

Modern Non-Pharmacological and Non-Surgical Treatments for Hip Pain

Paul Y F Lee^{1*}, Sam Rozewicz², Mallikarjun Honnenahalli chandrappa¹, Ahmed Othman³, Christian Jury⁴ and Bethan Whiting²

¹Lincolnshire Elective Orthopaedics Institute, Grantham and District Hospital, Manthorpe Road, Grantham, NG31 8DG, UK

²South Wales Orthopaedics Research Network, Welshbone, Princess of Wales Hospital, Coity Road, Bridgend, CF31 1RQ, UK

³Trauma and Orthopaedics Department, Grantham and District Hospital, Manthorpe Road, Grantham, NG31 8DG, UK

⁴Route Du Fort Surgery, Lido Medical Centre, St Saviour, Jersey, JE2 7LA, UK

*Corresponding author: Paul Y F Lee, Lincolnshire Elective Orthopaedics Institute, Grantham and District Hospital, Manthorpe Road, Grantham, NG31 8DG, UK, Tel: 447764614688; E-mail: paullee1@nhs.net

Received date: November 20, 2017; Accepted date: December 28, 2017; Published date: January 05, 2018

Copyright: © 2018 Lee PYF, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Osteoarthritis of the hip describes a clinical syndrome of joint pain accompanied by varying degrees of functional limitation and reduced quality of life. Osteoarthritis may not be progressive and most patients will not need surgery, with their symptoms adequately controlled by non-surgical measures. The treatment of hip osteoarthritis is aimed at reducing pain and stiffness and improving joint mobility. Total hip replacement remains the most effective treatment option but it is a major surgery with potential serious complications. NICE guideline has suggested a holistic approach to management of hip osteoarthritis which includes both nonpharmacological and pharmacological treatments. The non-pharmacological treatments range from education, physical therapy and behavioral changes, walking aids. The ESCAPE (Enabling Self-Management and Coping of Arthritic Pain Through Exercise) rehabilitation programme for hip and knee osteoarthritis which integrates simple education, self-management and coping strategies, with an exercise regimen has shown to be more cost-effective than usual care. There is a choice of reviewed pharmacological treatments available, but there are few current reviews of possible non-pharmacological methods. This review will focus on the non-pharmacological and non-surgical methods.

Keywords: Hip pain; Non-pharmacological; Non-surgical; Treatments; Unloader

Introduction

Hip pain is a major cause of disability in adults. By far the most common cause is osteoarthritis (OA) of the hip, with the prevalence in UK adults estimated in one study to be 6.3% in males and 10.3% in females [1-3]. It has a significant impact on a patient's life, impeding their ability to walk and reducing their quality of life [4].

Around 450 patients per 100,000 populations will present to primary care with hip pain each year. Of these, 25% will improve within three months and 35% at twelve months; this improvement is sustained. OA of the hip describes a clinical syndrome of joint pain accompanied by varying degrees of functional limitation and reduced quality of life. OA may not be progressive and most patients will not need surgery, with their symptoms adequately controlled by non-surgical measures. Symptoms progress in 15% of patients within 3 years and 28% within 6 years [1-4].

According to the Osteoarthritis Research Society International (OARSI) guidelines, treatment is aimed at reducing pain and stiffness, maintaining and improving joint mobility, reducing disability, improving quality of life, limiting the progression of damage and educating patients about the disorder [5]. There are a range of pharmacological treatments, from analgesia with paracetamol, NSAIDs and opiates to intra-articular steroid injections [6]. However, surgery remains the only definitive treatment. Although conservative surgical methods include pelvic or femoral osteotomy, the mainstay of surgical management is joint replacement; total hip arthroplasty

(THA) is one of the most commonly performed and successful operations [6,7].

However, THA is not a perfect solution. Revision rates in the UK have been found to be up to 4% across four commonly used types of prosthesis, and higher when using a fifth [8]. Furthermore, not all patients are happy with their outcome – 7% of patients in a recent study were found to be dissatisfied with the results of this operation [9]. Additionally, whilst THA is one of the best operations, it may not be suitable for everyone, especially younger patients who will be more likely to require a revision and less likely to be recover comparable function to others in their age group [10]. There is the need, therefore, to consider alternate solutions, if not to replace the need for THA, but to, at the least, delay surgery and thereby reduce the likelihood of revision. The ESCAPE rehabilitation programme for hip and knee osteoarthritis which integrates simple education, self-management and coping strategies, with an exercise regimen has shown to be more cost-effective than usual care.

As described above, there is a choice of reviewed pharmacological treatments available, but there are few current reviews of possible non-pharmacological methods [6]. This review will therefore focus on the non-pharmacological and non-surgical methods, upon which there has been relatively less research carried out.

Management Options

Topical agents

While topical agents such as NSAID creams that can be effective for OA are likely to be considered a pharmacological intervention and therefore beyond the scope of this review, others such as capsaicin can

be viewed among alternate medicines, and therefore warrant discussion [11].

Capsaicin is the compound in 'chili' peppers that creates the sensation of heat when bound to nociceptors in the skin. When in topical creams and gels, it has been shown to be effective as an analgesic for chronic pain conditions [12]. It is recommended for use in several guidelines for hand and knee OA, although the evidence for this stems from very few randomised-controlled trials [5,13,14]. An advantage is the lack of systemic side-effects, but it may cause localised burning and erythema at the site of application [15]. However, despite its potential effectiveness in OA of other joints, it is not recommended in hip OA guidelines and there is no evidence to support its use [6]. Indeed, none of the topical therapies currently recommended for use in either hand or even knee joints are recommended for use in hips [5,6]. This is likely to be a function of the anatomy of the hip joint where it is further below the surface and therefore less likely to be affected by agents applied to the skin above.

Copper and magnetic agents

Two other therapies that have been proposed are copper or magnetic bracelets. Both have been claimed to be effective at reducing pain and improving function. However, few studies have been carried out to verify these claims, and there is yet to be proposed a plausible mechanism of action to support the effect of these. In a randomised placebo-controlled crossover trial, neither copper bracelets nor magnetic ones were found to be effective at managing pain, reducing stiffness or maintaining physical function for any joint that may be affected by OA, let alone specifically the hip [16]. This reflected the findings of a separate study evaluating the use of copper-salicylate gel applied to the forearms [17]. Indeed, whilst this found no demonstrable improvement in either hip or knee OA compared to placebo, it did lead to significantly more adverse effects, mostly in the form of skin rashes. It is clear, therefore, why there is no recommendation for the use of either of these therapies in hip OA.

Acupuncture

Another therapy that has its roots in complementary medicine is acupuncture. Unlike copper and magnetic agents, however, potential mechanisms of action have been proposed: acupuncture needles can stimulate the nervous system to release neurotransmitters involved in pain-suppressing mechanisms [18,19]. A recent Cochrane systematic review found that while patients undergoing acupuncture found significant differences in pain and function compared to sham-acupuncture (a technique used to minimise placebo effects and show the true biological effects of acupuncture), these differences were small and did not meet clinically relevant levels [20]. They concluded that these differences were more likely to be due to incomplete blinding and poor quality trials rather than the effects of the acupuncture itself.

With regards specifically to Hip OA, the review identified three trials evaluating the use of acupuncture in management of hip OA, one of which was evaluating the use of electro acupuncture as opposed to the traditional needle methods [21-23]. However, the studies were deemed to be too heterogenous to be included in a meta-analysis. Across all three studies there was a high drop-out rate (almost 50% in one case). Only one study found a difference in pain and function between acupuncture and control groups. This was found after a shorter follow-up than the other two studies (14 weeks v. 6 months), which may

reduce the validity of their findings when considered over the long time period that hip OA affects patients.

Oral Supplements

A number of oral supplements have been suggested as either improving the symptoms of OA (pain and loss of function) or modifying the structures involved (for example the joint-space).

Chondroitin

Chondroitin is a glycosaminoglycan found in cartilage, bone, cornea, skin and arterial walls. It has been suggested to restore the extracellular matrix of cartilage, reducing degradation in OA, and provide sulphur-containing amino acids that are essential for the cartilage extra-cellular matrix, which may be deficient from regular diets [24,25]. A systematic review of chondroitin found that chondroitin had small to moderate effects on pain and physical function in patients with OA, which were clinically significant [26]. It also noted the lower risk of adverse events in patients taking chondroitin supplementation. However, there was some heterogeneity across the studies that were included. Though most studies used a daily 800mg or greater dose of chondroitin, some used a lower dose. A further issue is that while the review included a wide range of studies, only one of them specifically assessed the use of chondroitin in hip OA [27]. A separate meta-analysis focusing specifically on hip and knee OA found that chondroitin had no clinically relevant effect on joint pain or on the joint space compared with placebo [28]. They did, however, note that many patients were convinced that it was beneficial and concluded that as it was safe, patients could take it at their own expense, rather than that of the NHS.

Glucosamine

Glucosamine is an amino-saccharide acting as the substrate in the synthesis of aggrecan and proteoglycans for cartilage. It is thought that it may be beneficial in OA by inhibiting catabolic genes for cartilage [29]. Like chondroitin, it is an unregulated supplement and there is controversy regarding its use in the treatment of OA [30]. The supplement has been the subject of several systematic reviews. One review found, from pooled results, that there may be improvements in pain and function with glucosamine. However, when including only the high-quality studies, they found that whilst glucosamine is likely to be safe, it did not produce any benefit with regards to pain management or physical function [31]. This finding was mirrored in a more recent systematic review specifically assessing the effect on knee and hip OA, concluding that there was no clinical effect on pain or the joint space [28].

Collagen

Collagen, when taken as collagen hydrolysate, has been suggested to protect cartilage, even in patients with symptomatic OA [32]. A randomised controlled trial comparing patients taking 1200mg of collagen hydrolysate with placebo found that while pain visual-analogue scale scores were improved at least 20%, there was no difference in health-related quality of life which indicated that there were no side effect associated with taking collagen [33]. This finding was mirrored in a systematic review which concluded that despite some studies that found similar benefits to acetaminophen, which is recommended by OARSI guidelines for hip OA, the number of high

quality studies reporting positive results was emerging to promote the use of collagen hydrolysate in hip OA [5,32].

Weight loss

Weight loss, in obese and over-weight patients, is suggested as one of the best non-pharmacological and non-surgical measures to take for the treatment of knee pain [6]. It has been suggested that recommending patients to lose 5-10% of their weight would lead to a 26% reduction in pain from knee OA through the reduced load and burden on the joint [34]. However, the evidence that it is as effective in patients with osteoarthritic hip pain is less clear. There is a clear plausible mechanism, whereby the reduced load through the joint reduces stress on it, reducing pain, and there may be a cumulative effect where some weight loss allows better function for exercise, which allows further weight loss and subsequent improvements. However, one systematic review found too few studies on hip OA to make any firm conclusions, while another highlighted the need for more high-quality studies into the effect of weight loss for hip OA [35,36]. Nonetheless, it remains a key recommendation in the OARSI guidelines for OA of the hip based largely on expert opinion and evidence from case-control studies [5].

Osteopathy

Osteopathy, the use of touch, physical manipulation, stretching and massage, is aimed at increasing the mobility of joints [37]. There have been suggestions that through skin stimulation over the affected sites, osteopathy can be effective at managing the pain from hip OA [38]. However there is a distinct lack of evidence to support these claims: this review could identify no trials, randomised or otherwise, of the effect of osteopathic medicine. As such, there is yet to be made a recommendation for its use in the treatment in guidelines from any institution, and, thus, it should not be considered in the management of hip OA [5,39].

Physical therapy

The aim of physiotherapy in hip OA is to increase the range of movement of the leg and reduce the associated pain. This is achieved currently with a mixture of exercises to strengthen the muscles around the joint, stabilizing it and manual therapy to improve the mobility of the joint capsule and the surrounding tissue [40]. However, its use in the past has largely been based on expert consensus rather than a research base. There have been several recent systematic reviews to evaluate the use of physiotherapy in the management of hip OA, all looking at the use of exercise therapy and manual therapy together or manual therapy alone.

With regards to exercise therapy, while it was noted that there was a paucity of high-quality evidence over long-term periods, two reviews found that group classes or home exercises were effective at managing the pain associated with Hip OA [40,41]. One study found that a 12-week exercise programme, where patients performed exercises two to three times a week, reduced the need for THR by up to 44% [42]. It may also have a role in supporting weight loss, the benefits of which are described above. These findings were mirrored in a Cochrane review that also suggested there was clear benefit to exercise programmes [43].

There were, however, contrasting findings regarding manual therapy across the reviews. One review found what they suggested was low-quality evidence that the use of manual therapy alongside exercise

therapy could be beneficial for both pain and physical function [40]. The remaining reviews, including the one that focused specifically on manual therapy alone found that there was no benefit from it, either with regards to the management of pain or the mobility and function of the hip [41,44].

The ESCAPE(Enabling Self-Management and Coping of Arthritic Pain Through Exercise) evidence-based, NICE-recommended group rehabilitation programme for hip and knee osteoarthritis integrates simple education, self-management and coping strategies, with an exercise regimen individualised for each person has shown to be more cost-effective than usual care with reductions achievement of overall health and social care utilisation of £1,118 per person per annum post-programme , may help delay or avoid surgery, promotes physical activity, reducing the risk of acquiring or exacerbating comorbidities such as diabetes and cardiovascular conditions .

Walking aids

The use of a cane contralateral to the affected side, walking with the affected limb and cane in tandem, is perceived to be beneficial by both patients and healthcare professionals alike [45]. A cane can reduce the compressive forces going through the hip by as much as 20-30% [46]. However, a study found no difference with regards to pain, stiffness or physical function after four weeks of using a cane [47]. The authors suggest that this may be the result of suboptimal use. Poor technique may mean that patients are not offloading the weight from their hip effectively. Alternatively, patients may not use the cane as frequently as recommended as they felt that the canes were difficult or risky to use. However, they found that the majority of patients felt that the cane was useful as an aid to balance. Further study is necessary to ascertain whether current recommendations for the use of the cane should be upheld [48].

Hip braces

Unlike the management of OA of the knee, where recommendations in guidelines for the use of braces and orthoses are now commonplace, there has been far less research in to the potential benefits of bracing the hip joint [5]. However, recent developments in producing hip braces look promising.

One such brace is the S-form WISH-type hip brace (Figure 1), developed by the Wakamaya Medical College. It is designed to reinforce the hip joint in movement, correct inadequate positioning of the limb and reduce outward movement of the femoral head [49,50]. It has been shown to reduce pain immediately when used during walking. One study found that the brace could improve functional mobility, as measured by the Timed Up and Go Test. Patients were timed as they stood up from a chair, walked 3m, round a cone and back to sit down. Those with hip OA wearing the brace were significantly faster at completing the exercise than those not [50]. It has also been suggested that with long term use to aid exercise can produce benefits in function later on, even when removed [51].

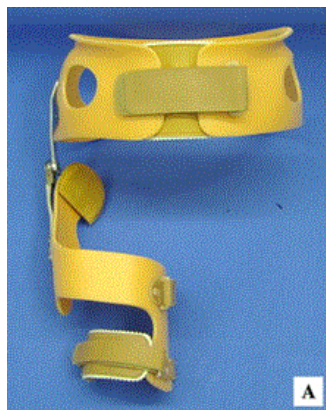


Figure 1: Wish-type S-form hip brace (Wakamaya Medical College).

An alternative proposed brace is the Unloader Hip Brace (Figure 2), developed and produced by Ossur. The brace is aimed at increasing hip external rotation and abduction with an elastic strap that wraps around the lower thigh in a medial to lateral, distal to proximal direction [52]. Whilst it is a very recent development, early study of the brace looks promising: it effectively appears to decrease levels of internal abduction, which is a major contributor to the compressive forces through the joint. This may lead, as it did immediately in some of the study patients, to reduced pain whilst wearing the device during walking [53,54]. There is, of course, the need for more in-depth study of the characteristics and effects of the brace, though it may become an attractive management plan to delay the need for THR.



Figure 2: Unloader hip brace (Ossur).

Conclusion

There is a vast range of non-pharmacological, non-surgical options available for the management of hip OA. The evidence base for some of the complimentary medicines suggests that, while they, by-and-large, may not be harmful, they are not likely to be effective and should not be prescribed. Nevertheless, there are many useful options that should be considered.

Given the larger size of the hip joint compared to other joints susceptible to OA, and its relative deep-lying position in the body, certain therapies such as topical creams that are very effective in other

forms of OA do not have as much effect in the hip. The same, however cannot be said for physical therapy and weight-loss. Referral to a physiotherapist who can provide specific exercises to strengthen the hip joint and allow for weight loss should be a vital part of the management plan and can significantly delay the need for THR. With stronger evidence base, there is the possibility that braces may soon be able to play a significant part in this, and further delay the need for surgery. This should therefore become a focus of future research, with a long-term study evaluating the effect of wearing a brace on pain, physical function and mobility.

References

1. Frankel S, Eachus J, Pearson N, Greenwood R, Chan P, et al. (1999) Population requirement for primary hip-replacement surgery: a cross-sectional study. *Lancet* 353: 1304-1309.
2. Dawson J, Linsell L, Zondervan K, Rose P, Randall T, et al. (2004) Epidemiology of hip and knee pain and its impact on overall health status in older adults. *Rheumatology (Oxford)* 43: 497-504.
3. Birrell F, Lunt M, Macfarlane G, Silman A (2005) Association between pain in the hip region and radiographic changes of osteoarthritis: results from a population-based study. *Rheumatology (Oxford)* 44: 337-341.
4. Hopman-Rock M, Kraaijaat FW, Bijlsma JW (1997) Quality of life in elderly subjects with pain in the hip or knee. *Qual Life Res* 6: 67-76.
5. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, et al. (2008) OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis Cartilage* 16: 137-162.
6. Aresti N, Kassam J, Nicholas N, Achan P (2016) Hip osteoarthritis. *BMJ* 354: i3405.
7. de l'Escalopier N, Anract P, Biau D (2016) Surgical treatments for osteoarthritis. *Ann Phys Rehabil Med* 59: 227-233.
8. Kandala NB, Connock M, Pulikottil-Jacob R, Sutcliffe P, Crowther MJ, et al. (2015) Setting benchmark revision rates for total hip replacement: analysis of registry evidence. *BMJ* 350: h756.
9. Anakwe RE, Jenkins PJ, Moran M (2011) Predicting dissatisfaction after total hip arthroplasty: a study of 850 patients. *J Arthroplasty* 26: 209-213.
10. Polkowski GG, Callaghan JJ, Mont MA, Clohisy JC (2012) Total hip arthroplasty in the very young patient. *J Am Acad Orthop Surg* 20: 487-497.
11. De Silva V, El-Metwally A, Ernst E, Lewith G, Macfarlane GJ, et al. (2011) Evidence for the efficacy of complementary and alternative medicines in the management of osteoarthritis: a systematic review. *Rheumatology (Oxford)* 50: 911-920.
12. Mason L, Moore RA, Derry S, Edwards JE, McQuay HJ (2004) Systematic review of topical capsaicin for the treatment of chronic pain. *BMJ* 328: 991.
13. Zhang WY, Li Wan Po A (1994) The effectiveness of topically applied capsaicin. A meta-analysis. *Eur J Clin Pharmacol* 46: 517-522.
14. Jordan KM, Arden NK, Doherty M, Bannwarth B, Bijlsma JW, et al. (2003) EULAR Recommendations 2003: an evidence based approach to the management of knee osteoarthritis: Report of a Task Force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). *Ann Rheum Dis* 62: 1145-1155.
15. Altman RD, Aven A, Holmburg CE, Pfeifer LM, Sack M, et al. (1994) Capsaicin cream 0.025% as Monotherapy for Osteoarthritis: A double-blind study. *Seminars in Arthritis and Rheumatism* 23: 25-33.
16. Richmond SJ, Brown SR, Campion PD, Porter AJ, Moffett JA, et al. (2009) Therapeutic effects of magnetic and copper bracelets in osteoarthritis: a randomised placebo-controlled crossover trial. *Complement Ther Med* 17: 249-256.
17. Shackel NA, Day RO, Kellett B, Brooks PM (1997) Copper-salicylate gel for pain relief in osteoarthritis: a randomised controlled trial. *Med J Aust* 167: 134-136.

18. Lewith GT, Kenyon JN (1984) Physiological and psychological explanations for the mechanism of acupuncture as a treatment for chronic pain. *Soc Sci Med* 19: 1367-1378.
19. Han JS (2003) Acupuncture: neuropeptide release produced by electrical stimulation of different frequencies. *Trends Neurosci* 26: 17-22.
20. Manheimer E, Cheng K, Linde K, Lao L, Yoo J, et al. (2010) Acupuncture for peripheral joint osteoarthritis. *Cochrane Database Syst Rev* 2010: CD001977.
21. Fink MG, Kunsebeck H, Wipferman B, Gehrke A (2001) Non-specific effects of traditional Chinese acupuncture in osteoarthritis of the hip. *Complement Ther Med* 9: 82-89.
22. Haslam R (2001) A comparison of acupuncture with advice and exercises on the symptomatic treatment of osteoarthritis of the hip--a randomised controlled trial. *Acupunct Med* 19: 19-26.
23. Stener-Victorin E, Kruse-Smidje C, Jung K (2004) Comparison between electro-acupuncture and hydrotherapy, both in combination with patient education and patient education alone, on the symptomatic treatment of osteoarthritis of the hip. *Clin J Pain* 20: 179-185.
24. Johnson KA, Hulse DA, Hart RC, Kochevar D, Chu Q (2001) Effects of an orally administered mixture of chondroitin sulfate, glucosamine hydrochloride and manganese ascorbate on synovial fluid chondroitin sulfate 3B3 and 7D4 epitope in a canine cruciate ligament transection model of osteoarthritis. *Osteoarthritis Cartilage* 9: 14-21.
25. Cordoba F, Nimni ME (2003) Chondroitin sulfate and other sulfate containing chondroprotective agents may exhibit their effects by overcoming a deficiency of sulfur amino acids. *Osteoarthritis Cartilage* 11: 228-230.
26. Singh JA, Noorbaloochi S, MacDonald R, Maxwell LJ (2015) Chondroitin for osteoarthritis. *Cochrane Database Syst Rev* 1: CD005614.
27. Conrozier T, Vignon E (1992) The efficacy of chondroitin sulfate in the treatment of the arthrosis of the hip joint. A double-blind study versus placebo. *Litera Rheumatologica* 14: 69-75.
28. Wandel S, Juni P, Tendal B, Nuesch E, Villiger PM, et al. (2010) Effects of glucosamine, chondroitin, or placebo in patients with osteoarthritis of hip or knee: network meta-analysis. *BMJ* 341: c4675.
29. Reginster JY, Bruyere O, Neuprez A (2007) Current role of glucosamine in the treatment of osteoarthritis. *Rheumatology (Oxford)* 46: 731-735.
30. Mushtaq S, Choudhary R, Scanzello CR (2011) Non-surgical treatment of osteoarthritis-related pain in the elderly. *Curr Rev Musculoskelet Med* 4: 113-122.
31. Towheed TE, Maxwell L, Anastassiades TP, Shea B, Houpt J, et al. (2005) Glucosamine therapy for treating osteoarthritis. *Cochrane Database Syst Rev* 2005: CD002946.
32. Van Vlijven JP, Luijsterburg PA, Verhagen AP, van Osch GJ, Kloppenburg M, et al. (2012) Symptomatic and chondroprotective treatment with collagen derivatives in osteoarthritis: a systematic review. *Osteoarthritis Cartilage* 20: 809-821.
33. Bruyere O, Zegels B, Leonori L, Rabenda V, Janssen A, et al. (2012) Effect of collagen hydrolysate in articular pain: a 6-month randomized, double-blind, placebo controlled study. *Complement Ther Med* 20: 124-130.
34. Bliddal H, Christensen P, Riecke BF, Aaboe J, Frederiksen R, et al. (2011) Osteoarthritis - a role for weight management in rheumatology practice: an update. *Clin Obes* 1: 50-52.
35. Quintrec JL, Verlhac B, Cadet C, Bréville P, Vetel JM, et al. (2014) Physical exercise and weight loss for hip and knee osteoarthritis in very old patients: a systematic review of the literature. *Open Rheumatol J* 8: 89-95.
36. O'Reilly S, Doherty M (2001) Lifestyle changes in the management of osteoarthritis. *Best Pract Res Clin Rheumatol* 15: 559-568.
37. General Osteopathic Council (2017) About Osteopathy.
38. Blanchard P (2015) In adults with painful hip osteoarthritis physical therapy did not lead to better improvements in pain or function than sham therapy. *International Journal of Osteopathic Medicine*.
39. Fernandes L, Hagen KB, Bijlsma JW, Andraessen O, Christensen P, et al. (2013) EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Ann Rheum Dis* 72: 1125-1135.
40. Sampath KK, Mani R, Miyamori T, Tumilty S (2016) The effects of manual therapy or exercise therapy or both in people with hip osteoarthritis: a systematic review and meta-analysis. *Clin Rehabil* 30: 1141-1155.
41. Beumer L, Wong J, Warden SJ, Kemp JL, Foster P, et al. (2016) Effects of exercise and manual therapy on pain associated with hip osteoarthritis: a systematic review and meta-analysis. *Br J Sports Med* 50: 458-463.
42. Svege I, Nordsletten L, Fernandes L, Risberg MA (2015) Exercise therapy may postpone total hip replacement surgery in patients with hip osteoarthritis: a long-term follow-up of a randomised trial. *Ann Rheum Dis* 74: 164-169.
43. Franssen M, McConnell S, Hernandez-Molina G, Reichenbach S (2014) Exercise for osteoarthritis of the hip. *Cochrane Database Syst Rev* 2014: CD007912.
44. Wang Q, Wang TT, Qi XF, Yao M, Cui XJ, et al. (2015) Manual Therapy for Hip Osteoarthritis: A Systematic Review and Meta-analysis. *Pain Physician* 18: E1005-20.
45. Hawkeswood J, Reebye R (2010) Evidence-based guidelines for the nonpharmacological treatment of osteoarthritis of the hip and knee. *BCM J* 52: 399-403.
46. Shrier I, Feldman DE, Gaudet MC, Rossignol M, Zukor D, et al. (2006) Conservative non-pharmacological treatment options are not frequently used in the management of hip osteoarthritis. *J Sci Med Sport* 9: 81-86.
47. Fang MA, Heiney C, Yentes JM, Harada ND, Masih S, et al. (2012) Clinical and spatiotemporal gait effects of canes in hip osteoarthritis. *PM R* 4: 30-36.
48. Nelson AE, Allen KD, Golightly YM, Goode AP, Jordan JM (2014) A systematic review of recommendations and guidelines for the management of osteoarthritis: The chronic osteoarthritis management initiative of the U.S. bone and joint initiative. *Semin Arthritis Rheum* 43: 701-712.
49. Kawamura T (1983) [Development of the S-form hip brace of Wakayama Medical College type for osteoarthritis of the hip]. *Nihon Seikeigeka Gakkai Zasshi* 57: 1665-1679.
50. Sato E, Sato T, Yamaji T, Watanabe H (2012) Effect of the WISH-type hip brace on functional mobility in patients with osteoarthritis of the hip: evaluation using the Timed Up & Go Test. *Prosthet Orthot Int* 36: 25-32.
51. Sato T, Yamaji T, Inose H, Sekino Y, Uchida S, et al. (2008) Effect of a modified S-form hip brace, WISH type, for patients with painful osteoarthritis of the hip: a role in daily walking as a hip muscle exercise. *Rheumatol Int* 28: 419-428.
52. Schulz A, Smeets V, Nicholls M (2016) Non-surgical management of hip osteoarthritis - Implementation of a novel solution to modify the biomechanics of the osteoarthritic hip.
53. Nérot A, Nicholls M (2017) Clinical study on the unloading effect of hip bracing on gait in patients with hip osteoarthritis. *Prosthet Orthot Int* 41: 127-133.
54. Hurley MV, Walsh NE, Mitchell H, Nicholas J, Patel A (2012) Long-term outcomes and costs of an integrated rehabilitation program for chronic knee pain: a pragmatic, cluster randomized, controlled trial. *Arthritis Care Res (Hoboken)*. 64: 238-247.