

Musculoskeletal Rehabilitation: State-of-the-Art

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Abstract: Musculoskeletal rehabilitation has been receiving growing attention in the scientific research field taking into account the functional consequences of chronic pain that have been frequently underestimated and undertreated. The usual rehabilitative care of a wide range of diseases affecting physical function and independence in activities of daily living needs to be improved with novel approaches. In this scenario, the recent literature has highlighted the great advantages of multidisciplinary and comprehensive pain management. The Special Issue highlights the importance of advancements in musculoskeletal rehabilitation in terms of instrumental physical therapies, therapeutic exercise, osteopathic manual therapy, innovative approaches and the correlation with dentistry. Physicians should be aware of the presence of novel therapeutic approaches that are changing the clinical scenario of musculoskeletal rehabilitation.

Keywords: rehabilitation; musculoskeletal disorders; sarcopenia; osteoarthritis; pain management; physical exercise; muscles; bone



Citation: de Sire, A.; Invernizzi, M. Musculoskeletal Rehabilitation: State-of-the-Art. *Appl. Sci.* **2021**, *11*, 6243. <https://doi.org/10.3390/app11146243>

Received: 28 June 2021

Accepted: 2 July 2021

Published: 6 July 2021

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1. Introduction

Musculoskeletal rehabilitation has been receiving growing attention in the research field, not only in terms of functional recovery, but also in counteracting chronic pain. Musculoskeletal pain disorders are considered the second most common cause of disability worldwide [1]. Conventional techniques for pain management are mainly focused on pharmacological approaches [2]; however, the functional and performance consequences of chronic pain have been frequently underestimated and undertreated [3]. In this scenario, several studies [4–6] have highlighted the great advantages of multidisciplinary and comprehensive pain management approaches, including technological advancements that might play a key role in musculoskeletal rehabilitation [7].

Therefore, this Special Issue is aimed at stimulating clinical research in the area of musculoskeletal pain management, with a specific focus on emerging multitarget comprehensive rehabilitative approaches.

2. Technology Advancement

To date, technological advancements have drastically influenced rehabilitative approaches in different fields and have improved the management of patients suffering from musculoskeletal conditions substantially [8–10]. In this context, Jung et al. [11] assessed the effects of a novel gait rehabilitation system, providing functional electric stimulation controlled by deep neural networks, for hemiplegic patients. The electromyography (EMG) data related to joint torque were collected from healthy subjects during isometric contractions to recover a natural gait pattern. Interestingly, the authors found promising results in the ankle range of motion and in muscle fatigue through the stimulation of the soleus

and tibialis anterior muscles, suggesting potential clinical implications of a comprehensive rehabilitation approach combined with robotic exoskeleton devices.

Similarly, intriguing results were reported by Wu et al. [12] that assessed the effects of a joint mobilization apparatus in terms of range of motion recovery in patients with frozen shoulders. This innovative equipment was composed of pulling units, a power unit, and an adjustable structure, allowing multi-directional mobilization of the shoulder. The authors reported significant advantages of the mobilization apparatus combined with standard therapy in terms of shoulder flexion (11%), abduction (25%), internal rotation (41%), external rotation (24%), and pain score (34%) compared to standard therapy alone.

Technological advancement has also influenced the diagnosis of musculoskeletal disorders. In particular, the recent review by Mezian et al. [13] underlined the need for ultrasound in daily clinical practice to better characterize elbow pathologies and to guide mini-invasive procedures, targeting pathological areas, and avoiding vulnerable structures, such as nerves or vessels.

In this context, Bernetti et al. [14] demonstrated the role of the rasterstereographic system, Formetric 4D, in the assessment of postural adaptations in professional athletes practicing symmetric and asymmetric sports. The authors reported significant differences in the cervical ($p = 0.041$) and lumbar ($p = 0.047$) fleche of Stagnara [15], a parameter indicating the forward projection of spine curvature. The results supported the feasibility of the rasterstereographic system, Formetric 4D, combined with posture evaluation in sports athletes to assess unknown posture adaptations related to repetitive exercise-specific movements.

In this scenario, postural adaptation interventions were studied also by Picelli et al. [16] who evaluated the effects of a novel dynamic tool in sagittal plane trunk adaptations. A significant difference ($p < 0.001$) between dynamic and conventional sitting postures was recorded, suggesting a potential role for patients suffering from back pain or poor posture. However, further studies are needed to support the efficacy of the dynamic stool in musculoskeletal diseases management.

Recently, technological advancements have also drastically influenced oncological rehabilitation, providing novel orthoses, potentially effective in breast cancer-related lymphedema (BCRL) reduction. In particular, a study performed by our research group [17] introduced an innovative self-adaptive inelastic compressive device for complex decongestive therapy of patients suffering from BCRL. The results showed a significant reduction of lymphedema volume after the treatment ($p = 0.001$) and a good safety profile, suggesting potential implementation in rehabilitative approaches for lymphedema.

2.1. Instrumental Physical Therapies for Pain Management

Instrumental physical therapies are currently used as a complementary approach for the management of musculoskeletal pain [9,10,18,19]. In this scenario, transcutaneous electrical nerve stimulation (TENS) is a wide-spread physical therapy, currently used in routine clinical practice. Recently, an umbrella review of systematic reviews has been published [20], assessing the effects of TENS in patients with cervical pain. The authors included eleven systematic reviews that supported the role of TENS in short-term pain relief in both acute and chronic cervical pain.

Furthermore, another painful condition of rehabilitative interest is complex regional pain syndrome (CPRS), characterized by a continuing regional pain disproportionate in time or degree to the usual course of any lesion [21]. In this context, a recent scoping review performed by Moretti et al. [22] assessed the effects of physical therapies in treating CPRS, reporting potential benefits in terms of both pain relief and functional improvement by TENS and pulsed electromagnetic field therapy.

Moreover, percutaneous electrical nerve stimulation (PENS) has been introduced in the management of mixed chronic pain in musculoskeletal disorders [23]. Our research group recently performed a scoping review [24] assessing the state-of-the-art of this mini-invasive neuromodulation technique. Despite the high heterogeneity of the studies, PENS

effectiveness seemed to be supported by the scientific literature in the management of low back pain (LBP) and osteoarthritis knee pain not responding to conventional therapy.

2.2. Therapeutical Exercise and Osteopathic Manual Therapy

Considering that therapeutic exercise is a cornerstone of musculoskeletal rehabilitation, recent evidence has been focusing on different training modalities, including multisensory-based training, to provide advantages in motor-learning enhancements [25,26]. In particular, a recent RCT by Andrenelli et al. [27] assessed the effects of visuomotor training compared with standard rehabilitation. Interestingly, the results showed that physical therapy programs, including visuomotor training, could provide significantly faster improvements in terms of functional recovery when compared to standard physical therapy alone in patients with post-surgery musculoskeletal conditions.

Furthermore, effects of different types of exercise training were assessed by Agten et al. [28], who compared high-intensity training to moderate-intensity training in patients suffering from unspecific chronic LBP. The authors focused on muscle fiber type composition of lumbar multifidus. The exercise protocol was composed of cardiorespiratory training associated with full-body resistance and core muscle training 2 times/week for 12 weeks at different intensities. The authors reported significant differences ($p < 0.05$) in terms of muscle area occupied by type II muscle fibers, supporting the potential role of high intensity training (HIT) in the promotion of the glycolytic process of energy biogenesis in multifidus muscle; however, the effects of HIT on reducing non-specific chronic LBP have still to be clarified.

Osteopathic manual therapy is currently used in the clinical practice of musculoskeletal rehabilitation, albeit, given the difficulty in standardization, its effects on pain relief are still debated. Thus, a systematic review by Vanti et al. [29] showed the effectiveness of manual osteopathic procedures, such as pump techniques and pompages in musculoskeletal disorders. The authors underlined that, despite the presence of heterogeneity in the included studies, pump techniques might reduce pain in several painful conditions related to musculoskeletal disorders.

2.3. Innovative Musculoskeletal Approaches

Some innovative musculoskeletal approaches have been proposed by authors in the present Special Issue, including the Alexander technique and acupressure.

The Alexander technique is a widely used awareness-building method to teach participants to reduce habitual tension during activities of daily living (ADL) [30]. In this context, Becker et al. [31] recently assessed the role of exercise targeting neck pain using the Alexander technique, a non-exercise modulation of postural muscle activity characterized by preventing excessive contraction of postural muscles. The authors reported that the Alexander technique was at least as effective as exercise-specific training for reducing neck pain; however, the effects must be clarified in terms of posture modulation.

Another interesting technique used for the management of musculoskeletal disorders, such as osteoarthritis, is acupressure. A recent systematic review with meta-analyses performed by Ang et al. [32] assessed the efficacy of acupressure in the management of osteoarthritis, without reporting any significant improvements in terms of pain relief or physical function. Thus, the authors concluded that acupressure is not supported by clear evidence in the management of osteoarthritis.

2.4. Dentistry and Rehabilitation

To date, a stomatognathic system has been proposed to have a key role in postural adaptations related to several painful musculoskeletal diseases. In this scenario, the study by Ginszt et al. [33] recently assessed the effects of myofascial compression techniques in the stomatognathic system. The results of the study underlined the significant effects in resting activity ($p = 0.006$) and clenching activity ($p = 0.014$) of the masseter muscle after a standardized compression technique over the myofascial trigger point. Despite several techniques being described to have a role in stomatognathic system rehabilitation (includ-

ing myofascial release, acupuncture, soft tissue mobilization) [34], the results supported the effectiveness of myofascial compression techniques; however, the long term effects of this treatment should be still clarified.

Finally, a musculoskeletal rehabilitative approach has also been introduced in the regeneration of nerve injuries after oral surgery procedures, including type I collagen-based device application. Rocuzzo et al. [35] performed a systematic review assessing the current evidence on the use of type I collagen-based devices in the regeneration of mandibular or lingual nerve injuries. Surprisingly, only four studies were included in the review, with positive results in terms of sensorial improvements. Despite the low level of evidence, the authors affirmed that collagen might play a crucial role in the enhancement of nerve regeneration after oral surgery procedures. Nevertheless, further clinical trials are necessary to support this approach.

3. Conclusions

Taken together, the studies included in the Special Issue highlight the importance of technological advancements in musculoskeletal rehabilitation, to improve the usual care of a wide range of diseases affecting physical function and independence in ADL. In addition, a comprehensive rehabilitative approach, including different therapeutic strategies, should be taken into consideration, starting from patient characteristics. In light of these considerations, physicians should be aware of the presence of novel therapeutic approaches that are changing the clinical scenario of musculoskeletal rehabilitation.

Author Contributions: Both authors have contributed equally to the development of this editorial. Both authors have read and agreed to the published version of the manuscript.

Funding: This editorial received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We would like to thank all the authors contributing to our Special Issue. Moreover, we extend our sincere appreciation of the hard work of Frederic Yuan and of the entire editorial team of *Applied Sciences*.

Conflicts of Interest: The author declares no conflict of interest.

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