



Case Report

High intensity resistance training as intervention method to knee osteoarthritis



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ABSTRACT

High intensity resistance training (HI-RT) is a treatment option for Knee Osteoarthritis (KOA). Isotonic machines (leg press, leg extension) are utilized for standardization and reproducibility reasons, but the load used during the protocol is often low, considering that elder people usually have low strength levels, training so with high intensities calculated on low loads. The physiological response of an elder woman trained with high loads on a free weight exercise, the regular barbell deadlift, with a 1 Repetition Maximum (1RM) of 100 kg, can be appreciated in this report, so that for the first time we can see the effect of a one year of high intensity resistance training program on a powerlifting exercise on a 72 year-old woman with KOA. A Western Ontario and McMaster Universities Arthritis Index (WOMAC) questionnaire was administered before starting the training program (T0) and after 1 year of training, as long as a control RX, to evaluate the effect of HI-RT on joint functionality and quality of life.

Introduction

Osteoarthritis is a disease characterized by degeneration of cartilages and its underlying bone within a joint as well as bony overgrowth: today it represents one of the major causes of disability, observed more in women than in men, and this condition is considered nonreversible.^{1,2}

Symptoms like joint pain and stiffness, loss of flexibility, grating sensation, swelling and tenderness are common signs of osteoarthritis that usually progress, even slowly over years, causing increasing levels of disability in the elder population.

Physical activity has been validated as a tool to reduce pain, improve autonomy and function, and maintain a proper range of motion and flexibility of the joint, applying a variety of stimuli such as aerobic and aquatic training, flexibility and stretching, balance and proprioception but also strength training.^{2–14}

In this case report it seems to emerge that high intensity resistance training, with compound barbell exercises such as the powerlifting deadlift with high loads on the barbell, is compatible with physical training prevention and rehabilitation program for patients with KOA.

Methods

The patient is a 72 year-old woman, 80 kg of body weight and 160 cm of height without other illnesses complaining a daily knee pain: a first RX taken in November 2016 showed medial joint stress with meniscal suffering and reshaping of the bone (Fig. 1). The pain was reported on a daily basis and the Western Ontario and McMaster Universities Arthritis Index (WOMAC) score was equal to 43%.

We started an initial training program, composed of aerobic training of moderate intensity on a bike (20 min at 65%–70% of Maximum Heart Rate), joint mobility, sensorimotor control, isometric and open-chain training for the lower limb for four weeks.

After this initial conditioning program, we added a resistance training protocol composed of quadrabar barbell deadlift, with an eight weeks linear progression starting from 30 kg and reaching 60 kg.

In February 2017 we progressed to the powerlifting regular deadlift: to achieve a proper technique on the exercise, the patient trained twice a week with a first session focused on analytic training on partial phases of the lift and a second one with a global approach with a light load and slow tempo.

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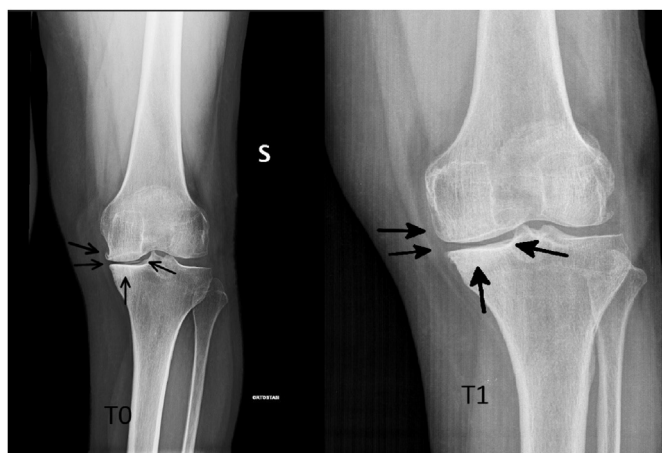


Fig. 1. Left image baseline RX, November 2016; right image control RX, August 2018.

Fig. 2 shows the patient during the initial and final phases of the lift, and during competition.

From this point, we started an undulated periodization for 12 months, with a lighter day focused on technique (55%–65% of 1 RM) and a heavier training session (70%–90% of 1 RM). In February 2018 the patient was able to conquer her Italian master IV record during a national deadlift competition with 100 kg on the barbell.

In August 2018 we required a second RX for checking the joint response to this kind of heavy resistance training. We also administered a new WOMAC questionnaire. From February to August the patient kept her regular training routine with an undulated periodization.

RX analysis showed a clear joint morphology reshaping with more functional load distribution, a wider medial joint space and a reduction of bone rarefaction (Fig. 1), with a –34% concomitant reduction in the WOMAC Osteoarthritis Index for a final 9% score (Table 1).

The reduction in WOMAC pain, stiffness and function scores are consistent with other High Intensity Resistance Training (HI-RT) studies,^{7,11,13} but the main difference consists in the use of a multi-joint barbell exercise starting from a basic practice but that led to an excellent result in a competitive sport such as powerlifting.

The evident reduction in Joint Space Narrowing (JSN) seems to be a new finding, considering that the evidence collected only shows a slowing in JSN progression with HI-RT and not a reversion.²

The patient gave informed consent before starting the study.

Discussion

It seems that KOA can not only slow down but even shows an improvement in response to regular strength training both from a

Table 1

Baseline and Western Ontario and McMaster Universities Arthritis Index questionnaires.

WOMAC Questionnaire	Pain	Stiffness	Impact on Quality of life	Overall
T0 – November 2016	10	6	28	45.8%
T1- August 2018	2	2	5	9.4%
Overall reduction	–80%	–66.6%	–82.1%	–36.4%

morphological and functional perspective and consequently in symptoms intensity.

It is possible that JSN can be slowed and possibly reversed via strength training; we hypothesize an effect of rebalancing leg muscle activation patterns, strengthening weak muscle groups that result in a more centered alignment of the joint; joint also benefits of more cartilage growth factors production (e.g. Transforming Growth Factor beta, TGF-β) due to mechanical loading.^{12,14}

Given the high heterogeneity in KOA condition and the necessary training and supervision to proper use barbell exercises instead of isotonic machines for resistance training, this program cannot be generalized nor thought of as a gold standard; but this case report highlights how under the supervision of trained and experienced personnel, compound movements such as the barbell regular deadlift could be used in selected population as an alternative option to isotonic machine training.

The classic treatment approach to KOA through strength training is usually composed of balance and aquatic exercises, low intensity aerobic training and selective quadriceps reinforcement^{3–6}; in this case report we can see that given a proper technique and necessary supervision, even free weights exercise like the powerlifting barbell deadlift, even with high loads, can be very beneficial for KOA remission and it could become a part of the normal life of the subject (becoming, in this case, a pleasant hobby).

The strength of this finding is represented by the high load used and long competitive training time without any injury or negative findings, but important limits are that we've analyzed a single patient, the need for expert supervision and proper patient instruction to reproduce a similar situation in further studies.

Conclusions

More studies are needed to highlight the potential risks and benefits of free weight exercise implementation in a regular strength training program for KOA treatment in the elder population, using both high intensity and high load, and to state that osteoarthritis can ameliorate even in the elder population.

The evident reduction in JSN may be the first step, at least, to consider this protocol as a valid alternative, considering that most of the evidence



Fig. 2. On the left: the patient during the 2 phases of the regular deadlift; on the right: the patient lifting 100 kg in competition.

collected, only shows a slowing in JSN progression with HI-RT and not a reversion.²

Ethical approval statement

The authors declare, according with Medical School, they acted following Declaration of Helsinki.

Consent for publication

The patient provided written informed consent for the publication of the present case report.

Submission statement

The manuscript has not been published and is not under consideration for publication elsewhere.

Authors' contributions

AM wrote the paper. MM and MB supervised training program, SC and AC evaluate clinical History and patient progress, RC wrote the paper and supervised all the process.

Conflict of interest

None of the authors have relevant interests to disclose.

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References

- Vina ER, Kwok CK. Epidemiology of osteoarthritis: literature update. *Curr Opin Rheumatol*. 2018 Mar;30(2):160–167. [https://doi: 10.1097/BOR.0000000000000479](https://doi.org/10.1097/BOR.0000000000000479).
- Vincent KR, Vincent HK. Resistance exercise for knee osteoarthritis. *Pharm Manag PM R*. 2012 May;4(5):S45–S52. [https://doi: 10.1016/j.pmrj.2012.01.019](https://doi.org/10.1016/j.pmrj.2012.01.019).
- Nguyen C, Lefèvre-Colau MM, Poiraudou S, Rannou F. Rehabilitation (exercise and strength training) and osteoarthritis: a critical narrative review. *Ann Phys Rehabil Med*. 2016 Jun;59(3):190–195. [https://doi: 10.1016/j.rehab.2016.02.010](https://doi.org/10.1016/j.rehab.2016.02.010). Epub 2016 May 5.
- Goh SL, Persson MSM, Stocks J, et al. Relative efficacy of different exercises for pain, function, performance and quality of life in knee and hip osteoarthritis: systematic review and network meta-analysis. *Sports Med*. 2019 May;49(5):743–761. [https://doi: 10.1007/s40279-019-01082-0](https://doi.org/10.1007/s40279-019-01082-0). PMID: 30830561.
- Kraus VB, Sprow K, Powell KE, et al. Physical activity guidelines advisory committee*. Effects of physical activity in knee and hip osteoarthritis: a systematic umbrella review. *Med Sci Sports Exerc*. 2018;51(6):1324–1339. [https://doi: 10.1249/MSS.0000000000001944](https://doi.org/10.1249/MSS.0000000000001944). PMID: 31095089.
- Wellsandt E, Golightly Y. Exercise in the management of knee and hip osteoarthritis. *Curr Opin Rheumatol*. 2018 Mar;30(2):151–159. [https://doi: 10.1097/BOR.0000000000000478](https://doi.org/10.1097/BOR.0000000000000478). PMID: 29251659.
- Lange AK, Vanwanseele B, Fiatarone Singh MA. Strength training for treatment of osteoarthritis of the knee: a systematic review. *Arthritis Rheum*. 2008;59:1488–1494. <https://doi.org/10.1002/art.24118>.
- Lange AK, Vanwanseele B, Fiatarone Singh MA. Strength training for treatment of osteoarthritis of the knee: a systematic review. *Arthritis Rheum*. 2008 Oct 15;59(10):1488–1494. [https://doi: 10.1002/art.24118](https://doi.org/10.1002/art.24118). PMID: 18821647.
- Mikesky AE, Mazzuca SA, Brandt KD, Perkins SM, Damush T, Lane KA. Effects of strength training on the incidence and progression of knee osteoarthritis. *Arthritis Rheum*. 2006 Oct 15;55(5):690–699. [https://doi: 10.1002/art.22245](https://doi.org/10.1002/art.22245). PMID: 17013851.
- Vincent KR, Vincent HK. Resistance exercise for knee osteoarthritis. *Pharm Manag PM R*. 2012 May;4(5):S45–S52. [https://doi: 10.1016/j.pmrj.2012.01.019](https://doi.org/10.1016/j.pmrj.2012.01.019).
- Turner MN, Hernandez DO, Cade W, Emerson CP, Reynolds JM, Best TM. The role of resistance training dosing on pain and physical function in individuals with knee osteoarthritis: a systematic review. *Sport Health*. 2020 Mar/Apr;12(2):200–206. [https://doi: 10.1177/1941738119887183](https://doi.org/10.1177/1941738119887183).
- Miller MS, Callahan DM, Tourville TW, et al. Moderate-intensity resistance exercise alters skeletal muscle molecular and cellular structure and function in inactive older adults with knee osteoarthritis. *J Appl Physiol*. 1985;122(4):775–787. [https://doi: 10.1152/jappphysiol.00830.2016](https://doi.org/10.1152/jappphysiol.00830.2016). Epub 2017 Jan 12.
- Turner MN, Hernandez DO, Cade W, Emerson CP, Reynolds JM, Best TM. The role of resistance training dosing on pain and physical function in individuals with knee osteoarthritis: a systematic review. *Sport Health*. 2020 Mar/Apr;12(2):200–206. [https://doi: 10.1177/1941738119887183](https://doi.org/10.1177/1941738119887183).
- Ruhdorfer A, Wirth W, Eckstein F. Association of knee pain with a reduction in thigh muscle strength - a cross-sectional analysis including 4553 osteoarthritis initiative participants. *Osteoarthritis Cartilage*. 2017 May;25(5):658–666. [https://doi: 10.1016/j.joca.2016.10.026](https://doi.org/10.1016/j.joca.2016.10.026).