work alongside neurologists, neurosurgeons, orthopaedic surgeons, rheumatologists, geriatricians, oncologists, intensivists, cardiologists, pulmonologists, family physicians, and public health experts. Rehabilitation is no longer a referral afterthought; it is an indispensable component of comprehensive patient care.

The World Health Organization's "Rehabilitation 2030" initiative reminds us that rehabilitation is a core health service and should be available to every individual who needs it. Kerala has both the healthcare infrastructure and the human resources to emerge as a national model for integrated rehabilitation services.

As physiatrists, our mission extends beyond treating diseases. We restore function, preserve dignity, foster independence, and enable participation. Every step regained after stroke, every child with cerebral palsy who achieves a new milestone, every older person who walks confidently after a hip fracture, and every individual returning to work after disability is a testament to the transformative power of rehabilitation.

The future of Physical Medicine and Rehabilitation in Kerala is exceptionally promising. However, fulfilling that promise requires visionary planning, expansion of training programmes, investment in rehabilitation infrastructure, integration of geriatric rehabilitation into routine healthcare, promotion of research, and stronger policy support.

The coming decades will belong not merely to those who cure disease, but to those who restore lives. PM&R is uniquely positioned to lead that transformation, and Kerala has every opportunity to become India's benchmark for rehabilitation excellence.

Our specialty is not defined by the diseases we treat, but by the abilities we restore.

Long live IAPMR

Jai Hind

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Original Article

Ultrasonographic Evaluation of Therapeutic Effects of Complex Decongestive Therapy in Patients with Breast Cancer Related Lymphedema

Chithu K Sadanandan[1], Sindhuja Suresh[2]

Abstract

Background: Breast cancer-related lymphedema (BCRL) is a common complication following breast cancer treatment and can result in persistent limb swelling, functional impairment and reduced quality of life. Complex decongestive therapy (CDT) is the standard conservative treatment for BCRL. While limb circumference is commonly used to assess treatment response, ultrasonography may provide additional information on tissue changes.

Objectives: To evaluate the therapeutic effects of complex decongestive therapy using ultrasonographic assessment of soft tissue thickness and tissue compliance in patients with unilateral breast cancer-related lymphedema, and to compare these findings with conventional arm circumference measurements.

Methods: This prospective observational study included 16 women with Stage I or Stage II unilateral breast cancer-related lymphedema. All participants underwent one month of CDT comprising manual lymphatic drainage, compression therapy, therapeutic exercises and skin care. Arm circumference and ultrasonographic measurements of soft tissue thickness and tissue compliance were obtained before and after treatment. Stage-wise subgroup analyses were also performed.

Results: Following CDT, significant reductions were observed in arm circumference and ultrasonographic soft tissue thickness in the affected limb. Tissue compliance showed improvement after treatment; however, statistically significant improvement was observed only among patients with Stage I lymphoedema. No significant changes were observed in the unaffected limb.

Conclusion: Complex decongestive therapy was associated with reductions in limb size and soft tissue thickness in patients with breast cancer-related lymphedema. Ultrasonographic assessment of tissue compliance may provide additional information regarding tissue response to therapy and appears to be a useful adjunct to conventional clinical assessment, particularly in early-stage disease.

Keywords: Breast cancer-related lymphedema; complex decongestive therapy; ultrasonography; tissue compliance; rehabilitation.

Introduction

Breast cancer-related lymphoedema (BCRL) is a common treatment-related complication that can persist long after completion of cancer therapy. It is characterised by impaired lymphatic drainage and accumulation of protein-rich interstitial fluid, resulting in limb swelling and progressive changes in the subcutaneous tissues. These changes may be associated with discomfort, heaviness, restricted upper-limb function and reduced quality of life. Early recognition and appropriate rehabilitation are therefore important to minimise progression and support functional recovery [1–4].

Complex decongestive therapy (CDT), comprising manual lymphatic drainage, compression therapy, therapeutic exercises and skin care, is a standard conservative treatment for BCRL, recommended for patients with early-stage lymphoedema[2,5,6]. In rehabilitation practice, response to CDT is commonly monitored using changes in limb circumference or volume. Although these measures provide useful information about reduction in limb size, they provide limited information about changes in the underlying soft tissues.

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Conflicts of Interest : Nil

Tissue characteristics may evolve with the duration and severity of lymphoedema, with increasing fibrosis and reduced tissue compressibility potentially limiting reversibility in more established disease. Thus, an assessment method that can complement measurements of limb size by providing information about tissue characteristics may have clinical relevance in rehabilitation.

Ultrasonography is a non-invasive, readily available and radiation-free technique that can be performed repeatedly during rehabilitation follow-up. In addition to measuring soft-tissue thickness, ultrasonography can assess tissue compressibility, which may provide an indirect measure of tissue compliance. Previous work has demonstrated the ability of ultrasonographic measurements of soft-tissue thickness and compliance to differentiate lymphoedematous from unaffected limbs, while systematic review evidence suggests that ultrasonography is a promising adjunct in the assessment of BCRL. However, evidence regarding its use for monitoring tissue response during treatment remains limited[8,9]. Importantly, whether changes in ultrasonographic tissue characteristics provide additional information beyond conventional limb measurements during a course of CDT remains insufficiently explored.

Therefore, this prospective observational study evaluated changes in arm circumference, ultrasonographic soft-tissue thickness and tissue compliance following one month of CDT in women with unilateral Stage I or Stage II BCRL. Measurements were obtained from both affected and contralateral unaffected limbs to provide an internal reference. The study also explored whether ultrasonographic assessment could serve as a complementary objective measure of tissue response to CDT, alongside conventional clinical assessment during rehabilitation.

Materials and Methods

Study Design and Setting

A prospective observational study was conducted in the Department of Physical Medicine and Rehabilitation, District Model Hospital, Peroorkada, Kerala, over a three-month period. The study evaluated changes in limb size and ultrasonographic soft-tissue characteristics following a one-month programme of complex decongestive therapy (CDT) in women with unilateral breast cancer-related lymphoedema (BCRL).

Study Participants

Women with unilateral BCRL attending the Physical Medicine and Rehabilitation outpatient department during the study period were screened for eligibility. Consecutive sampling was used for recruitment. Sixteen participants fulfilling the eligibility criteria were included.

Inclusion Criteria

Participants were eligible if they:

- were women with unilateral breast cancer-related lymphoedema;
- had Stage I or Stage II lymphoedema according to the International Society of Lymphology (ISL) staging system; and
- had no evidence of active metastatic breast cancer.

Exclusion Criteria

Participants were excluded if they:

- were undergoing radiotherapy at the time of recruitment;
- had congestive heart failure, pulmonary oedema, renal insufficiency or hepatic failure; or
- had active lymphangitis.

Complex Decongestive Therapy

All participants underwent a standardised one-month programme of CDT comprising manual lymphatic drainage, non-elastic compression bandaging, therapeutic exercises and skin care. Participants were also instructed in self-manual lymphatic drainage and home exercises using an educational booklet. Follow-up assessments were performed at two weeks and one month after initiation of therapy.

Outcome Measures

Participants were clinically reviewed at two weeks, while study outcome measurements were obtained at baseline and after completion of one month of CDT. Arm circumference and ultrasonographic measurements were obtained from the affected and contralateral unaffected upper limbs. The unaffected limb was assessed at the same anatomical sites and under the same measurement conditions and was used as an internal reference.

Arm Circumference

Upper-limb circumference was measured using a non-stretch measuring tape at two predefined anatomical sites:

1. 10 cm distal to the lateral epicondyle of the humerus; and
2. 10 cm proximal to the lateral epicondyle.

Measurements were obtained bilaterally at baseline and after one month of CDT.

Ultrasonographic Assessment

Ultrasonographic assessment was performed at the same anatomical levels used for circumference measurement. Examinations were performed using an Esaote My Lab Gamma ultrasound system with 16MHz linear-array transducer. B-mode ultrasonography was used for assessment of subcutaneous soft-tissue thickness and tissue compressibility. The same ultrasound system and measurement protocol were used for the affected and contralateral unaffected limbs at baseline and follow-up.

Participants were positioned consistently for all examinations, with the forearm supinated. The measurement sites were identified using the predefined anatomical landmarks before ultrasonographic assessment (Figure 1).

Soft-Tissue Thickness

Soft-tissue thickness was measured with the transducer placed over the predefined site without deliberate external compression. Care was taken to minimise transducer pressure during acquisition. An example of ultrasonographic measurement of soft-tissue thickness without compression is shown in Figure 2a. The thickness of the relevant soft-tissue layer was measured according to the technique described by Kim et al[8].

Tissue Compliance

Tissue compliance was assessed by measuring soft-tissue thickness before and after transducer compression, according to the method described by Kim et al. The same anatomical site was used for both measurements. An example of ultrasonographic measurement during transducer compression is shown in Figure 2b. Tissue compliance was calculated as:

$$\frac{\text{Thickness without compression} - \text{Thickness with compression}}{\text{Thickness without compression}}$$

Higher values indicate greater tissue compressibility.

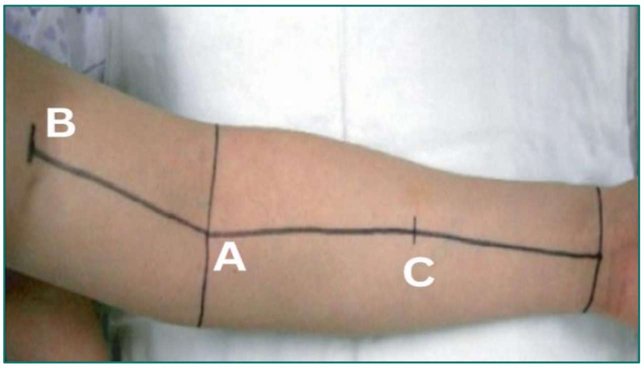

Figure 1. Arm circumference and soft tissue thickness and compliance were measured from two points [C and B]

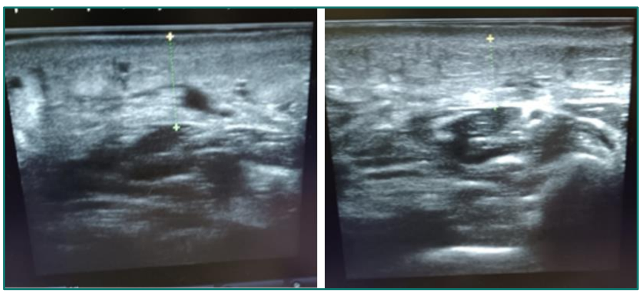

Figure 2. Ultrasonographic measurement of affected limb (a) without compression, (b) with compression

Data Collection

Data were collected using a structured proforma. Demographic variables, including age and body mass index (BMI), were recorded. Clinical variables included stage of lymphedema, arm circumference, ultrasonographic soft tissue thickness, and tissue compliance.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation, while categorical variables are presented as frequencies. Baseline and post-treatment measurements were compared using appropriate paired statistical tests. Subgroup analyses were performed separately for Stage I and Stage II lymphedema. A p-value of less than 0.05 was considered statistically significant.

Results

Baseline Characteristics

A total of 16 women with unilateral breast cancer-related lymphedema were included in the study. The mean age of the participants was 52.6 ± 7.59 years, and the mean BMI was 26.5 ± 2.5 kg/m^2. According to the ISL staging system, six (37.5%) patients had Stage I lymphedema and ten (62.5%) had Stage II lymphedema. [Table 1]

Changes in Arm Circumference

Following one month of complex decongestive therapy, a significant reduction in arm circumference was observed in the affected limb. The mean circumference measured 10 cm distal to the elbow decreased from 29.12 ± 2.30 cm to 28.39 ± 2.12 cm (p=0.03). Similarly, the circumference measured 10 cm proximal to the elbow decreased from 33.62 ± 3.25 cm to 31.23 ± 2.25 cm (p=0.01). No significant changes in circumference were observed in the unaffected limb. [Table 2]

Changes in Ultrasonographic Soft Tissue Thickness

Soft tissue thickness measured by ultrasonography decreased following CDT in the affected limb. A statistically significant reduction was observed at 10 cm proximal to the elbow, where the mean thickness decreased from 0.92±0.40cm to 0.80±0.25 cm (p=0.01).

Table 1. Comparison of arm circumference before and after CD

Characteristic	Value
Number of participants	16
Age (years), mean ± SD	52.6 ± 7.59
BMI (kg/m^2), mean ± SD	26.5 ± 2.5
Stage I lymphedema, n (%)	6 (37.5)
Stage II lymphedema, n (%)	10 (62.5)

Table 2. Comparison of arm circumference before and after CD

Measurement site	Pre-treatment	Post-treatment	*p* value
Affected limb			
10 cm distal to elbow	29.12 ± 2.30	28.39 ± 2.12	0.03
10 cm proximal to elbow	33.62 ± 3.25	31.23 ± 2.25	0.01
Unaffected limb			
10 cm distal to elbow	27.30 ± 2.75	27.06 ± 1.22	0.10
10 cm proximal to elbow	29.23 ± 1.69	29.20 ± 1.06	0.25

Although a reduction was also observed at 10 cm distal to the elbow, the change did not reach statistical significance (p=0.06). No statistically significant changes were observed in the unaffected limb. [Table 3]

Changes in Ultrasonographic Tissue Compliance

The mean tissue compliance of the affected limb showed a slight increase following treatment. Compliance measured 10 cm distal to the elbow increased from 0.18 ± 0.17 to 0.19 ± 0.13 (p=0.60), while compliance measured 10 cm proximal to the elbow increased from 0.23 ± 0.15 to 0.25 ± 0.20 (p=0.08). However, these changes were not statistically significant. No significant changes in tissue compliance were observed in the unaffected limb. [Table 4]

The overall changes in affected-limb arm circumference, ultrasonographic soft-tissue thickness and tissue compliance following one month of CDT are illustrated in Figure 4.

Stage-wise Analysis

Subgroup analysis demonstrated significant reductions in arm circumference and ultrasonographic soft tissue thickness in both Stage I and Stage II lymphedema following CDT. However, tissue compliance improved significantly only in patients with Stage I disease. In Stage I lymphedema, significant improvements in tissue compliance were observed at both measurement sites (p = 0.04 and p = 0.02). In contrast, no significant improvement in tissue compliance was observed among patients with Stage II lymphedema (p=0.72 and p=0.51). [Table 5]

Table 3. Comparison of ultrasonographic soft tissue thickness

Measurement site	Pre-treatment	Post-treatment	*p* value
Affected limb			
10 cm distal to elbow	0.82 ± 0.31	0.80 ± 0.27	0.06
10 cm proximal to elbow	0.92 ± 0.40	0.80 ± 0.25	0.01
Unaffected limb			
10 cm distal to elbow	0.69 ± 0.26	0.68 ± 0.27	0.25
10 cm proximal to elbow	0.81 ± 0.34	0.75 ± 0.36	0.07

Table 4. Comparison of ultrasonographic tissue compliance

Measurement site	Pre-treatment	Post-treatment	*p* value
Affected limb			
10 cm distal to elbow	0.18 ± 0.17	0.19 ± 0.13	0.60
10 cm proximal to elbow	0.23 ± 0.15	0.25 ± 0.20	0.08
Unaffected limb			
10 cm distal to elbow	0.20 ± 0.12	0.21 ± 0.17	0.72
10 cm proximal to elbow	0.56 ± 0.11	0.55 ± 0.16	0.47

Discussion

The present study evaluated the effects of CDT in patients with breast cancer-related lymphoedema using both conventional arm circumference measurements and ultrasonographic assessment of soft tissue thickness and tissue compliance. After one month of treatment, there was a significant reduction in arm circumference and soft tissue thickness in the affected limb. An interesting finding was the difference in tissue compliance between the two stages of lymphoedema. Improvement in tissue compliance was seen only in patients with Stage I disease, whereas no significant change was observed in those with Stage II lymphoedema. This suggests that ultrasonographic assessment of tissue compliance may provide information on response to therapy that is not captured by conventional measurements of limb size alone.

The reduction in arm circumference seen in this study is in keeping with previous reports supporting the effectiveness of CDT in the conservative management of breast cancer-related lymphoedema. CDT combines manual lymphatic drainage, compression therapy, therapeutic exercises and skin care to reduce oedema by improving lymphatic drainage and decreasing interstitial fluid accumulation[5,6]. Limb circumference measurement continues to be the most used method for monitoring treatment response because it is simple, inexpensive and easily performed in the outpatient setting. Similar reductions in limb size after CDT have been reported by Lasinski et al. and McNeely et al[5,6]. However, while circumference measurements are useful for documenting changes in limb volume, they provide little information about the condition of the underlying soft tissues[2].

The present study showed a significant reduction in ultrasonographic soft tissue thickness following CDT, particularly at the proximal measurement site.

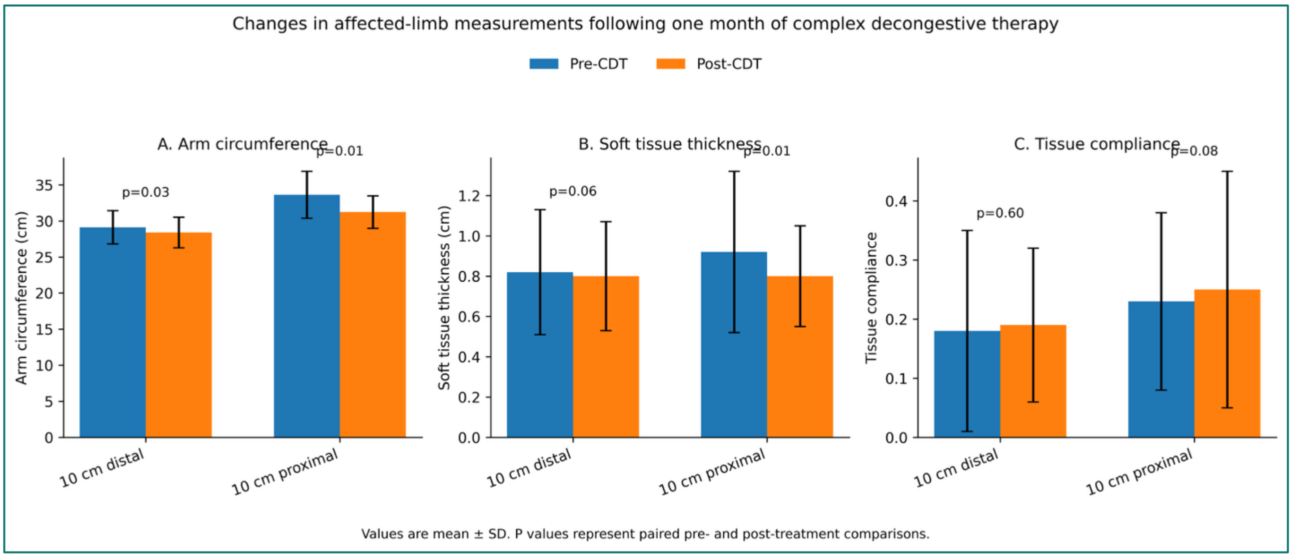

Figure 3. Changes in affected-limb arm circumference, ultrasonographic soft tissue thickness and tissue compliance following one month of complex decongestive therapy.

Table 5. Stage-wise comparison of treatment response after CDT

Outcome	Stage I (*p* value)	Stage II (*p* value)
Arm circumference (10 cm distal)	0.02	0.02
Arm circumference (10 cm proximal)	0.001	0.02
Soft tissue thickness (10 cm distal)	0.01	0.03
Soft tissue thickness (10 cm proximal)	0.01	0.04
Tissue compliance (10 cm distal)	0.04	0.72
Tissue compliance (10 cm proximal)	0.02	0.51

This reduction probably reflects decreased interstitial fluid within the subcutaneous tissues as lymphatic drainage improves with treatment. Unlike circumference measurements, ultrasonography provides direct information about the soft tissues and may detect changes that are not apparent from limb size alone. Kim et al. demonstrated that measurements of soft tissue thickness and tissue compliance could reliably distinguish lymphedematous limbs from unaffected limbs and proposed ultrasonography as an objective method for evaluating lymphedema.[8] Most published studies, however, have focused on the diagnostic role of ultrasonography, while relatively few have explored its usefulness in monitoring response to CDT.[10] A recent systematic review also identified ultrasonography as a promising tool for assessing breast cancer-related lymphedema but highlighted the limited evidence regarding its role in treatment monitoring.[9]

One of the interesting findings in our study was the difference in tissue compliance between Stage I and Stage II lymphoedema. Although no significant change was seen when all participants were analysed together, subgroup analysis showed improvement only in patients with Stage I disease. This observation is consistent with the pathological changes that occur as lymphoedema progresses. In the early stage, oedema is largely due to the accumulation of protein-rich interstitial fluid and the tissue architecture remains relatively preserved. With longstanding lymphatic dysfunction, persistent inflammation promotes adipose tissue deposition and fibrosis, making the tissues less compressible.[2,11] It is therefore understandable that while CDT reduced limb swelling in both groups, improvement in tissue compliance was evident only in the earlier stage of the disease.

This stage-specific improvement in tissue compliance may have practical implications for rehabilitation. Early identification of patients with reversible tissue changes is consistent with prospective surveillance models proposed for breast cancer rehabilitation.[12] In routine clinical practice, treatment response is usually assessed by changes in limb circumference or volume, which provide little information about the condition of the underlying tissues.[2] Ultrasonographic assessment of tissue compliance may complement these conventional measurements by providing insight into tissue quality and its response to treatment. Patients whose tissue compliance improves may represent those with predominantly reversible changes, whereas persistently poor compliance despite reduction in limb size could indicate more established fibrosis. Although these observations need confirmation in larger prospective studies, they suggest that tissue compliance may be a useful objective parameter for monitoring treatment response, particularly in the earlier stages of breast cancer-related lymphoedema.[4] Ultrasonography has several practical advantages that make it well suited for routine rehabilitation practice. Unlike lymphoscintigraphy, computed tomography and magnetic resonance imaging, it is inexpensive, widely available, non-invasive and does not involve exposure to ionizing radiation.[2,9] It can be performed repeatedly during follow-up with minimal inconvenience to the patient while providing information on both soft tissue thickness and tissue compliance. These features make ultrasonography a useful adjunct in the assessment of patients with lymphoedema, particularly in resource-limited settings where access to advanced imaging may be restricted.

This study has certain limitations. The sample size was small, and all participants were recruited from a single center, which limits the generalizability of the findings. Follow-up was limited to one month, making it difficult to determine whether the observed improvements were sustained over time. Ultrasonographic measurements are also operator-dependent, and neither intra-observer nor inter-observer reliability was assessed. In addition, patient-reported outcomes such as pain, upper limb function and quality of life were not evaluated. Larger prospective studies with longer follow-up are needed to determine whether changes in ultrasonographic tissue compliance correlate with long-term clinical outcomes and functional improvement in patients with breast cancer-related lymphoedema.

Conclusion

Complex decongestive therapy reduced arm circumference and ultrasonographic soft tissue thickness in patients with breast cancer-related lymphoedema. Although reduction in limb size was seen in both Stage I and Stage II disease, improvement in tissue compliance was observed only in patients with Stage I lymphoedema. This finding suggests that ultrasonographic assessment of tissue compliance may complement conventional circumference measurements by providing additional information on tissue response to treatment. Given its simplicity, non-invasive nature and wide availability, ultrasonography appears to be a practical tool for monitoring treatment response in routine rehabilitation practice.

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Case Report

Virtual Reality-Assisted Rehabilitation Combined with Progressive Resistance Exercise for Chronic Post-Traumatic Internal Derangement of the Knee - A Case Report

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Abstract

Background: Chronic post-traumatic internal derangement of the knee may result in persistent pain, restricted range of motion (ROM), muscle weakness, gait impairment, and functional disability despite conventional rehabilitation. Virtual reality (VR)-assisted rehabilitation has emerged as a promising adjunct to enhance patient engagement and facilitate task-orientated rehabilitation.

Case Presentation: A 39-year-old woman presented four months after sustaining a traumatic right knee injury with persistent pain, restricted knee motion, quadriceps weakness, extensor lag, and dependence on a walker for ambulation. MRI demonstrated a partial anterior cruciate ligament tear, complete posterior cruciate ligament tear, Grade I medial collateral ligament sprain and Grade I chondromalacia patella. She underwent an 18-session rehabilitation programme over six weeks comprising VR-assisted rehabilitation combined with progressive resistance exercise.

Results: Following rehabilitation, knee range of motion improved from a 10° extension deficit with flexion limited to 60° to full ROM (0°–135°). Pain during activity decreased from NRS 10/10 to 2/10, muscle strength improved from MRC Grade 3/5 to Grade 4/5, extensor lag resolved, and the patient progressed from walker-assisted to independent ambulation. No adverse events were reported.

Conclusion: This case suggests that VR-assisted rehabilitation combined with progressive resistance exercise may be a useful adjunct to conventional rehabilitation in chronic post-traumatic internal derangement of the knee. Further prospective studies are required to establish its effectiveness.

Keywords: Virtual reality; rehabilitation; knee injury; internal derangement; progressive resistance exercise; case report.

Introduction

Traumatic internal derangement of the knee involving the cruciate and collateral ligaments can produce prolonged pain, restricted joint mobility, quadriceps weakness, instability, and gait dysfunction. Persistent limitation following the acute phase can significantly impair activities of daily living, community mobility, and overall quality of life. Although many patients recover with appropriate management, some continue to experience chronic pain, functional impairment, and reduced participation despite conventional rehabilitation.[1,2]

Conventional rehabilitation focuses on restoration of range of motion (ROM), progressive muscle strengthening, proprioceptive training, balance, and gait retraining. Progressive resistance exercise (PRE) plays a central role in improving muscle strength and functional stability, while task-specific training facilitates the recovery of mobility and independence. However, maintaining patient motivation and adherence during prolonged rehabilitation remains a challenge, particularly in individuals with chronic musculoskeletal conditions.[2,3]

Virtual reality (VR) has emerged as a promising adjunct to rehabilitation by providing an interactive, task-orientated environment that facilitates repetitive movement practice, real-time visual feedback, and enhanced patient engagement. These features may enhance motor learning, improve adherence to rehabilitation, and facilitate functional recovery. Although the use of VR has shown encouraging results in various neurological and musculoskeletal conditions, evidence regarding its role in chronic post-traumatic multi-ligament knee injuries remains limited.[4–6]

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We report the functional outcome of a patient with chronic post-traumatic right knee internal derangement who underwent a six-week VR-assisted rehabilitation program combined with progressive resistance exercises, resulting in marked improvements in pain, knee range of motion, muscle strength, and functional mobility.

Case Presentation

A 39-year-old woman with hypertension on regular medication sustained a self-fall resulting in injury to her right knee. Following the injury, she developed persistent right knee pain, swelling, and difficulty in walking. Four months after the injury, she continued to experience considerable limitation of knee movement and required a walker for ambulation because of pain and instability.

Magnetic resonance imaging (MRI) of the right knee demonstrated:

- Partial anterior cruciate ligament (ACL) tear
- Complete (high-grade) posterior cruciate ligament (PCL) tear
- Grade I medial collateral ligament (MCL) sprain
- Grade I chondromalacia patella

Based on the clinical and radiological findings, a diagnosis of chronic post-traumatic internal derangement of the right knee with multiple ligament involvement was made.

Rehabilitation Assessment

At presentation to the Department of Physical Medicine and Rehabilitation, approximately four months after the injury, the patient was ambulant only with walker support. She reported persistent pain that significantly interfered with mobility and activities of daily living. On the Numerical Pain Rating Scale (NPRS), pain scores were 7/10 at rest, 10/10 during activity, and 6/10 at night.

Functionally, the patient was able to perform long sitting and high sitting but was unable to ambulate independently and relied on a walker for mobility. She also experienced considerable difficulty performing activities of daily living, including squatting to use an Indian-style toilet and carrying out routine household chores because of pain and restricted knee movement.

Clinical examination of the right knee revealed a flexion deformity with an extension deficit of 10° and painful knee flexion limited to 60°. Muscle strength of the knee extensors and flexors was MRC Grade 3/5 within the available range of motion, with the presence of an extensor lag. Examination of the contralateral lower limb was unremarkable.

Knee flexion was associated with significant pain. Clinical ligament examination demonstrated features suggestive of ligamentous instability, consistent with the MRI findings.

The major rehabilitation problems identified were chronic knee pain, severe restriction of knee range of motion, quadriceps weakness with extensor lag, impaired functional mobility, dependence on a walker for ambulation, and difficulty performing activities of daily living.

Intervention

The patient underwent a structured 18-session rehabilitation programme over six weeks, with three supervised sessions per week. Each session incorporated VR-assisted therapeutic activities along with progressive resistance exercise (PRE), conventional therapeutic exercise, and functional training. The rehabilitation programme was individualized according to the patient's pain, range of motion, muscle strength, functional ability, and tolerance to exercise.

VR-assisted rehabilitation

VR-assisted rehabilitation was delivered using a device name REWIN HEALTH VR QUEST3 model. The system was immersive type VR, with the patient interacting with the virtual environment through head-mounted display.

The VR component consisted of head mount display, motion sensor, controller, strap, Lenovo tab plus. The activities were selected to facilitate repetitive, task-oriented lower-limb movements and progressive weight-bearing while maintaining patient engagement. The VR activities included seated games then progressed to standing target-reaching, stepping, weight-shifting, virtual walking, obstacle negotiation. During these activities, the patient performed progressively increasing knee flexion and extension, weight shifting, stepping, and lower-limb loading, according to her functional tolerance. Each VR session lasted approximately 30 minutes. [Table 1]

The intensity and complexity of the VR tasks were progressively increased according to improvement in pain, knee range of motion, weight-bearing ability, balance, and functional mobility. Further weeks patient came for endurance and psychological support and recovery program. [Table 2]

Table-1 Session structure

S.No	Segment	Duration	Tools/goals
1.	Warm-up	5min	Calm breathing,focus temple, immersion
2	Mobility / motor task	8-10 min	Save the Jerry,animal bath for step,shif and sit to stand integration
3	Sensor based control	6 min	Kinetic Aura for ROM and accuracy monitoring
4	Endurance/ cognitive task	6-8 min	Circuit movement in kinetic aura,save the Jerry repetition
5	Cool down	3 min	Relaxation games(calm, focus temple)

Table-2 Core Components and Weekly Progression Plan

Sno	Week	Phase	Focus areas	VR modules/ motion task	Objective indicators
1	1-2	Desensitization & pain relief	Calm breathing, light leg movement	Calm, focus temple	Decrease pain, Relaxation, improve tolerance
2	2-3	Reduce stiffness & improve mobility	Weight shifting Stepping Sit- stand	Save the Jerry, animal bath, kinetic aura	Increase knee ROM, reduce stiffness
3	3-5	Motor control	Diagonal steps, lunges, forward reaching	Save the Jerry, animal bath, kinetic aura	Increase dynamic mobility, Decrease fear avoidance
4	5-6	Spasm reduction	Low load rhythmic movement, visual feedback	Animal bath, Jerry coastal saga, save the jerry	Increase proprioception, decrease muscle guarding

The intensity and complexity of the VR tasks were progressively increased according to improvement in pain, knee range of motion, weight-bearing ability, balance, and functional mobility. Further weeks patient came for endurance and psychological support and recovery program.

Progressive resistance exercise

In conjunction with the VR interventions, exercise was performed for the quadriceps strengthening, hamstring stretching, and hip abductor/adductor strengthening, as per. AAOS guidelines [Table-3] Exercises were initially performed with body weight or manual resistance and progressed with elastic resistance, including Thera-band exercises. Ankle weights were progressed according to the patient's tolerance and improvement in muscle strength.

Each exercise was performed as per Table 3 with resting period of 90s between sets initially then reduced to 60s. Training was performed 4-5 days per week / during each supervised session. Resistance was increased when the patient was able to complete the prescribed repetitions with good movement quality and without significant increase in pain. [Table 4]

Additional rehabilitation

The programme also incorporated knee range-of-motion exercises, balance and proprioceptive training, gait retraining, and functional task practice. Weight-bearing and gait activities were progressively advanced from walker-assisted mobility towards independent ambulation according to the patient's functional recovery.

Table 3 AAOS Guidelines

Exercise type	Frequency, repetition , duration
Straight leg raise	3 sets, 10-15 rep Holding time 5-10s
Heel slide	3 sets, Holding time 5-10s
Terminal knee extension	3sets, 10 reps, holding time 6-10s
Hamstring curls(prone)	3sets, 10 reps
Side lying hip abduction	3 sets, 10 reps, holding time 5s

Table 4 Resistant band

Resistant band	Estimated LBS
Initially green colour Thera band	5 LBS
Then blue	10 LBS
Finally yellow colour theraband	15-20 LBS

The overall rehabilitation goal was to progressively restore knee mobility, lower-limb strength, weight-bearing capacity, balance, gait, and independence in activities of daily living. The patient completed all 18 supervised rehabilitation sessions over six weeks without any interruption.

Results

After the 6-week VR-assisted rehabilitation program, substantial clinical and functional improvement was observed. The patient demonstrated marked reduction in pain, restoration of knee range of motion, improvement in muscle strength, resolution of extensor lag, and progression from walker-assisted to independent ambulation. [Figure 1][Table 5]. No adverse events related to the VR-assisted rehabilitation programme were reported.

Figure 1 Ambulation before and after six weeks of rehabilitation

Table 5 Comparison of clinical outcomes

Outcome measure	Baseline	After 6 weeks
Knee ROM	10° extension deficit to 60° flexion	Full ROM (0°–135°)
Pain (Numerical Pain Rating Scale)	10/10 during activity	2/10
Knee muscle strength (MRC)	Grade 3/5	Grade 4/5
Extensor lag	Present	Absent
Ambulation	Walker-assisted	Independent

Discussion

The patient showed substantial improvement in pain, knee range of motion, muscle strength and functional mobility after six weeks of rehabilitation combining virtual reality (VR)-assisted training with progressive resistance exercise. She progressed from walker-assisted ambulation to independent walking, with restoration of full knee range of motion and resolution of extensor lag. Since VR was delivered as part of a comprehensive rehabilitation programme, it is not possible to determine how much of the improvement was specifically related to VR. Nevertheless, the favourable clinical outcome suggests that VR may be a useful adjunct to conventional rehabilitation in patients with chronic post-traumatic knee dysfunction.

Rehabilitation following ligamentous injuries of the knee is primarily directed towards restoring joint mobility, muscle strength, proprioception and normal gait. Progressive resistance exercise remains an essential component because persistent quadriceps weakness is closely related to pain, instability and reduced function after knee injuries.[2,3] In the present case, VR was incorporated into a structured rehabilitation programme to provide repetitive, task-orientated lower-limb training alongside conventional exercises.

Interest in VR-based rehabilitation has grown in recent years because it provides an interactive environment that encourages repeated practice while offering immediate visual feedback. This may improve patient motivation and adherence, particularly during prolonged rehabilitation. In their systematic review and meta-analysis, Gumaa and Youssef found that VR-based rehabilitation was associated with improvements in pain and functional performance across a range of orthopaedic conditions, although the available evidence was heterogeneous.[4] Howard also highlighted the potential of VR to enhance motor learning and patient engagement through enriched feedback and repetitive practice.[5] Most published studies have evaluated VR following anterior cruciate ligament reconstruction, knee osteoarthritis or total knee arthroplasty rather than chronic multiligament knee injuries. Reports describing its use in chronic post-traumatic multiligament knee injuries remain scarce. Although conclusions cannot be drawn from a single case, the present report suggests that VR-assisted rehabilitation may also be feasible in this subgroup of patients.

Another interesting feature of this case was the extent of functional recovery despite MRI evidence of persistent multiligament injury. In rehabilitation practice, imaging findings should always be interpreted together with the patient's symptoms, physical examination and functional limitations rather than in isolation. Structural abnormalities on MRI do not always correlate with functional impairment. Hence, rehabilitation should ultimately be guided by clinical goals and the patient's functional needs. This case illustrates that meaningful improvements in mobility and independence can still be achieved despite significant structural pathology.

The present report has several limitations. It describes a single patient, and the improvement observed cannot be attributed to VR alone because conventional rehabilitation and progressive resistance exercise were provided simultaneously. Natural recovery may also have contributed to the outcome. In addition, validated functional outcome measures such as the IKDC or KOOS were not used, and long-term follow-up was unavailable. Further prospective studies and larger case series are needed to clarify the contribution of VR-assisted rehabilitation in patients with chronic post-traumatic knee injuries.

Conclusion

A 6-week virtual reality (VR)-assisted rehabilitation program combined with progressive resistance exercise, administered three times weekly, was associated with marked clinical and functional improvement in a 39-year-old woman presenting four months after traumatic internal derangement of the right knee. Knee range of motion improved from a 10° extension deficit with flexion limited to 60° to full ROM (0°–135°), muscle strength improved, extensor lag resolved, pain was substantially reduced, and mobility progressed from walker-assisted ambulation to independent walking.

This case illustrates that favourable functional recovery may be achieved with a structured rehabilitation programme incorporating VR-assisted training and progressive resistance exercise in patients with chronic post-traumatic knee dysfunction. While the findings are encouraging, the improvement observed cannot be attributed to VR alone because it was delivered as part of a comprehensive rehabilitation programme. Further prospective studies and larger case series are needed to better define the role of VR-assisted rehabilitation in the management of chronic post-traumatic internal derangement of the knee.

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Feature

Frailty and Sarcopenia in Older Adults: An Integrated Review of Assessment and Rehabilitation

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Abstract

Frailty and sarcopenia are common geriatric syndromes associated with functional decline, falls, disability, loss of independence and mortality. Although distinct, they frequently coexist and share important pathways, including age-related physiological decline, physical inactivity, inadequate nutrition, chronic disease, inflammation and impaired anabolic responses. For rehabilitation practice, recognition is important because apparently minor reductions in strength, balance or endurance may translate into substantial limitations in mobility and activities of daily living. This review summarizes practical approaches to screening and assessment and emphasizes a rehabilitation-oriented strategy. Frailty may be screened using the Fried phenotype, Clinical Frailty Scale, PRISMA-7 or multidimensional instruments such as the Edmonton Frail Scale. Sarcopenia screening can begin with SARC-F or SARC-CalF, followed by objective assessment of muscle strength and physical performance and, when appropriate, muscle quantity and quality. Handgrip strength, gait speed, five-times sit-to-stand, Short Physical Performance Battery and Timed Up and Go provide useful, repeatable functional measures. Management should combine progressive resistance exercise, nutritional optimization, balance and gait training, fall prevention, management of comorbidities and medication review. The clinically meaningful endpoint is preservation or improvement of function and independence rather than muscle mass alone.

Keywords: frailty; sarcopenia; rehabilitation; grip strength; gait speed; exercise; older adults

Introduction

Frailty and sarcopenia are increasingly recognized as major contributors to disability in older adults. Both are associated with falls, fractures, reduced quality of life, institutionalization and mortality, and their coexistence may increase vulnerability further. Frailty refers to reduced physiological reserve and increased vulnerability to stressors, whereas sarcopenia is primarily a disorder of skeletal muscle involving impaired strength, muscle quantity and physical performance. Neither should be regarded simply as an inevitable consequence of ageing. Early recognition can identify potentially modifiable contributors and provide an opportunity to preserve mobility and independence.

From a physiatrist's perspective, assessment should move beyond identifying weakness to determining how impairments translate into activity limitations and participation restrictions. A practical approach therefore combines screening with objective measurement of strength, mobility and performance, followed by individualized exercise, nutritional and multidisciplinary interventions.

Frailty

Frailty is a progressive age-related decline in physiological systems that reduces reserve and increases vulnerability to relatively minor stressors. It is multi-factorial rather than a single pathological process. Ageing is accompanied by chronic low-grade inflammation ('inflammaging'), altered protein metabolism, endocrine changes, neuromuscular decline and reduced physical activity. These processes may interact with chronic disease and nutritional inadequacy to accelerate loss of function. Prevalence is reported to be approximately 12% among community-dwelling older adults and substantially higher in institutionalized populations, with increasing prevalence at advanced ages.

Assessment of Frailty

The Fried frailty phenotype emphasizes five measurable physical domains:

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unintentional weight loss, exhaustion, low physical activity, slow gait speed and weak grip strength. The phenotype is valuable because it identifies physical vulnerability using readily assessable characteristics.[1] However, frailty may also involve cognitive, psychological, nutritional and social factors. The Edmonton Frail Scale therefore provides a multidimensional approach, incorporating cognition, general health, functional independence, social support, medication use, nutrition, mood, continence and functional performance.[1] The Clinical Frailty Scale and PRISMA-7 are additional practical tools for categorizing vulnerability. A PRISMA-7 score of ≥3 suggests increased likelihood of frailty. Screening should be followed by objective functional assessment when rehabilitation planning is required. [Table 1]

Sarcopenia

Sarcopenia is characterized by progressive deterioration of skeletal muscle. Age-related motor neuron loss, preferential loss of fast-twitch fibres, reduced muscle mass per motor unit and impaired force generation contribute to weakness and reduced performance. Sarcopenia is recognized in ICD-10 as M62.84.[3] Importantly, muscle mass alone does not adequately represent muscle function: an individual may have relatively preserved muscle quantity but poor muscle quality and reduced force-generating capacity.

Reported prevalence is approximately 5–13% among adults over 60 years and 11–50% among those over 80 years, with higher rates in acute hospitals and long-term care settings.[2]. Sarcopenia may be primary, when ageing is the principal identifiable cause, or secondary to systemic disease, inadequate nutrition or malabsorption, and physical inactivity.[2]

Pathophysiology and Muscle Quality

Muscle mass reflects the balance between muscle protein synthesis and breakdown. With ageing, anabolic resistance reduces the response of skeletal muscle to dietary protein and exercise stimuli, while inactivity, chronic illness and nutritional inadequacy may further shift the balance toward loss.[4] Changes in muscle quality, including fat infiltration, fibrosis, altered architecture and neuromuscular dysfunction, can reduce strength even when measured muscle quantity is maintained. This explains why rehabilitation assessment should not depend exclusively on DXA or other estimates of muscle mass. [Table 2]

Table 1. PRISMA-7 Questionnaire

1	Are you more than 85 years?	Yes = 1 point
2	Male?	Yes = 1 point
3	In general, do you have any health problems that require you to limit your activities?	Yes = 1 point
4	Do you need someone to help you on a regular basis?	Yes = 1 point
5	In general, do you have any health problems that require you to stay at home?	Yes = 1 point
6	In case of need, can you count on someone close to you?	No = 1 point
7	Do you regularly use a stick, walker or wheelchair to get about?	Yes = 1 point
	Total	

Screening and Diagnosis of Sarcopenia

SARC-F is a simple screening tool addressing difficulty with strength, walking, rising from a chair, climbing stairs and falls. SARC-CalF adds calf circumference and may improve identification of individuals at risk; calf circumference thresholds of ≤34 cm in men and ≤33 cm in women have been used in screening. A positive screen should be followed by objective assessment.

Handgrip strength is inexpensive, portable and reproducible. Lower grip strength has been associated with adverse outcomes including hip and vertebral fractures, and greater pre-rehabilitation grip strength in people with hip fracture has been associated with better functional outcomes.[5] Gait speed is particularly useful because it reflects several interacting components of mobility. The five-times sit-to-stand test assesses lower-limb strength and transfer ability; age-specific values are important because performance naturally slows with age.[6] The Short Physical Performance Battery (SPPB) combines balance, gait and chair-stand components and is scored from 0 to 12, with lower scores indicating poorer performance. Timed Up and Go (TUG) incorporates standing, walking, turning and sitting and is practical in routine rehabilitation.[7] [Table 3]

Assessment of Muscle Quantity and Quality

When clinically appropriate, muscle quantity can be assessed using DXA, bioimpedance analysis (BIA), CT, MRI or ultrasonography. DXA is widely used for appendicular skeletal muscle estimation, whereas BIA is more accessible in many settings. CT and MRI can provide information on muscle area, volume and fat infiltration, while ultrasonography can assess muscle thickness and structural characteristics. Muscle quality is increasingly important because fatty infiltration, fibrosis and altered architecture may impair force generation despite relatively preserved muscle quantity. Assessment should be selected according to the clinical question and available resources.

Table 2. Severity of Sarcopenia

Pre Sarcopenia	Sarcopenia	Severe Sarcopenia
low muscle mass	low muscle mass	low muscle mass
	low muscle strength	low muscle strength
		low physical performance

Table 3. Common Quantitative Assessment Tools

Measure	Practical threshold / interpretation	Rehabilitation relevance
Handgrip strength	<27 kg men; <16 kg women (EWGSOP)	Simple measure of strength; useful for baseline and follow-up
Gait speed	<0.8 m/s suggests impaired performance	Integrates strength, balance and mobility
Five-times sit-to-stand	Age-specific time should be considered	Lower-limb strength and transfer ability
Short Physical Performance Battery	≤9 suggests low physical performance	Composite lower-extremity functional measure
Timed Up and Go	8–10 s in healthy adults; increasing time indicates greater impairment/fall risk	Practical measure of transfers, walking and turning

Frailty and Sarcopenia: An Interconnected Spectrum

Frailty and sarcopenia are not interchangeable diagnoses, but their manifestations frequently overlap. Sarcopenia can promote physical frailty through weakness and reduced mobility, while frailty may promote inactivity and inadequate nutritional intake, accelerating muscle loss. This creates a self-perpetuating cycle: ageing and chronic disease lead to reduced activity and nutritional inadequacy; these contribute to muscle loss and weakness; weakness further reduces mobility and exercise participation, resulting in deconditioning, dependence and greater vulnerability to stressors.

The consequences extend beyond muscle weakness. Frailty is associated with functional and cognitive decline, falls, fractures, institutionalization, poor quality of life and mortality. Sarcopenia contributes to mobility disorders, falls, fractures, difficulty with activities of daily living and loss of independence. Early rehabilitation may interrupt this cycle by targeting modifiable impairments before severe disability develops.

Comprehensive Evaluation

Evaluation should identify potentially reversible contributors to weakness and poor performance. Depending on the clinical context, investigations may include complete blood count, albumin and nutritional markers, vitamin D, renal and liver function, thyroid function, HbA1c, vitamin B12 and selected endocrine or inflammatory markers such as testosterone, CRP, IL-6 and ESR. These tests should be guided by history and examination rather than applied as a separate panel. Anaemia, nutritional deficiency, endocrine disease, chronic organ dysfunction, systemic inflammation and medication effects may all influence functional capacity and should be addressed when relevant.

Rehabilitation

Exercise programme :

Exercise is a cornerstone of treatment for both frailty and sarcopenia. Progressive resistance exercise provides a strong stimulus for muscle protein synthesis and can improve strength and physical performance. Training may use weights, resistance bands, suspension systems, body-weight exercises or other appropriately selected resistance. Prescription should be individualized according to baseline strength, comorbidities, pain, balance, cognition, exercise tolerance and functional goals.

Resistance training performed at least three times weekly for approximately 12 weeks, at an intensity above 60% of one-repetition maximum, has been associated with improvements in handgrip strength, knee-extensor strength, gait speed and other functional measures in older adults with sarcopenia.[9] Importantly, improvements in strength and performance may occur without large measurable increases in muscle mass. Treatment response should therefore be judged using functional outcomes as well as body-composition measures.

Resistance exercise should be integrated with balance training, gait retraining, transfer practice, endurance conditioning and fall-prevention strategies according to individual need. Functional, task-specific training is particularly important when weakness has already resulted in activity limitation.

Nutrition and Anabolic Resistance

Exercise may be less effective when nutritional intake is inadequate. Age-related anabolic resistance means that older muscle may require a greater protein stimulus to achieve a comparable anabolic response.[4] Resistance exercise and dietary protein therefore act synergistically. The IGF-1/PI3K/Akt/mTOR pathway has an important role in muscle protein synthesis, and leucine-rich, high-quality proteins can stimulate anabolic signaling. Whey and milk proteins, eggs and other high-quality animal or appropriately selected dietary proteins are useful sources.

Suggested protein intakes are approximately 1.0–1.2 g/kg/day for healthy older adults, 1.2–1.5 g/kg/day in chronic illness, and up to 2.0 g/kg/day in critically ill or severely malnourished individuals, with approximately 0.40 g/kg per meal proposed for older adults.[8] These figures should be individualized according to nutritional status and renal and hepatic function. Nutritional intervention should complement, not replace, resistance exercise.

An Integrated Rehabilitation Approach

Frailty and sarcopenia frequently occur in the context of multiple chronic diseases. Therefore, management should include review and optimization of comorbidities and medications. Conditions contributing to fatigue, weakness, poor balance or reduced exercise tolerance should be identified and addressed. From a rehabilitation perspective, treatment should focus on functional goals. Resistance training can be combined with balance exercises, gait training, transfer practice, endurance conditioning and fall-prevention strategies according to the individual's needs. A simple rehabilitation pathway is:

screen → confirm → characterize → intervene → reassess.

Screen for sarcopenia with SARC-F or SARC-CalF and for frailty with PRISMA-7, Clinical Frailty Scale or Fried phenotype. Those who screen positive should undergo objective assessment of strength and physical performance using handgrip strength, gait speed, five-times sit-to-stand, SPPB and/or TUG. Muscle quantity and quality can then be characterized when clinically appropriate. Potentially reversible contributors, comorbidities, medication-related problems, nutritional deficits and physical inactivity should be addressed.

Intervention should combine progressive resistance exercise with nutritional optimization and other rehabilitation components dictated by the patient's goals. Reassessment with the same objective measures allows the clinician to demonstrate change and modify the programme. Improvement in grip strength, chair-stand performance, gait speed, SPPB or TUG may be clinically meaningful even when muscle-mass change is modest.

Key Points for Practice

- Frailty and sarcopenia frequently coexist but should be assessed as distinct clinical syndromes.
- Screening should be followed by objective measurement of strength and physical performance.
- Handgrip strength, gait speed, five-times sit-to-stand, SPPB and TUG are practical measures for rehabilitation settings.
- Muscle quantity and quality should be assessed when the clinical context warrants it; muscle mass alone does not define functional status.
- Progressive resistance exercise, adequate protein intake and management of reversible contributors form the core of an integrated rehabilitation strategy.
- Functional outcomes and independence should remain the principal treatment goals.

Conclusion

Frailty and sarcopenia are distinct but closely interconnected geriatric syndromes that contribute substantially to disability and loss of independence. Their shared pathways include age-related physiological decline, inflammation, inactivity, inadequate nutrition and altered skeletal-muscle metabolism. Early recognition using practical screening tools, followed by objective assessment of strength and physical performance, can identify opportunities for intervention.

Progressive resistance exercise remains central to rehabilitation, while adequate protein intake and nutritional optimization support the anabolic response. Management should also address balance, gait, endurance, falls, comorbidities and potentially reversible contributors. Ultimately, the goal is not simply to increase muscle mass, but to preserve mobility, independence and quality of life. An integrated rehabilitation approach can help modify the trajectory of frailty and sarcopenia and promote healthier ageing.

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Feature

Gait Abnormalities and Rehabilitation in Older Adults

Jijo Varghese[1]

Abstract

Gait disorders are among the most common geriatric syndromes and constitute a major cause of falls, disability, loss of independence, institutionalization, and mortality among older adults. Gait is a complex motor activity requiring coordinated function of the nervous, musculoskeletal, cardiovascular, respiratory, and sensory systems. Age-related physiological changes and disease-related impairments can disrupt gait performance, resulting in characteristic gait abnormalities. Recognition of these disorders is essential because gait speed and mobility have emerged as important indicators of overall health status, cognitive decline, and survival in older adults. Clinical evaluation requires a comprehensive history, focused physical examination, assessment of balance, and functional mobility testing. Rehabilitation forms the cornerstone of management and should address impairments, activity limitations, and participation restrictions within the framework of multidisciplinary care. Exercise interventions, particularly strengthening, balance training, aerobic conditioning, and fall-prevention programs such as the Otago Exercise Programme, have demonstrated significant benefits. Emerging technologies including wearable sensors and smart monitoring systems offer new opportunities for assessment and rehabilitation. This review discusses the physiology of gait, age-related gait changes, classification and evaluation of gait disorders, and evidence-based rehabilitation strategies relevant to rehabilitation physicians.

Keywords: Gait disorders, older adults, rehabilitation, falls, balance, geriatric mobility

Introduction

Walking is one of the most fundamental activities of daily living and serves as an important indicator of overall health and functional independence in older adults[1,2]. Gait disorders affect approximately 10% of individuals aged 60–69 years, with prevalence increasing to more than 60% among those older than 80 years[3]. These disorders are associated with increased risk of falls, hospitalization, institutionalization, reduced quality of life, and mortality[4].

Historically, gait abnormalities in old age were often attributed to an inevitable process of aging and described as “senile gait.” However, advances in neuroscience and movement science have demonstrated that most gait abnormalities reflect identifiable impairments affecting neural, Musculoskeletal, sensory, or cardio pulmonary systems rather than normal aging alone[5]. Contemporary understanding recognizes gait as a highly integrated function requiring continuous interaction between central pattern generators, supraspinal control centers, sensory feedback mechanisms, and musculoskeletal effectors[6]

For rehabilitation physicians, gait assessment provides valuable information regarding mobility, balance, cognition, and functional capacity. Appropriate evaluation and targeted rehabilitation interventions can substantially improve mobility and reduce fall risk in older adults[7]. This review summarizes current concepts in gait disorders and rehabilitation relevant to clinical practice.

Physiology of Gait and Age-Related Changes

Normal gait is a series of rhythmic and alternating movements of the trunk and limbs that result in forward progression of the center of gravity of the body[8]. The basic unit of gait is the gait cycle or stride, extending from initial contact of one foot to the subsequent initial contact of the same foot. The gait cycle during normal walking, consists of stance and swing phases, occupying approximately 60% and 40% of the cycle [8], respectively.

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Gait performance depends upon coordinated functioning of multiple body systems. The musculoskeletal system provides structural support and force generation, while the nervous system regulates motor planning, initiation, coordination, and adaptation. Sensory inputs from visual, vestibular, and proprioceptive systems continuously provide information regarding body position and environmental conditions[6,9].

Central pattern generators within the spinal cord generate the rhythmic locomotor pattern, while cortical, cerebellar, basal ganglia, and brainstem networks modulate gait according to environmental and cognitive demands.[6] Dynamic stability during walking is maintained through predictive, reactive, and proactive control mechanisms that enable adaptation to obstacles and perturbations.[10]

Aging affects each component involved in gait control. Cardiovascular and pulmonary changes reduce exercise tolerance and endurance. Musculoskeletal aging results in sarcopenia, decreased muscle power, osteoarthritis, reduced joint range of motion, and osteoporosis.[11] Neurological aging is characterized by reduced proprioceptive sensitivity, slower nerve conduction velocities, loss of brain volume, impaired executive function, and increased cognitive-motor interference. [12]

As a consequence, characteristic gait adaptations occur. Walking speed declines by approximately 1% annually after middle age, step length decreases, double-support time increases, and gait variability becomes more pronounced.[13] Older adults frequently adopt protective strategies including wider step width, stooped posture, and prolonged foot contact with the ground to enhance stability.[14]

Importantly, gait speed has emerged as a powerful predictor of functional decline, cognitive impairment, hospitalization, and mortality in older populations.[15] Consequently, gait assessment is increasingly regarded as a "functional vital sign" in geriatric practice.[Table 1]

Classification of Gait Disorders

Gait disorders may be classified anatomically, hierarchically, or phenomenologically.[5] Anatomical classification divides disorders into neurological and non-neurological causes. Neurological causes include Parkinson disease, stroke, normal-pressure hydrocephalus (NPH), peripheral neuropathies, myopathies, cerebellar disorders, and vestibular dysfunction.[16] Non-neurological causes include osteoarthritis, lower-limb deformities, cardiopulmonary disease, visual impairment, deconditioning, and adverse medication effects.[17]

Nutt and colleagues proposed a hierarchical classification consisting of low-level, middle-level, and high-level gait disorders.[5] Low-level disorders result from deficits affecting sensory systems or peripheral locomotor structures, whereas middle-level disorders involve central sensorimotor pathways. High-level disorders arise from impaired cortical control and include frontal gait disorders and gait apraxia.

Phenomenological classification remains clinically useful because it relies on observable gait patterns. Common examples include antalgic gait, waddling gait, spastic gait, sensory ataxic gait, cerebellar ataxic gait, hypokinetic gait, dyskinetic gait, anxious gait, and psychogenic gait.[18]

Among older adults, hypokinetic gait associated with Parkinsonism, sensory ataxic gait secondary to peripheral neuropathy, and gait disturbances related to NPH are important because specific treatment options may improve outcomes.[16] [Table 2]

Clinical Assessment of Gait Disorders

Assessment begins with a detailed history focusing on symptom onset, progression, falls, near-falls, precipitating factors, medications, alcohol use, comorbidities, and functional limitations.[19] Particular attention should be given to medications that increase fall risk, such as benzodiazepines, antipsychotics, antidepressants, opioids, and antihypertensive agents[20]

Table 1. Age-Related Changes Affecting Gait

System	Age-Related Changes	Effect on Gait
Cardio vascular	Reduced reserve, arrhythmias, vascular disease	Reduced endurance and slower walking speed
Musculo skeletal	Sarcopenia, osteoarthritis, osteoporosis	Reduced strength, shorter stride length
Neurological	Brain atrophy, slower nerve conduction	Impaired coordination and balance
Sensory	Visual and vestibular decline	Increased instability and falls
Cognitive	Executive dysfunction and dual-task interference	Reduced gait adaptability and safety

Table 1. Age-Related Changes Affecting Gait

Gait Pattern	Clinical Features	Common Causes
Antalgic	Reduced stance phase on affected side	Osteoarthritis, painful joints
Waddling	Trendelenburg sign, trunk lurch	Myopathies, hip abductor weakness
Spastic	Circumduction, scissoring	Stroke, myelopathy
Sensory Ataxic	Stomping gait, worse in darkness	Peripheral neuropathy
Cerebellar Ataxic	Broad-based, unsteady gait	Cerebellar disease
Hypokinetic	Shuffling, freezing, reduced arm swing	Parkinsonism, NPH
Dyskinetic	Involuntary movements while walking	Chorea, dystonia
Anxious	Slow, broad-based, "walking on ice"	Fear of falling

Physical examination should include cardiovascular, musculoskeletal, neurological, cognitive, and sensory evaluation. Orthostatic blood pressure measurement is important because orthostatic hypotension is a frequent and reversible cause of gait instability in older adults.[21]

Balance assessment is an essential component of clinical examination. Useful bedside tests include single-leg stance, tandem stance, five-times sit-to-stand test, functional reach test, and pull test.[22] Standardized instruments such as the Berg Balance Scale and Short Physical Performance Battery provide additional objective information.[23]

Qualitative gait analysis involves observation of posture, arm swing, stride length, cadence, turning, floor clearance, and gait trajectory under usual and challenging conditions.[18] Dual-task assessment, such as walking while counting backward, may reveal cognitive-motor interference. The “Stops Walking When Talking” phenomenon has been associated with increased fall risk among older adults.[24]

Quantitative assessment tools provide objective measurements and facilitate longitudinal monitoring. Commonly used measures include gait speed, the Timed Up and Go (TUG) test, and the Performance-Oriented Mobility Assessment (POMA).[25,26][Table 3]

Rehabilitation

Rehabilitation is the cornerstone of management for most gait disorders in older adults.[7] The goal is not merely to correct gait abnormalities but to optimize function, independence, participation, and quality of life according to the International Classification of Functioning, Disability and Health framework.[27]

Management should begin with identification and treatment of reversible causes. Optimization of diabetes, hypertension, nutritional deficiencies, Parkinson disease, visual impairment, vestibular dysfunction, and orthopedic conditions may significantly improve gait performance.[16,17] Medication review and deprescribing of fall-risk-increasing drugs should be performed whenever appropriate.[20]

A multidisciplinary team approach involving physiatrists, physiotherapists, occupational therapists, rehabilitation nurses, psychologists, orthotists, social workers, caregivers, and patients is often necessary to address the multifactorial nature of gait disorders.[27]

Table 3. Common Quantitative Assessment Tools

Assessment Tool	Clinical Purpose	Interpretation
Gait Speed	Mobility and frailty assessment	<1.0 m/s indicates increased risk
Timed Up and Go	Fall-risk screening	>13.5s suggests increased fall risk
Berg Balance Scale	Balance evaluation	Low scores indicate poor balance
POMA (Tinetti)	Combined gait and balance assessment	≤18 indicates high fall risk
Functional Ambulation Classification	Walking independence	Grades 0–5

Exercise therapy is the most evidence-supported intervention for improving gait and reducing falls.[28] Aerobic exercise improves cardiovascular fitness, endurance, and walking capacity. Current recommendations encourage at least 150 minutes of moderate-intensity physical activity per week, whenever feasible.[29] Strengthening exercises target muscle groups commonly contributing to gait dysfunction, including hip extensors, hip abductors, knee extensors, ankle dorsiflexors, plantar flexors, and core musculature.[30] Progressive resistance training improves walking speed, balance, and functional mobility in older adults.[31]

Flexibility and range-of-motion exercises help maintain joint mobility and reduce the effects of contractures and muscle tightness. Stretching programs should emphasize the gastrosoleus complex, hamstrings, quadriceps, gluteal muscles, and hip adductors.[7] Balance training represents another essential intervention. Activities such as tandem walking, weight shifting, single-leg stance, multidirectional stepping, obstacle negotiation, and task-oriented gait practice improve postural control and reduce fall risk.2[8]

Appropriate prescription of orthoses and walking aids can substantially enhance mobility and safety. Ankle-foot orthoses may improve foot clearance in patients with dorsiflexor weakness, while canes and walkers increase stability and confidence during ambulation.[7] Environmental modifications are particularly important because many falls occur within the home. Recommended measures include improved lighting, removal of loose rugs, reduction of clutter, installation of grab bars and railings, use of non-slip surfaces, and adjustment of chair and toilet height.[32]

Assistive technologies are increasingly incorporated into rehabilitation practice. Wearable sensors, smart insoles, smartwatches, motion detectors, and automated fall-alert systems provide objective monitoring and may facilitate early intervention when mobility deteriorates.[33]

Among structured fall-prevention interventions, the Otago Exercise Programme remains one of the best-studied approaches. Developed in New Zealand, this home-based program combines strengthening, balance training, and walking exercises and has been shown to reduce falls by approximately 35–40% in community-dwelling older adults[34].

Future Directions

Technological advances continue to transform gait assessment and rehabilitation. Three-dimensional motion analysis systems, wearable inertial sensors, artificial intelligence – assisted gait analysis, and telerehabilitation platforms are becoming increasingly accessible.[33,35] These technologies provide objective measurements of gait variability, symmetry, and mobility patterns that may improve diagnostic accuracy and individualized treatment planning. Integration of digital health technologies with conventional rehabilitation programs may further enhance outcomes in aging populations.

Conclusion

Gait disorders are common among older adults and represent a major contributor to falls, disability, and loss of independence. Modern understanding recognizes gait as a complex interaction of neurological, musculoskeletal, cardiopulmonary, sensory, and cognitive systems. Comprehensive assessment incorporating history, physical examination, balance evaluation, and functional mobility testing is essential for accurate diagnosis. Rehabilitation remains the cornerstone of management and should emphasize exercise therapy, balance training, environmental modification, assistive devices, and multidisciplinary care. Evidence-based interventions, particularly structured exercise programs such as the Otago Exercise Programme, can significantly improve mobility and reduce fall risk. As wearable technologies and digital rehabilitation tools continue to evolve, rehabilitation physicians will have expanding opportunities to optimize gait and functional outcomes in older adults.

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Guest Article

Geriatric Mental Health: An Emerging Priority for Physical Medicine and Rehabilitation Practice

Aleena Johnson[1]

Abstract

Kerala is India's most demographically "aged" state, with the highest proportion of older adults in the country and life expectancy well above the national average. Mental health problems in older adults like depression, anxiety, dementia and its behavioral and psychological symptoms (BPSD), delirium, and psychological distress following disability are common, frequently under-recognized, and closely intertwined with the physical impairments that bring patients to physiatrist's services. Dementia deserves particular emphasis: BPSD affect the great majority of people living with dementia, drive caregiver burden, and are closely linked to elder abuse, an under-reported but common problem in Indian households. This article reviews the full spectrum of geriatric psychiatric morbidity using the diagnostic and clinical framework of Kaplan & Sadock's Synopsis of Psychiatry and the Comprehensive Textbook of Psychiatry (CTP), along with a discussion of management, and the role of the multidisciplinary rehabilitation team in early recognition and holistic care of the ageing.

Keywords: geriatric depression; dementia; behavioral and psychological symptoms of dementia (BPSD); elder abuse; caregiver burden; rehabilitation; Kerala; mental health screening

Introduction

Kerala completed its demographic transition earlier and more sharply than any other Indian state. According to the 2021 estimates, the proportion of persons aged 60 and above in Kerala rose to roughly 16.5 per cent, up from about 10.5 per cent in 2001, and Kerala continues to record the highest share of elderly residents in the country; projections suggest this could approach 23 per cent within the next decade and nearly 30 per cent by mid-century. Kerala also leads India in life expectancy, with female life expectancy exceeding 80 years.[13] Ageing is accompanied not only by musculoskeletal, neurological, and cardiopulmonary morbidity but also by a substantial burden of psychiatric illness that is frequently missed in routine rehabilitation encounters.

The National Mental Health Survey of India found that psychiatric morbidity, including depressive and anxiety disorders, is disproportionately concentrated in adults above 50 years, and Kerala specifically recorded the highest suicide risk among all surveyed states, with elevated rates of neurotic and stress-related disorders and substance use in its older population.[1] A community-based study from Thiruvananthapuram district found that more than a third of older women screened had moderately severe to severe depression, associated with urban residence, being unmarried, chronic morbidity, and sleep disturbance.[2]

For the physiatrist, these numbers matter directly: unrecognised depression, anxiety, or early cognitive impairment routinely undermines motivation, therapy adherence, pain reporting, and ultimate functional outcomes in stroke, fracture, amputation, and chronic pain rehabilitation. This article surveys the major geriatric mental health issues relevant to PMR practice and proposes a pragmatic framework for their identification and management within a rehabilitation setting.

Spectrum of Geriatric Psychiatric Disorders

Kaplan & Sadock's Synopsis of Psychiatry and the CTP conceptualize late-life psychiatric disorders as arising from the interplay of neurobiological ageing, cumulative medical burden, polypharmacy, and psychosocial stressors and losses, including bereavement, retirement, functional decline, and social isolation.

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Hospital-based data from Kerala illustrate this complex burden: an audit of a psychogeriatric clinic at a tertiary centre found that organic psychiatric disorders accounted for approximately one-quarter of referrals, comprising dementia, delirium, and organic mood disorders, in addition to mood, anxiety, and psychotic disorders identified in the same clinical setting. The major diagnostic categories are considered below, with emphasis on those most relevant to routine geriatric and rehabilitation practice.[3,7,8]

Depressive disorders

Depression is the commonest treatable geriatric psychiatric condition. The Synopsis and CTP both emphasize its atypical late-life presentation—somatic complaints, irritability, loss of interest, and cognitive slowing that can mimic dementia ("depressive pseudodementia")—rather than the overt sadness seen in younger adults. Chronic illness, functional dependency, and lack of social support are important associated factors. Depression in old age also carries a high risk of completed suicide, particularly among elderly men. First-line management follows CTP guidance: SSRIs or SNRIs in preference to tricyclics because of the latter's anticholinergic and cardiac burden, structured psychotherapy such as CBT, and electroconvulsive therapy for severe, psychotic, or treatment-refractory depression[4,5,6,8]

Anxiety and somatoform presentations

Anxiety disorders, most often generalized anxiety and health-related anxiety, are common in late life and are frequently comorbid with depression rather than occurring in isolation. Anxiety and somatisation—physical complaints without an adequate organic basis—are common presenting complaints. CTP notes that anxiety in the elderly is often under-recognized because worry is attributed to legitimate medical illness or normalized as an expected feature of ageing. Management favors SSRIs/SNRIs and psychotherapy; benzodiazepines should be used cautiously and briefly because of their association with falls, cognitive impairment, and dependence in older adults.[5,8]

Delirium

Delirium is an acute, fluctuating disturbance of attention and awareness with associated cognitive change, distinct from the more insidious and stable course of dementia. Common precipitants include infection, metabolic derangement, drug toxicity or withdrawal, immobilization, sensory impairment, and uncontrolled pain. Delirium is frequently missed or misdiagnosed as dementia, depression, or a primary psychotic disorder, particularly in its hypoactive form. Management prioritizes identifying and treating the underlying cause, non-pharmacological measures (reorientation, sleep–wake regulation, early mobilisation, correcting sensory deficits), and reserving low-dose antipsychotics for severe agitation posing safety risk.[8]

Late-onset psychosis

Very-late-onset schizophrenia-like psychosis ("late paraphrenia") is a recognised geriatric syndrome, typically presenting with persistent persecutory delusions and often preserved affect and personality. It is associated with sensory impairment, particularly acquired hearing loss, and social isolation. It must be distinguished from delirium-related psychosis and the psychotic symptoms of BPSD, since aetiology and management differ. Treatment combines low-dose antipsychotic medication with correction of sensory deficits and reduction of social isolation.[8]

Substance use disorders

Substance use in the elderly, particularly alcohol misuse and misuse of prescribed benzodiazepines or opioids, is often under-screened because presentations such as falls, confusion, and self-neglect are attributed to other causes. Late-life substance use can cause or mask depression, contribute to cognitive impairment, and interact dangerously with commonly prescribed medications. Routine history-taking should include explicit, non-judgemental enquiry about alcohol and sedative use.

Sleep disorders

Age-related changes in sleep architecture—reduced slow-wave sleep, fragmented sleep, and earlier waking—make insomnia common in later life. Insomnia is often secondary to depression, anxiety, nocturia, pain, or sleep apnoea rather than a primary disorder. CTP recommends treating the underlying cause and using sleep hygiene measures before considering pharmacological treatment; long-term hypnotic use should generally be avoided because of the risks of falls, fractures, and cognitive impairment.[5,8]

Dementia and mild neurocognitive disorder

Dementia is a major neuropsychiatric disorder in older adults, with Alzheimer's disease and vascular dementia accounting for most cases. A substantial proportion of dementia remains undetected in primary care and general hospital settings, and community-based work has highlighted the overlap between dementia and serious mental illness, as well as barriers to accessing appropriate psychiatric care.[9-13]

Behavioural and Psychological Symptoms of Dementia (BPSD)

BPSD encompasses the psychological symptoms and behavioural disturbances that commonly accompany dementia and represents one of the principal causes of caregiver stress, institutionalisation, and disruption of rehabilitation.[7,8]

Clinical clusters

- Psychological symptoms: depression, anxiety, apathy, delusions (commonly of theft or infidelity), hallucinations, and misidentification syndromes.

- Behavioural symptoms: agitation, physical and verbal aggression, wandering, disinhibition, repetitive vocalization, sleep–wake cycle disturbance ("sun downing"), and resistance to care.

Etiological models

Several complementary models are described in CTP

Unmet needs model: disturbed behaviour represents communication of underlying pain, discomfort, boredom, or unmet psychosocial needs in a person who can no longer verbalize them.

Neurobiological models: disruption of frontal-sub cortical circuits and cholinergic/serotonergic pathways.

Progressively lowered stress-threshold model: the reduced capacity of a demented brain to process stimuli leads to catastrophic reactions when environmental demand exceeds a lowered coping threshold[8].

Assessment and management

Assessment should therefore begin with a systematic search for reversible contributors such as pain, constipation, urinary retention, infection, medication effects, or environmental triggers. [15]

Non-pharmacological interventions including caregiver education, structured daily routines, cognitive and sensory stimulation, physical activity, music therapy, reminiscence therapy, and environmental modification, remain first-line management. Antipsychotics should be reserved for severe agitation, aggression, or psychosis associated with significant distress or safety concerns, using the lowest effective dose for the shortest possible duration.[15]

In practice, a rehabilitation unit treating a patient with dementia should include a brief behavioural chart in the admission routine, noting the timing, apparent trigger, and context of any agitation or resistance to therapy. This "antecedent–behaviour–consequence" approach frequently reveals modifiable triggers — fatigue, overstimulation, unfamiliar staff, or pain during a specific movement — that can be addressed by adjusting session timing, using consistent therapists, simplifying instructions, and involving a familiar family member during early sessions.

For rehabilitation teams, BPSD has direct practical implications. Agitation, apathy, resistance to therapy, and unrecognised pain frequently interfere with physiotherapy and occupational therapy. Thus, screening for BPSD should be a routine part of geriatric rehabilitation assessment.

Elder abuse

The World Health Organization defines elder abuse as a single or repeated act, or lack of appropriate action, occurring within a relationship of trust, which causes harm or distress to an older person. Recognised forms include physical, psychological/emotional, financial, and sexual abuse, neglect and abandonment.[20]

From a geriatric psychiatry perspective, psychological abuse and neglect are particularly important, as they may be subtle and contribute to depression, anxiety, social withdrawal and other behavioural or psychological symptoms.

Kerala and Indian data

Elder abuse in India shows wide variation across studies depending on the screening instrument used, ranging from roughly 10 per cent to over 60 per cent in different samples, versus a much lower figure of about 5 per cent nationally when the Longitudinal Ageing Study in India relied on direct self-report rather than structured screening. Community-based work in rural Kerala[17] using the Hwalek-Sengstock Elder Abuse Screening Test found a prevalence of about 60 per cent, rising to nearly three-quarters among those aged 80 and above, compared with roughly 58–59 per cent among the "young-old" (60–79 years). Across Indian studies, adult children and children-in-law are the most commonly identified perpetrators, with emotional abuse and neglect reported more often than physical or financial abuse. Depression and a prior history of abuse are independently associated with further abuse, pointing to a bidirectional relationship in which psychiatric morbidity increases vulnerability and abuse in turn worsens mental health.[16]

Risk factors particularly relevant in Kerala

- Cognitive impairment and dementia, which reduce the ability to recognise, resist, or report mistreatment.
- Widowhood, especially among older women, who form a disproportionate share of Kerala's oldest-old population.
- Functional dependency following stroke, fracture, or chronic illness—of particular relevance to rehabilitation practice and caregiver burden.
- The Gulf-migration pattern, in which adult children work abroad, leaving elderly parents cared for by hired attendants or living alone for extended periods—a distinctively Kerala-specific social vulnerability.
- Property and inheritance disputes within extended families.

Kerala's Policy and Service Response

Legally, elder abuse and neglect fall under the Maintenance and Welfare of Parents and Senior Citizens Act, 2007, which allows parents to claim maintenance from children and provides for eviction of abusive occupants from a senior citizen's property. Kerala has built substantial state infrastructure around this: the Vayomithram programme provides geriatric outpatient and outreach services through primary and taluk-level government hospitals, while the state's well-established Neighborhood Network in Palliative Care offers a model of trained community volunteers and home-based care that could be extended further into psychogeriatric and elder-protection outreach. For acute psychosocial distress, Kerala's DISHA helpline (1056) and the national Tele-MANAS helpline (14416) provide accessible, confidential first points of contact, and clinicians should routinely make patients and families aware of these services.[18,19]

Multidisciplinary Rehabilitation Team

Physiatrists and rehabilitation professionals are frequently the first point of sustained contact for older adults after stroke, hip fracture, or major surgery — precisely the population at highest risk for delirium, depression, BPSD, and abuse. Brief, validated screening tools are feasible within a busy rehabilitation OPD: the 15-item Geriatric Depression Scale, a brief cognitive screen (Mini-Cog or MMSE), and the informant-rated NPI-Q for behavioural symptoms can each be administered in under ten minutes. Equally important is training the full hospital workforce — nursing, physiotherapy, occupational therapy, front-office, and administrative staff — to recognise red flags of neglect or abuse (unexplained injury, poor hygiene, fearful affect around a particular caregiver, missed follow-up visits) and to know the referral pathway to psychiatry and medical social work. Discharge planning that proactively addresses caregiver burden, realistic home supervision arrangements, and post-discharge psychiatric follow-up is one of the most effective, low-cost interventions against both BPSD-related crises and domestic elder abuse. Review poly pharmacy at every visit; several commonly prescribed drugs in older patients (anticholinergics, benzodiazepines, some analgesics) can precipitate or worsen delirium, falls, and cognitive impairment.

Conclusion

Kerala's demographic profile offers an early and instructive window into the psychiatric consequences of population ageing that the rest of India will confront over the coming decades. Depression, delirium, and dementia remain under-recognised in routine medical and rehabilitation encounters, while BPSD and elder abuse — though common and closely interlinked with each other and with underlying psychiatric morbidity — are still too often treated as separate, peripheral concerns rather than core components of geriatric assessment. Embedding brief, validated screening for cognitive, mood, and behavioural symptoms, alongside routine enquiry about safety and caregiving circumstances, into every geriatric medical and rehabilitation encounter, backed by Kerala's existing Vayomithram, palliative-care, and tele-mental-health infrastructure, offers a practical and scalable path forward.

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Osteoporosis in Older Adults: Current Concepts in Diagnosis, Risk Assessment and Management

Reshma M[1]

Osteoporosis is a systemic skeletal disorder characterised by low bone mass and deterioration of bone microarchitecture, resulting in increased bone fragility and susceptibility to fracture. It is often clinically silent until a fragility fracture occurs and is therefore an important cause of disability, loss of independence and mortality in older adults. Consequently, it is often referred to as the silent disease.[1–4]

The ageing of the global population has transformed osteoporosis into a major healthcare challenge. Approximately one-third of women and one-fifth of men aged 50 years or older are expected to sustain an osteoporotic fracture during their remaining lifetime, although estimates vary across populations. Hip, vertebral, proximal humeral and distal radial fractures constitute the major clinical burden. [3,4]

In India, increasing longevity, inadequate calcium intake, vitamin D insufficiency, reduced physical activity and other age-related risk factors contribute to the growing burden. The Indian Society for Bone and Mineral Research (ISBMR) has highlighted that osteoporotic fractures may occur at an earlier age in Indians than in Western populations and recommends earlier screening in high-risk individuals. Despite effective treatments, osteoporosis remains substantially underdiagnosed and undertreated.[1,2]

Pathophysiology

Bone undergoes continuous remodelling through coordinated osteoclastic resorption and osteoblastic formation. With advancing age, bone formation becomes insufficient to compensate for bone resorption. Reduced osteoblast number and function, age-related hormonal changes, altered RANK–RANKL–osteoprotegerin signalling, vitamin D and calcium-related factors, chronic low-grade inflammation and declining muscle mass all contribute to skeletal fragility. In older adults, sarcopenia and impaired balance further increase fracture risk through a higher likelihood of falls.[3,5]

Risk Factors and Secondary Causes

Risk assessment should consider skeletal, demographic, lifestyle and functional factors, together with secondary causes of osteoporosis. Important risk factors are summarised in Table 1.

Older adults should also be evaluated for secondary osteoporosis due to hyper-thyroidism, primary hyperparathyroidism, cushing syndrome, hypogonadism, chronic kidney disease, chronic liver disease, malabsorption syndromes, rheumatoid arthritis, diabetes mellitus and Long-term glucocorticoid therapy, before initiating pharmacotherapy.[1]

Clinical Features

Osteoporosis is frequently asymptomatic until a fragility fracture occurs. Vertebral fractures may remain clinically silent and are detected incidentally on spinal imaging

Table 1. Important risk factors of osteoporosis

Non-modifiable	Modifiable
Advanced age	Low body mass index (BMI)
Female sex	Physical inactivity
Previous fragility fracture	Smoking
Family history of hip fracture	Excess alcohol intake
Asian ethnicity	Low dietary calcium
Early menopause	Vitamin D deficiency
Genetic predisposition	Poor protein intake
	Recurrent falls
	Sarcopenia

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or may sometimes present with height loss, kyphosis or chronic back pain. Hip, vertebral, proximal humeral and distal radial fractures may result in pain, impaired mobility, dependence in activities of daily living and loss of independence. Hip fracture is associated with substantial morbidity and mortality. [3,4]

Diagnosis and Fracture-Risk Assessment

Clinical assessment

Assessment should include previous fragility fractures, falls, family history of hip fracture, smoking and alcohol use, nutritional status, physical activity, medication history (particularly glucocorticoids), comorbidities and possible secondary causes. Height should be measured periodically, and a height loss of approximately 4 cm or more should prompt consideration of vertebral fracture assessment.[1,2]

Bone mineral density

Dual-energy X-ray absorptiometry (DXA) remains the standard method for assessing bone mineral density (BMD), with measurement at the lumbar spine, femoral neck and total hip. In postmenopausal women and men aged 50 years or older, the WHO T-score classification is commonly used. According to WHO classification, a T-score of more than −1.0 is normal, between −1.0 and −2.5 indicates low bone mass and less than −2.5 indicates osteoporosis.[1–3]

Fracture Risk Assessment (FRAX)

FRAX estimates the 10-year probability of a major osteoporotic fracture and hip fracture using clinical risk factors with or without femoral-neck BMD. Treatment thresholds should always be stated with reference to the guideline being used, because thresholds differ between guidelines. In the ISBMR position statement, adults older than 50 years with a T-score between −1.0 and −2.5 may be considered for treatment when the 10-year probability is at least 3.5% for hip fracture or at least 10.5% for major osteoporotic fracture.1 The ISBMR also notes that the Indian FRAX model has limitations because its fracture data are derived from Singaporean Indian populations and have not been fully validated in the native Indian population.[1,6]

Laboratory evaluation

Laboratory evaluation is primarily directed towards identifying secondary osteoporosis and reversible contributors. Common baseline tests include complete blood count, serum calcium, phosphate, creatinine, liver function tests, alkaline phosphatase and 25-hydroxyvitamin D. Parathyroid hormone, thyroid-stimulating hormone, testosterone, celiac serology, serum protein electrophoresis, cortisol testing or HbA1c should be guided by clinical suspicion and initial findings.[1,2]

Bone turnover markers

Serum procollagen type I N-terminal propeptide (PINP) and C-terminal telopeptide of type I collagen (CTX) are commonly used reference markers of bone formation and resorption. Their principal clinical value is in selected settings for monitoring treatment response or adherence rather than establishing the diagnosis.[7]

Management

Management aims to reduce fracture risk, maintain skeletal health, prevent falls and preserve function. Treatment should be individualised according to fracture history, BMD, age, comorbidities, secondary causes, medication risks, life expectancy, treatment feasibility and patient preferences. Recent guidance increasingly emphasises matching the intensity and sequence of therapy to the individual's fracture risk rather than using a uniform treatment strategy. [2,8,9,10]

Calcium, vitamin D and lifestyle measures

Adequate calcium intake should preferably be achieved through diet, with supplementation when necessary. Vitamin D deficiency or insufficiency should be corrected according to individual clinical needs, without relying on a single universal 25-hydroxy vitamin D target.[1,2]

Regular physical activity should include appropriately prescribed weight-bearing and progressive resistance exercise, together with balance training where indicated. Exercise prescription should be adapted to frailty, vertebral fractures, comorbidities and functional status. Fall-prevention measures include vision assessment, medication review, home-hazard modification, appropriate footwear, adequate lighting, and strength and balance training.[2,4]

Pharmacological therapy

Bisphosphonates remain appropriate first-line treatment for many patients at high fracture risk. Alendronate, risedronate and zoledronic acid reduce vertebral, non-vertebral and hip fracture risk. Intravenous zoledronic acid is particularly useful when oral therapy is unsuitable and has demonstrated benefit after hip fracture.[2,4,11]

Denosumab is a potent RANKL inhibitor administered subcutaneously every six months. It does not require renal dose adjustment, but hypocalcaemia risk is increased in advanced chronic kidney disease. Calcium and vitamin D status should be assessed and corrected where appropriate.[2,9,12]

Teriparatide is an anabolic agent used in selected patients with very high fracture risk, including those with severe osteoporosis or multiple vertebral fractures. Treatment is generally limited to the approved duration, after which an antiresorptive agent should be used to maintain skeletal benefit.[4,10,11,13]

Romosozumab, a sclerostin inhibitor with anabolic and antiresorptive actions, is another option for selected patients at very high fracture risk; cardiovascular risk should be considered before prescribing and current local product information followed.[2,8,9]

Raloxifene, a Selective Estrogen Receptor Modulators, reduces vertebral fracture risk and lowers the incidence of estrogen receptor-positive breast cancer, but does not reduce hip fracture risk. However, it does not reduce hip fracture risk and is associated with an increased risk of venous thromboembolism. It is therefore appropriate only for selected postmenopausal women.[4,8]

Treatment sequencing and drug holidays

Current evidence supports an anabolic-first strategy with teriparatide, abaloparatide or romosozumab for patients at very high fracture risk, followed by antiresorptive therapy with bisphosphonate or denosumab. Similarly, patients discontinuing denosumab should receive a potent antiresorptive, such as zoledronic acid or alendronate, to reduce rebound bone loss and vertebral fracture risk.[8,10]

Bisphosphonate treatment may be followed by a treatment pause in selected patients after reassessment of fracture risk; a routine 'drug holiday' is not appropriate for patients who remain at high or very high fracture risk.[8–10]

Monitoring

Follow-up should assess new fractures, falls, adherence, adverse effects, calcium and vitamin D intake, relevant secondary causes and clinically significant height loss. Repeat DXA is commonly considered 1– 2 years after treatment initiation or a major treatment change, with subsequent intervals individualised according to clinical circumstances and the precision of the DXA facility.

Treatment failure should be considered in patients with two or more new fragility fractures in spite of being adherent to therapy, a notable decline in BMD beyond the least significant change and persistent or newly identified secondary causes of bone loss despite treatment. Before labeling treatment failure, adherence, administration technique, treatment duration, interval fractures, and other secondary causes should be reassessed.[10] A new fracture or significant BMD decline should prompt reassessment of adherence, treatment administration, secondary causes and the appropriateness of the treatment strategy.[2,4,8]

Future perspectives

Advances in osteoporosis care are increasingly focused on more precise fracture-risk stratification, earlier identification of patients at imminent risk, individualised treatment sequencing and integrated secondary fracture prevention. Developments in tools such as trabecular bone score and enhanced fracture-risk prediction, together with wider implementation of fracture liaison services, may further improve personalised osteoporosis care.

Conclusion

Osteoporosis is a common and underdiagnosed disorder in older adults and a major cause of fragility fractures, disability and loss of independence. Effective management requires accurate fracture-risk assessment, identification of secondary causes, optimisation of calcium and vitamin D status, appropriate exercise and fall prevention, and individualised pharmacological treatment. Contemporary management increasingly emphasises treatment intensity and sequencing according to fracture risk, together with planned follow-up and secondary fracture prevention. [1,2,8–10]

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Cryoneurolysis: Current Concepts and Future Directions

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Introduction

Pain remains one of the most distressing symptoms worldwide and is a major target of pain rehabilitation interventions. While the multidisciplinary approach has significantly improved pain management, there remains a need for minimally invasive interventions that provide prolonged analgesia without permanently damaging peripheral nerves. Cryoneurolysis has emerged as one such technique and is increasingly being incorporated into interventional Physical Medicine and Rehabilitation. Prolonged pain relief with a low risk of permanent neurological deficits is particularly attractive for rehabilitation physicians managing chronic pain.

Mechanism of Action

Cryoneurolysis is based on the Joule–Thomson effect, whereby compressed gases such as nitrous oxide or carbon dioxide undergo rapid expansion at the probe tip, producing temperatures between −20°C and −100°C. The resulting ice ball encompasses the target nerve, leading to reversible interruption of axonal conduction. Exposure to these temperatures causes intracellular and extracellular ice crystal formation, osmotic injury, microvascular disruption, and subsequent Wallerian degeneration of the axon distal to the treatment site. Importantly, the supporting connective tissue layers—the endoneurium, perineurium, and epineurium—remain largely intact. Preservation of these structures maintains the endoneurial tubes which serve as biological scaffolds for axonal regeneration, allowing gradual restoration of nerve function over weeks to months.

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The extent of nerve injury generally corresponds to Sunderland grade II (axonotmesis), although deeper freezing may occasionally produce grade III injury. Because the neural framework is preserved, regenerating axons typically grow at approximately 1–2 mm/day, resulting in predictable recovery of sensory and, where applicable, motor function and a better option than radiofrequency ablation.

Equipment and Procedure

Modern cryoneurolysis systems consist of a console connected to a handheld cryoprobe through which compressed nitrous oxide or carbon dioxide is delivered. Expansion of the gas within the probe tip generates rapid cooling and forms an ice ball that can be visualised under ultrasound guidance. High-resolution ultrasound helps in the identification of the target nerve, adjacent vessels, and surrounding structures with improved procedural accuracy while minimising complications.

Ideal candidates include patients with chronic peripheral nerve-mediated pain who have demonstrated favourable responses to diagnostic nerve blocks.

Following sterile preparation and local anaesthesia, the cryoprobe is advanced adjacent to the nerve under continuous ultrasound visualisation. One or more freeze–thaw cycles, typically lasting two to three minutes each, are performed until an adequate ice ball encompasses the nerve.

Current Clinical Applications

Knee Osteoarthritis : In Patients who have failed conservative management but are either unsuitable for surgery or awaiting arthroplasty. Ultrasound-guided treatment of the infrapatellar branch of the saphenous nerve (IPBSN) and the anterior femoral cutaneous nerve (AFCN) has demonstrated clinically meaningful reductions in pain, improvements in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, and enhanced functional performance lasting approximately three to six months.

Perioperative analgesia in Total Knee Arthroplasty : Preoperative treatment of the superficial genicular sensory nerves reduces postoperative pain, opioid consumption, and hospital length of stay. Facilitate earlier mobilisation and participation in rehabilitation

Peripheral Neuralgias **:** Treatment of the greater occipital nerve in occipital neuralgia and selected cervicogenic headaches. Cryoneurolysis of intercostal nerves is increasingly used for persistent pain following thoracotomy or rib fractures. Morton's neuroma represents another promising indication, with studies reporting sustained pain relief, improved walking tolerance, and reduced need for surgical neurectomy.

Chronic Shoulder Pain **:** Cryoneurolysis targeting the suprascapular and axillary nerves in Glenohumeral osteoarthritis, rotator cuff pathology, and adhesive capsulitis. Although evidence remains limited, early studies suggest meaningful improvements in pain and shoulder function when combined with structured rehabilitation programmes.

Post-Amputation Pain: Cryoneurolysis of symptomatic peripheral nerves may reduce residual limb pain and improve prosthetic tolerance. Preliminary studies also suggest benefit in selected patients with painful neuromas, although further controlled trials are required.

Current evidence is strongest for knee osteoarthritis and perioperative pain management after total knee arthroplasty, while larger multicentre randomised controlled trials are needed to support wider adoption in emerging indications such as spasticity management.

Contraindications

The important contraindications include cold urticaria, cryoglobulinaemia, uncontrolled coagulopathy, Raynaud phenomenon, local infection or inability to cooperate during the procedure.

Advantages

- Minimize the risk of permanent nerve damage.
- Minimally invasive and can usually be performed under ultrasound guidance in an outpatient setting.
- Early return to normal activities making it compatible with rehabilitation programmes.
- No steroid-related adverse effects, when compared with repeated corticosteroid injections.
- Fewer dysesthesias and painful neuromas
- Long lasting analgesia than local anaesthetic injections and may substantially reduce opioid requirements following surgery.
- Pain relief allows patients to participate more actively in therapeutic exercise, gait training, strengthening programmes, and functional restoration, potentially producing benefits that extend beyond the duration of the nerve block itself.

Limitations and Complications

- Pain relief is temporary (generally ranges from three to nine months) as nerve regeneration eventually restores conduction.
- Requirement of specialised equipment and operator expertise in musculoskeletal ultrasound, which may limit availability in resource-constrained settings
- Mild and transient side effects including bruising, local swelling, dysesthesia, temporary numbness, and procedure-related discomfort
- Rarely skin pigmentation changes, frost injury, infection, and unintended motor weakness

Future Directions

The development of compact, portable cryoneurolysis devices may facilitate office-based procedures and improve accessibility. Further, artificial intelligence-assisted ultrasound integration with augmented reality navigation systems may simplify complex interventions and reduce operator dependence.

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History

Marjory Warren: A Pioneer of Geriatric Rehabilitation

Anand Raja D S[1]

Abstract

Marjory Warren (1897–1960) is widely recognised as a pioneer of geriatric medicine, but her contributions also hold enduring significance for rehabilitation medicine. At a time when many older adults with chronic disability were considered beyond recovery, Warren challenged the prevailing model of custodial care by introducing systematic assessment, active treatment, multidisciplinary management, and rehabilitation aimed at restoring function and independence. Her work demonstrated that frailty and advanced age did not preclude meaningful recovery and laid the foundation for many principles that continue to guide modern geriatric rehabilitation. This article reviews Warren's contributions from the perspective of Physical Medicine and Rehabilitation (PM&R), highlighting how her emphasis on functional assessment, multidisciplinary care, and community reintegration remains relevant to contemporary rehabilitation practice. Her legacy serves as a reminder that rehabilitation should be guided by a person's functional potential rather than chronological age.

Introduction

Older adults were not always considered ideal candidates for rehabilitation. At the turn of the twentieth century, many frail older people admitted to hospitals or long-term institutions were regarded as beyond recovery and received little more than custodial care. Functional disability in the elderly was generally accepted as an inevitable consequence of ageing, and therefore efforts were not usually made to assess their potential for improvement.[1–3].

It is in this context that the work of Dr. Marjory Winsome Warren (1897–1960) should be understood. She challenged prevailing practice and helped redefine the care of older adults. Trained in medicine in London, she worked at West Middlesex Hospital during the 1930s, where she encountered overcrowded chronic wards filled with older patients who were bedridden, inadequately assessed, and often regarded as permanent residents rather than individuals with the potential to recover. Systematic evaluation of function, mobility and rehabilitation potential was uncommon, and treatment was directed more towards long-term care than restoration of independence.[2,4]

Her reforms were both practical and systematic. Patients were grouped according to their medical conditions and degree of disability, allowing treatment to be tailored to individual needs. Greater emphasis was placed on thorough medical evaluation, treatment of reversible illnesses, early

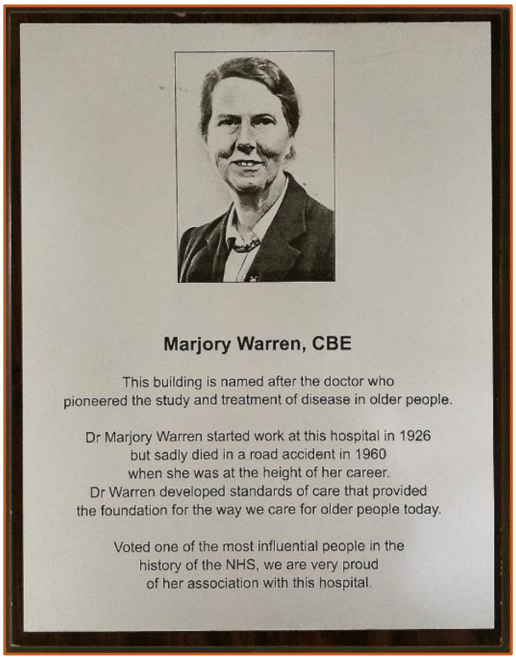

Figure 1. Commemorative plaque dedicated to Dr. Marjory Warren at West Middlesex Hospital, London.

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mobilization, physiotherapy, occupational therapy, and preparing patients to return to the community whenever possible.[1,2] As a result, many older adults who had previously been considered permanent residents of chronic wards regained sufficient function to be discharged home. Warren's work demonstrated that frailty and advanced age did not necessarily preclude recovery and that functional improvement was achievable with appropriate rehabilitation.[1–3]

Although Marjory Warren worked before PM&R had emerged as a distinct specialty, many of the principles she introduced are now integral to rehabilitation medicine. She viewed disability as more than a medical diagnosis, emphasizing mobility, independence, and the restoration of function. Her approach recognized that successful care depended not only on treating disease but also on helping patients regain the ability to live as independently as possible, a philosophy that closely aligns with the modern International Classification of Functioning, Disability and Health (ICF) framework.[1,3,6,7]

Equally important was her belief that rehabilitation required a team effort. Physicians, nurses, physiotherapists, occupational therapists, and social workers all contributed to restoring function and supporting a patient's return to the community.[1–4] This multidisciplinary model remains the foundation of modern rehabilitation services, whether caring for older adults, individuals recovering from stroke or spinal cord injury, people living with cancer, or those with limb loss and other disabling conditions.[5,6]

Relevance to Physical Medicine and Rehabilitation

Although Marjory Warren is remembered primarily as a geriatrician, her work has enduring relevance for rehabilitation physicians. She showed that age alone should never determine whether a person is offered rehabilitation. Instead, the focus should be on identifying reversible impairments, preventing avoidable complications, restoring function, and maximizing independence.[1–3]

These principles continue to underpin modern geriatric rehabilitation. Comprehensive assessment, early mobilization, multidisciplinary care, goal-directed therapy, falls prevention, and planned transition back to the community are now integral components of rehabilitation programmes for older adults. Evidence from Comprehensive Geriatric Assessment (CGA) has further demonstrated that coordinated multidisciplinary care improves functional outcomes and increases the likelihood of older adults remaining independent in their own homes.[4,5]

A Lasting Legacy

Marjory Warren's greatest achievement was changing the way older adults with chronic disability were viewed. More than eight decades after her landmark work, her central message remains relevant: treatment should not end with diagnosis; it should begin with understanding what a person can achieve through rehabilitation.

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Insulin Afrezza

Amina Basheer[1]

Achieving optimal postprandial glycemic control in diabetes mellitus often requires subcutaneous (SC) administration of rapid-acting insulin analogs (e.g., lispro, aspart, glulisine). However, standard SC insulins exhibit delayed absorption and prolonged clearance compared to endogenous pancreatic secretion. Technosphere insulin (TI), approved by the FDA as Afrezza, is a drug-device combination utilizing an ultrarapid-acting human insulin inhalation powder. It offers a distinct physiological advantage by accelerating systemic absorption via the expansive surface area of the pulmonary alveolar capillary network.

The Technosphere Delivery System

The pharmacokinetic breakthrough of Afrezza lies not in a novel insulin molecule, but in its proprietary carrier matrix, Fumaryl diketopiperazine (FDKP).

In the manufacturing process, FDKP self-assembles in mildly acidic conditions to form highly porous microspheres (Technosphere particles), roughly 2 to 2.5 micrometers in diameter. This specific aerodynamic sizing ensures the particles bypass the upper airways and deposit deeply within the alveoli. Upon reaching the neutral physiological pH of the deep lung (pH ~7.4), the FDKP microspheres dissolve instantly. This dissociates the insulin hexamers into monomers, facilitating near-immediate absorption across the thin alveolar epithelium into the systemic circulation. The biologically inactive FDKP is then excreted unchanged, primarily through the urine.

Pharmacokinetics and Pharmacodynamics

Afrezza is classified as an ultrarapid-acting insulin, distinguished by an onset and offset of action that are significantly faster than those of SC rapid-acting analogs.

Onset of Action: Systemic absorption occurs within minutes. Peak serum insulin concentrations are achieved in approximately 12 to 15 minutes.

Peak Action: Maximum glucose-lowering effect occurs between 35 and 55 minutes post-inhalation.

Duration of Action: Serum insulin levels return to baseline rapidly, usually within 160 to 180 minutes.

Clinical Significance of the PK/PD Profile: The rapid onset blunts the immediate postprandial hyperglycemic spike more effectively than SC analogs. More importantly, the rapid offset significantly curtails the "insulin tail"- the prolonged presence of exogenous insulin after gastric emptying is complete, thereby drastically reducing the incidence of late postprandial hypoglycemia. [Table 1]

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Dosage and Administration

Inhalation Powder: Single-use cartridges containing 4 units, 8 units, or 12 units of human insulin as a white powder, to be administered via oral inhalation with the AFREZZA inhaler only.

Timing: To be administered at the beginning of a meal.

Initiation: For insulin-naive patients, start on 4 units of AFREZZA at the beginning of each meal.

Transitioning: Current subcutaneous meal-time (prandial) insulin dosing may be converted to Afrezza as illustrated in the table. [Table 2]

Clinical Use in Geriatrics & Rehabilitation Medicine

Afrezza presents unique functional advantages in Physical Medicine and Rehabilitation, particularly for patients undergoing rigorous rehabilitation protocols or those navigating complex comorbidities.

Overcoming Motor, Sensory, and Vision Impairments

Stroke Rehabilitation: Hemiparesis and visual field deficits frequently hinder a patient's ability to dial a pen needle or manipulate a syringe safely. Afrezza's breath-actuated, palm-sized inhaler requires minimal grip strength and no fine motor precision, promoting independence.

Table 1. Comparison: Afrezza vs.Rapid-Acting SC Insulins

Feature	Afrezza (Inhaled)	SC Insulins
Onset of Action	1 to 5 minutes	10 to 20 minutes
Peak Action	35 to 55 minutes	60 to 90 minutes
Duration of Action	160 to 180 minutes	3 to 5 hours
Primary Advantages	Needle-free delivery; ultra-rapid onset closely mimics physiological insulin response; significantly lower risk of late-phase hypoglycemia.	Precise dose titration (1-unit increments); robust, decades-long safety profile; no pulmonary monitoring required.
Key Limitations	Fixed dosing increments (4, 8, 12 units); requires routine pulmonary monitoring; contraindicated in chronic lung disease; higher cost.	Requires subcutaneous injection; delayed offset ("insulin tail") increases the risk of delayed postprandial hypoglycemia.

Table 2. Conversion of Injected prandial insulin to Afrezza

Injected Mealtime Insulin Dose	AFREZZA® Dose	Cartridges Needed
Up to 4 units	4 units	1 x 4 unit (blue)
5–8 units	8 units	1 x 8 unit (green)
9–12 units	12 units	1 x 4 unit (blue) + 1 x 8 unit (green) OR 1 x 12 unit (yellow)
13–16 units	16 units	2 x 8 unit (green)
17–20 units	20 units	1 x 8 unit (green) + 1 x 12 unit (yellow)
21–24 units	24 units	2 x 12 unit (yellow)

Spinal Cord Injury (SCI): Patients with cervical SCI (tetraplegia) who lack the finger dexterity to pinch or grasp conventional insulin supplies can often manage an inhaler with adaptive gripping strategies.

Diabetic Neuropathy: Severe peripheral neuropathy impairs tactile feedback, making needle handling dangerous. A needle-free system removes this barrier entirely.

Mitigating Hypoglycemic Risks During Physical Conditioning

Geriatric Rehabilitation: Polypharmacy is a major driver of adverse drug events, with insulin-induced hypoglycemia being a leading cause of emergency hospitalizations. Older adults often suffer from hypoglycemia unawareness due to blunted autonomic responses. The ultra-rapid clearance of Afrezza drastically minimizes the risk of these delayed, dangerous drops in blood glucose.

Exercise-Based Rehabilitation Programs: Standard SC insulin often remains active during exercise sessions scheduled hours after a meal, triggering exercise-induced hypoglycemia. Afrezza's short 180-minute duration allows for uninterrupted physical conditioning, as the insulin has largely cleared by the time post-meal therapy sessions begin.

Adverse Effects and Contraindications

While the systemic safety profile of the insulin moiety is well-established, the pulmonary delivery route necessitates specific precautions, and the device presents certain practical limitations.

Pulmonary Safety & Contraindications:

Boxed Warning: Strictly contraindicated in patients with chronic lung diseases, such as asthma or Chronic Obstructive Pulmonary Disease (COPD), due to the severe risk of acute bronchospasm.

Smoking: Contraindicated in active smokers and those who have quit smoking in the last six months.

Decline in Pulmonary Function : Afrezza has been associated with a mild, non-progressive decline in pulmonary function (measured via FEV1) early in treatment. Baseline spirometry (FEV1) is required for all patients prior to initiation, with follow-up testing at 6 months, and annually thereafter.

Common Side Effects: The most frequently reported adverse events are non-productive cough (typically transient and mild) and throat irritation.

Practical and Clinical Limitations:

Limited Dosing Flexibility: Because cartridges are only available in 4, 8, and 12-unit increments, precise micro-adjustments (e.g., dialing 5 or 6 units) are impossible, which may challenge patients requiring tight, exact titrations.

Cost and Availability: Afrezza is generally more expensive than conventional SC rapid-acting insulins. Formulary restrictions and insurance coverage barriers can limit its availability for many patients.

Long-Term Data: Compared to the decades of robust longitudinal data available for standard injectable insulins, there is comparatively limited long-term data regarding the lifelong pulmonary safety of inhaling Technosphere particles.

Regimen Requirements: It must be used in combination with a basal insulin for patients with type 1 diabetes and cannot be used to manage Diabetic Ketoacidosis (DKA).

Conclusion

Afrezza represents a paradigm shift in prandial insulin delivery. By harnessing the expansive alveolar surface area via Technosphere technology, it achieves an ultra-rapid pharmacokinetic profile that closely approximates physiological insulin secretion. For physiatrists and rehabilitation professionals navigating the complexities of diabetes management alongside age-related functional decline, motor impairments, and rigorous physical therapy schedules, inhaled insulin provides a highly effective, needle-free alternative. But appropriate patient selection is paramount due to strict pulmonary contraindications, cost, and fixed dosing constraints.

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Football-Related Injuries: Patterns, Mechanisms, and Rehabilitation Perspectives—A Narrative Review

Nandana N[1]

Abstract

Football (soccer) is one of the world's most widely played sports and is associated with a significant risk of musculoskeletal injuries. These injuries predominantly involve the lower limbs and range from acute traumatic events to overuse conditions. This narrative review summarises the common injury patterns observed in football, their underlying biomechanical mechanisms, and general rehabilitation considerations. It also provides a brief discussion of contributing factors, including training load and movement patterns.

Introduction

Football (soccer) is one of the most widely played sports globally and is characterized by high-intensity, intermittent activity involving sprinting, acceleration, deceleration, cutting, jumping, kicking, and tackling. These dynamic and multidirectional movements place considerable mechanical stress on the musculoskeletal system, particularly the lower limbs, while player-to-player contact further contributes to traumatic injuries.[1,2,3]

The physical demands of football involve complex interactions between muscle strength, neuromuscular control, coordination, and endurance[2,4]. Repetitive loading combined with high-impact and high-speed movements predisposes players to both acute injuries and overuse conditions[5]. Thigh, knee, ankle, and foot are the most commonly affected regions[1,3].

Epidemiological studies have shown that injury rates in football are relatively high compared to many other sports, particularly in competitive and elite settings.[1,6] Injury incidence has been reported to range from approximately 6 to 9 injuries per 1000 hours of exposure. Match play is associated with a higher risk of injury than training, likely due to increased intensity, unpredictability of movements, and contact situations.[1,6]

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Football-related injuries are encountered not only in elite athletes but also among recreational and community-level players, where access to structured training, sports medicine expertise, and rehabilitation may be limited.[8] Delayed presentation, inadequate initial management, incomplete rehabilitation, and premature return to sport may contribute to persistent functional deficits and recurrent injury.[8,9]

From a rehabilitation perspective, understanding injury patterns and their underlying biomechanical mechanisms is essential for clinical assessment, individualised rehabilitation, injury prevention, and safe return to sport.[10] This narrative review discusses common football-related musculoskeletal injuries, their mechanisms and contributing factors, and the principles of rehabilitation and injury prevention, with particular emphasis on their relevance to rehabilitation professionals.

Muscle Injuries

Muscle injuries represent the most common category of injuries in football,[1,7] accounting for a substantial proportion of time-loss injuries. They predominantly affect the hamstrings, quadriceps, and calf muscles,[7,11] reflecting the high mechanical demands placed on these muscle groups during sprinting and other explosive movements.

Hamstring injuries are particularly common, accounting for a substantial proportion of muscle injuries and often resulting in significant time away from sport.[11] In clinical practice, recurrent hamstring strains are especially common among athletes who return prematurely to sprinting activities. Quadriceps injuries are more commonly associated with kicking actions, whereas calf injuries typically occur during the push-off phase of sprinting or during sudden acceleration.[7]

Mechanism

- Rapid acceleration and deceleration
- High-speed sprinting
- Sudden overstretching during changes in direction

The hamstrings are particularly vulnerable during eccentric loading as they decelerate the swinging limb during the late swing phase of running.[11,12] Inadequate eccentric strength, poor flexibility, and impaired lumbopelvic control may further increase susceptibility to injury. Fatigue, particularly during the later stages of play, can impair neuromuscular coordination and increase the risk of muscle strain.

Clinical Relevance

Hamstring injuries are associated with high recurrence rates, particularly among athletes who return to sport prematurely.[11] Inadequate rehabilitation, residual strength deficits, and persistent neuromuscular asymmetry may further increase the risk of reinjury.[2,10] Therefore, objective assessment of muscle strength, flexibility, and functional performance is essential before an athlete returns to play.

Ligament Injuries

Anterior Cruciate Ligament (ACL) Injury

ACL injuries are among the most serious injuries in football,[13] often resulting in prolonged absence from sport and potentially leading to long-term sequelae, including early osteoarthritis.[13,14] These injuries are particularly concerning in younger athletes because of their potential impact on long-term joint health and continued athletic participation. The incidence of ACL injury has been reported to be higher in female athletes, possibly because of a combination of anatomical, hormonal, and neuromuscular factors.

Mechanism

- Sudden deceleration with a change in direction
- Pivoting on a planted foot
- Knee valgus accompanied by internal rotation
- Non-contact mechanisms

Poor landing mechanics, reduced hip control, and delayed muscle activation patterns have also been implicated in the mechanism of ACL injury.[13,14]

Clinical Relevance

ACL injuries often require prolonged rehabilitation and may have significant functional and psychological consequences for athletes. Even after a successful return to sport, there remains a risk of reinjury or injury to the contralateral ACL. Psychological factors, including fear of reinjury and reduced confidence during high-demand movements, may influence return-to-play outcomes. Comprehensive rehabilitation should therefore address both physical recovery and psychological readiness before return to sport.

Ankle Ligament Injuries

Ankle sprains, particularly those involving the lateral ligament complex, are among the most common acute injuries in football.[3,7]

Mechanism

Ankle ligament injuries most commonly result from inversion injuries sustained during landing or rapid changes in direction. Uneven playing surfaces may further increase the risk of injury.

Clinical Relevance

Ankle sprains are frequently underestimated during their initial management. Inadequate rehabilitation may result in chronic ankle instability, recurrent sprains, persistent balance deficits, and altered gait mechanics, thereby increasing the risk of subsequent lower-limb injuries. Chronic ankle instability may also contribute to an increased risk of injuries involving other joints, including the knee.[15] Proprioceptive and balance training are essential components of rehabilitation and play a key role in preventing recurrence and improving functional stability.[15]

Meniscal Injuries

Meniscal injuries frequently occur in association with ligamentous injuries, particularly ACL tears, although they may also occur in isolation.[3,13]

Mechanism

Meniscal injuries typically occur as a result of twisting or rotational forces on weight-bearing knee and sudden changes in direction

Clinical Relevance

Meniscal injuries commonly present with pain, swelling, locking, or other mechanical symptoms that impair knee function. If not recognised and managed appropriately, they may lead to persistent functional limitations and accelerate degenerative changes within the knee joint. Early diagnosis and appropriate rehabilitation are therefore essential to preserve joint integrity and optimise long-term functional outcomes.

Overuse Injuries

Overuse injuries develop gradually as a result of repetitive loading without adequate recovery. Common conditions include patellar tendinopathy (jumper's knee), Achilles tendinopathy and stress fractures (particularly of tibia or metatarsals)

Contributing Factors

Overuse injuries are commonly associated with excessive training volume or intensity, poor load management, inadequate recovery, and insufficient physical conditioning.

Clinical Relevance

These injuries are typically insidious in onset and may result in prolonged absence from sport if not recognised and managed early. They are particularly common during periods of increased training load, such as pre-season conditioning or return to sport after prolonged inactivity.[5,9]

Management can be challenging, particularly when athletes continue to train despite persistent symptoms. Effective treatment generally requires temporary load modification, progressive rehabilitation, and correction of contributing biomechanical factors.

Contact Injuries

Contact injuries occur as a result of direct impact or collisions between players.. Common Types of contact injuries are contusions, fractures and Joint dislocations[3]

Mechanism

Contact injuries commonly occur during tackling, aerial duels and accidental collisions

Clinical Relevance

Contact injuries usually present acutely and are often recognised immediately during play. Their severity ranges from minor contusions and soft tissue injuries to major trauma, including fractures and joint dislocations, which may result in prolonged absence from sport.

Preventive strategies, including strict enforcement of the rules of play, proper tackling technique, appropriate use of protective equipment, and adherence to the principles of fair play, may help reduce the incidence and severity of contact injuries.

Biomechanical Considerations

Football requires a complex combination of linear sprinting, rapid acceleration and deceleration, multidirectional cutting, jumping, landing, and repetitive kicking actions.[2,4] These movements impose substantial mechanical stress on the muscle–tendon units, ligamentous structures, and articular surfaces of the lower limbs. Furthermore, many football movements are reactive rather than pre-planned, requiring rapid neuromuscular adjustments in response to opponents, ball trajectory, and evolving game situations. This inherent unpredictability further increases mechanical loading and the risk of injury.

The combination of high-speed movement and rapid changes in direction places considerable demands on neuromuscular control, making coordination and movement timing critical for injury prevention. Efficient neuromuscular control facilitates appropriate force absorption, joint stabilisation, and energy transfer throughout the kinetic chain, thereby reducing excessive stress on individual anatomical structures.

Key Injury Patterns

Several characteristic biomechanical injury patterns are observed in football. Hamstring strains commonly occur during the late swing phase of sprinting because of eccentric overload,[11] whereas ACL injuries are frequently associated with rapid deceleration, dynamic knee valgus, and pivoting movements.[13] Ankle sprains typically result from inversion injuries during landing or unstable foot placement.[15]

These injury patterns reflect the sport-specific demands of football, in which high-speed running, abrupt stopping, and rapid directional changes repeatedly challenge the musculoskeletal system.

Understanding these biomechanical mechanisms enables clinicians to identify injury risk, design targeted rehabilitation programmes, and develop effective injury prevention strategies. Video analysis and movement assessment may further assist in identifying faulty movement patterns that contribute to injury. Functional movement screening and sport-specific assessment can also detect deficits such as poor landing mechanics, impaired hip control, and asymmetrical loading, all of which may predispose athletes to injury.

Football requires a combination of endurance, speed, strength, and agility, with players frequently alternating between periods of low-intensity activity and high-intensity bursts. These fluctuations in activity create varying mechanical demands on tissues, contributing to both acute injuries and cumulative tissue overload.

Fatigue alters movement mechanics and increases susceptibility to injury. For example, reduced hip control and delayed muscle activation during fatigue may predispose athletes to hamstring strains and ACL injuries. Furthermore, repeated exposure to similar movement patterns without adequate recovery may result in the accumulation of microtrauma, thereby increasing the risk of overuse injuries.

Contributing Factors

Training Load

Sudden increases in training intensity or volume, inadequate recovery between training sessions, and poor periodisation are important contributors to injury risk.[5,9] Monitoring training load and ensuring gradual progression are essential for reducing injury incidence. Both excessive cumulative training loads and sudden spikes in workload have been associated with an increased risk of injury, highlighting the importance of appropriate workload management.

Muscle Imbalance and Fatigue

Reduced neuromuscular control, altered movement patterns, and fatigue-related biomechanical changes may increase injury risk, particularly during the later stages of play. Fatigue may result in delayed muscle activation, reduced joint stability, and impaired coordination, thereby increasing susceptibility to injury during high-demand movements.[2,12]

Playing Surface and Footwear

Hard or uneven playing surfaces may increase impact forces, while inappropriate footwear can adversely affect traction and stability. Surface characteristics, including wet natural grass and artificial turf, may also influence injury patterns.[3] Excessive traction between footwear and the playing surface may increase rotational stress across the knee, thereby contributing to ligament injuries.

Previous Injury

Previous injury remains one of the strongest predictors of future injury.[6] Residual deficits in strength, flexibility, coordination, or neuromuscular control may persist despite apparent clinical recovery. Comprehensive rehabilitation and objective return-to-play assessment are therefore essential to minimise the risk of recurrence. Failure to restore normal function before return to sport significantly increases the likelihood of reinjury, particularly following muscle and ligament injuries.

Rehabilitation Considerations

Early Management

Early management focuses on controlling pain and inflammation, protecting injured structures, and maintaining the mobility of adjacent joints. Controlled movement should be initiated early to minimise joint stiffness and facilitate tissue healing.[10] Prolonged immobilisation should be avoided whenever possible, as it may lead to muscle atrophy, joint stiffness, and delayed functional recovery.

Progressive Loading

Rehabilitation should incorporate the gradual restoration of strength and flexibility, with particular emphasis on eccentric strengthening while avoiding premature loading. Progression should be individualised according to symptom response, tissue healing, and functional capacity.[10,12] A structured transition from low-load to high-load activities promotes safe tissue adaptation and reduces the risk of reinjury.

Neuromuscular Training

Neuromuscular rehabilitation should include balance training, proprioceptive exercises, and movement control during cutting, landing, and pivoting activities. These interventions have been shown to reduce the risk of both primary and recurrent injuries. Incorporating dynamic stability, coordination exercises, and sport-specific movement retraining is essential for restoring optimal functional performance.

Sport-Specific Rehabilitation

Sport-specific rehabilitation should include a graded running progression, agility training, directional drills, and functional performance assessment before return to play. Return-to-play decisions should be based on objective functional performance rather than time since injury alone.[10] Measures such as strength symmetry, hop tests, and sport-specific performance assessments can improve the safety and quality of return-to-play decisions.

Challenges in Clinical Practice

Football-related injuries show considerable variation in presentation and recovery, influenced by individual biomechanics, training level, physical conditioning, and recovery capacity. This highlights the need for individualised assessment and rehabilitation.

Pressure for early return to play may lead athletes to under-report symptoms or resume sport before adequate recovery, increasing the risk of reinjury.

Limited access to structured rehabilitation, particularly in non-elite and community settings, may result in incomplete rehabilitation and reliance on unsupervised exercise programmes. Adherence may also be affected by limited motivation, time constraints, inadequate supervision, and inconsistent follow-up.

Conclusion

Football-related injuries predominantly affect the muscles, ligaments, and tendons of the lower limbs. Understanding their mechanisms and contributing factors is essential for effective rehabilitation and injury prevention. Structured, progressive, and sport-specific rehabilitation, together with evidence-informed return-to-play decisions and injury prevention strategies, is essential to reduce recurrence, optimise functional recovery, and support long-term athletic participation.

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Letter to Editor

The Myodural Bridge: Expanding the Patho-physiological Basis of Cervicogenic Vertigo

We read with great interest the case report by Akshay Kumar et al., "Cervicogenic Vertigo Associated with Cervical Osteophytes: A Case Report and Rehabilitation Approach." The authors are to be commended for highlighting cervicogenic vertigo as an often-overlooked cause of persistent dizziness and for demonstrating the clinical benefits of a structured rehabilitation programme. The report serves as an important reminder that persistent dizziness warrants evaluation for cervical pathology after vestibular and central neurological disorders have been excluded.

The authors attribute the patient's symptoms primarily to altered cervical proprioceptive input arising from degenerative cervical spine disease. While this mechanism is well recognized, we would like to highlight an emerging anatomical concept that may further complement this pathophysiological framework: the myodural bridge (MDB).

The MDB is a dense collagenous connective tissue complex connecting the rectus capitis posterior minor, rectus capitis posterior major, and, variably, the obliquus capitis inferior muscles to the cervical spinal dura mater through the posterior atlanto-occipital membrane.[1,2] The MDB contributes to stabilization of the cervical dura during head movement, prevention of dural infolding, maintenance of physiological dural tension, and potentially the regulation of cerebrospinal fluid dynamics through coordinated interactions between the suboccipital musculature and the craniospinal dura.[1,2,6] [Figure 1]

Cervical spondylosis, chronic neck pain, muscle guarding, restricted cervical mobility, and forward head posture may alter the biomechanics of the suboccipital musculature. Abnormal muscle contraction or persistent spasm may increase tension transmitted through the MDB to the cervical dura. Simultaneously, it may disrupt proprioceptive input from the richly innervated suboccipital muscles. This altered afferent information may contribute to abnormal integration of cervical, vestibular, and visual sensory inputs within the central nervous system. This sensory mismatch may result in dizziness, imbalance, and impaired postural control.[3,4,5]

The MDB itself should not be regarded as the primary pathological structure or as a direct therapeutic target. Current evidence does not support interventions directed specifically at the bridge. Rather, dysfunction of the suboccipital musculature appears to initiate the pathological process. Accordingly, rehabilitation strategies such as cervical proprioceptive retraining, deep cervical flexor strengthening, postural correction, suboccipital muscle relaxation, and vestibular rehabilitation may indirectly restore the mechanical and sensorimotor environment associated with the MDB. Although direct clinical evidence linking the MDB to cervicogenic vertigo remains limited, anatomical and biomechanical evidence supports its potential role in disorders including cervicogenic headache, chronic neck pain, whiplash-associated disorders, and cervicogenic dizziness.[2–6]

The present case report contributes valuable clinical evidence supporting rehabilitation-based management of cervicogenic vertigo. Incorporating the myodural bridge into future discussions may provide a broader anatomical framework linking cervical biomechanics, dural mechanics, proprioceptive dysfunction, and altered sensorimotor integration in patients with cervicogenic vertigo.

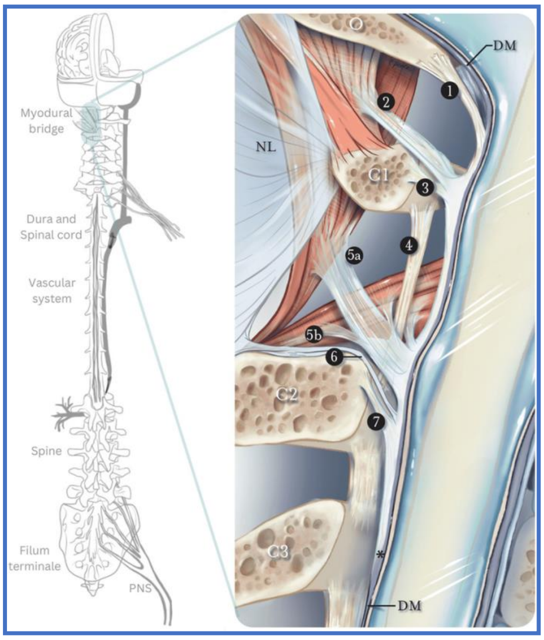

Fig. 1. The myodural bridge. Sagittal section of the myodural bridge and its connections to the dura and spine. The posterior atlanto-occipital membrane (1) extends from the occiput and coalesces with the dura mater at the craniospinal junction. The superior myodural bridge (2) merges with the superior vertebrodural ligament (3) of the atlas and fuses with the posterior atlanto-occipital membrane (PAOM) at the level of the atlanto-occipital interspace. The inferior myodural bridge, comprising the fascia of the rectus capitis posterior major (5a) and obliquus capitis inferior (5b), courses between the atlantoaxial ligamentum flavum (4) as bundles of dense fibres. The inferior myodural bridge fuses with the PAOM. The nuchal bridge (6) merges with the inferior vertebrodural bridge (7) and attaches to the PAOM. The PAOM terminates at the level of C3 after this transition point (*). The dura mater (DM) continues as an independent structure thereafter. O, occiput; C1, atlas; C2, axis; C3, third cervical vertebra; NL, nuchal ligament; PAOM, posterior atlanto-occipital membrane.[7]

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Dr Ijaz N Pillai presents a paper at 11th World Disability & Rehabilitation Conference

Dr Ijaz N Pillai, Consultant Physiatrist in Thanal Brain &Spine Medicity, Kannur, participated in the 11th World Disability and Rehabilitation Conference (WDRC 2026), held on 11–12 August 2026 in Bali, Indonesia. The conference brought together rehabilitation professionals, disability activists, policymakers, academicians, social workers, researchers, and other stakeholders from across disciplines to exchange perspectives on disability and rehabilitation.

Dr Ijaz N Pillai presented his paper titled "Attitudes, Awareness & Approach towards Disability – A Cross-Sectional Survey of the Public from South India". The study was conducted as part of the research activities of the Kerala Disability Festival, held in February 2026, which focused on promoting awareness, inclusion, accessibility, and participation of PwD in the community. The cross-sectional survey, conducted in Calicut, explored public attitudes and awareness regarding disability, including the influence of myths, misconceptions, mainstream media, and regional cinema on perceptions of disability.

Dr Anand Raja Wins First Prize at JPEF 2026 Annual Global Diabetes Convention

Dr Anand Raja, Assistant Professor in PM&R at Amrita Institute of Medical Sciences, Kochi, won First Prize in the Oral Presentation category at the JPEF 2026 Annual Global Diabetes Convention, held at Hotel Uday Samudra, Kovalam, Kerala, in July 2026.

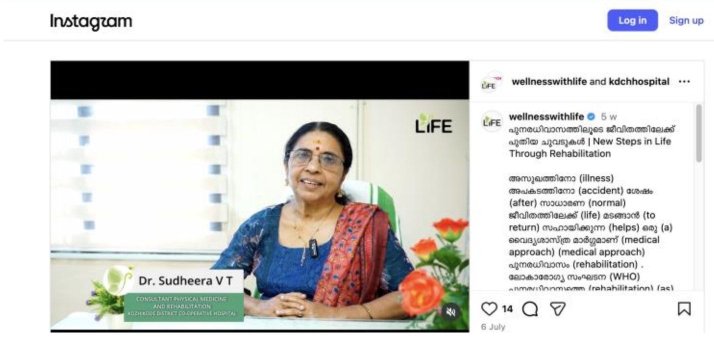
His award-winning presentation was titled "Developmental Tempo Buffering and the Global Diversity of Type 2 Diabetes Phenotypes: A Conceptual Framework." The presentation explored an evolutionary and developmental perspective on the marked heterogeneity of type 2 diabetes phenotypes across populations.

Dr Sreekala V. K. Shares Expertise on Knee Rehabilitation at Orthopaedic CME

Dr Sreekala V. K., Professor and Head of the Department of Physical Medicine & Rehabilitation, Sree Gokulam Medical College, served as a faculty speaker at the Orthopaedic CME 2026, "Master the Knee: From Fundamentals to Complex Realities," organized by the Department of Orthopaedics, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, on 2 July 2026 and delivered a presentation on "Rehabilitation of Knee Injuries," highlighting the important role of rehabilitation in the comprehensive management of knee conditions and the contribution of PMR to multidisciplinary musculoskeletal care.

District Co-operative Hospital, Kozhikode Celebrates National PMR Day

Dr Sudheera V. T., Consultant Physiatrist, District Co-operative Hospital, Kozhikode, observed National PMR Day by organizing activities to raise awareness about Physical Medicine and Rehabilitation and its role in improving function, independence, and quality of life.



The initiative provided an opportunity to engage with the community and highlight the importance of rehabilitation in the prevention and management of disability, while creating greater awareness about the scope of PMR as a specialty.

Aster MIMS Mother Hospital, Areekode, Organised Community Awareness Initiative

Dr Naeema K. and Dr Mohammed Al Majid K., Consultants in the Department of Physical Medicine and Rehabilitation (PMR), Aster MIMS Mother Hospital, Areekode, observed National PMR Day with a public awareness and experiential programme at Hilite Mall, Calicut. The initiative aimed to improve public understanding of Physical Medicine and Rehabilitation and highlight the role of multidisciplinary rehabilitation in restoring function, promoting independence, and enhancing quality of life.

As part of the programme, members of the public were introduced to the rehabilitation journey of a person with traumatic brain injury through informative leaflets and interactive sessions. Participants were also given an opportunity to experience different aspects of rehabilitation through activities representing physiotherapy, occupational therapy, and speech therapy. Disability-simulation activities offered participants an experiential understanding of some of the challenges faced by persons with disabilities, encouraging empathy and greater awareness. An interactive PMR quiz was also conducted, featuring questions on rehabilitation, disability, and the roles of members of the multidisciplinary rehabilitation team. The programme provided an opportunity for the PMR team to engage directly with the community and explain the broad scope of the specialty and the contributions of different rehabilitation professionals. A special contest, “Ability Beyond Disability,” was organized for persons with disabilities, providing a platform to showcase their talents and abilities. The initiative reinforced the message that disability does not define a person's potential, while emphasizing inclusion, participation, and empowerment.

As part of the National PMR Day celebrations, the **Advanced Regenerative Pain Clinic** was also launched under the Department of PMR at Aster MIMS Mother Hospital, Areekode, further expanding the department's services for patients with musculoskeletal and chronic pain conditions.

Dr Greeshma A. D. Serves as Faculty Speaker at Get Set Rehab 2.0

Dr Greeshma A. D., Assistant Professor in Physical Medicine and Rehabilitation, Sree Gokulam Medical College & Research Foundation, Venjarammoodu, Thiruvananthapuram, served as a Faculty Speaker at Get Set Rehab 2.0, held at Hotel Residency Towers, Thiruvananthapuram, on 5 July 2026 and delivered a presentation on “Cardiopulmonary Rehabilitation among the Elderly,” highlighting the role of rehabilitation in addressing cardiopulmonary health and functional needs among older adults. The programme was organized as part of the National PMR Day celebrations by Trivandrum Physiatrists’ Club (TPC).

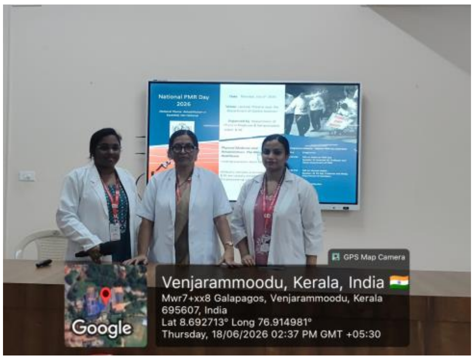
Sree Gokulam Medical College Celebrates National PMR Day

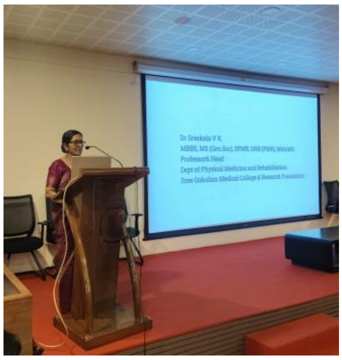
The Department of Physical Medicine & Rehabilitation, Sree Gokulam Medical College & Research Foundation, Venjaramoodu, Thiruvananthapuram, celebrated National PMR Day on 6 July with a series of academic and student-centred activities aimed at increasing awareness about Physical Medicine and Rehabilitation.

As part of the celebrations, the department organized a real-time quiz competition for final-year MBBS students and a caption contest open to all MBBS students. The winners were felicitated with certificates and cash awards by Dr Chandramohan, Dean; Dr Nandini, Principal; and Dr Krishna, Medical Superintendent.

A CME was also conducted as part of the celebrations. Dr Sreekala V. K. from the Department of PMR and Dr Abeer Abdul Razak from the Department of Psychiatry delivered academic presentations, providing perspectives from rehabilitation and mental health.

Dr Greeshma, Assistant Professor, proposed the vote of thanks, while Dr Amrutha Pria, Junior Resident, compered the programme. Faculty members and students actively participated in the celebrations, which were widely appreciated.





REVIEWER POOL

Dr Anil Kumar S DNB, DPMR
Former Chief Consultant,
Kerala State Health Services

Dr Ravi Sankaran MD PMR,
Professor & Head, Dept of PMR,
Amrita Institute of Medical Sciences,
Kochi

Dr Shiby T G MD, DNB
Professor (CAP), Dept of PMR,
Govt Medical College Thrissur

Dr Rajeena H MD PMR, DNB
Professor (CAP), Dept of PMR,
Govt Medical College Thrissur

Dr. Nitha J MD PMR
Consultant & Coordinator PMR,
KIMSHEALTH, Trivandrum

Dr Harsha P S DPMR, DSM, FIPM
Medical Officer
Sports Authority of India

A FINAL WORD

LOOKING AHEAD - NEXT ISSUE

This edition of KJPMR was themed on "Geriatric Rehabilitation". Going through the various articles, the readers may have noted the common underlying factor of how aging causes a decline in the various tissues and organ systems of the body. Thinking from the perspective of PMR, the loss of function with this inevitable physiologic process does challenge our efforts to preserve independence and quality of life.

There is a great deal of ongoing research on the possibilities of slowing down or reversing tissue damage. Regeneration is an often repeated term in this context with various interventions already in practice or in the pipeline aiming for the same. The physiatrist, of course, can never be satisfied with tissue regeneration alone. The goal ultimately is restoring a lost function to the patient.

Aiming for a scientific discussion on this rapidly evolving field, the theme for the next issue of KJPMR has been chosen as "Regenerative Medicine". We expect your continued support and encouragement.