



Considerable variety in usual care rehabilitation after knee arthroplasty : a survey amongst physiotherapists

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Knee arthroplasty (KA) is increasingly performed, but rehabilitation and the possibility of returning to sports after KA are understudied areas. A web-based survey amongst physiotherapists was conducted to obtain insight in current rehabilitation methods and their return to sports advice after KA. 82 physiotherapists (62%) completed the survey. Broad agreement existed concerning important goals of rehabilitation, including the improvement of ROM, muscle strength, coordination and gait pattern. However, physiotherapists use a wide variety of treatment strategies to achieve these goals. Return to low-impact sports is mostly recommended, while return to intermediate- and high-impact sports is either advised against or considered impossible. The development of new evidence-based guidelines on physiotherapy after KA could lead to a more uniform approach in the rehabilitation for KA patients. Furthermore, investigating effects of individualization in the rehabilitation may prove valuable in optimising both patient outcomes and cost-effectiveness of this worldwide increasingly performed intervention.

Keywords : physiotherapy ; rehabilitation ; knee ; arthroplasty ; return to sports.

INTRODUCTION

Knee arthroplasty (KA) is a well-accepted, reliable, cost-effective and suitable surgical

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procedure for end-stage osteoarthritis of the knee to relieve pain and to improve function and health-related quality of life (6,11,34). KA is one of the fastest growing interventions in medicine, with incidences increasing mostly in younger and more active patients (11,27,29). Despite the described positive effects of KA, 17-19% of patients remain dissatisfied after surgery (5,9). It has been described that a lack of fulfilment of patient expectations plays

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an important role (10,12). In particular, the fulfilment of expectations regarding the ability to participate in sports and leisure time activities after KA is lacking, with described satisfaction percentages of only about 20% (24).

Reaching an activity level that matches pre-operative patient expectations is an important goal of the rehabilitation after KA. Although the provision of postoperative physiotherapy (PT) is almost universal, rehabilitation is one of the most understudied areas concerning KA surgery, and the available studies do not sufficiently describe what 'standard rehabilitation' consists of (25,31). In recent years, length of hospital stay after joint replacements has decreased significantly as a result of fast track and even day-care joint replacement surgery (26). These developments emphasise the importance of optimising outpatient rehabilitation strategies and PT after KA even more. Although a recent systematic review showed short-term improvements of functional results by PT and exercise therapy after KA, many aspects concerning rehabilitation after KA remain unclear (4). For instance, it is unknown to what extent general or individualized PT protocols are used in PT practice. Furthermore, uncertainties exist concerning the preferred method of delivery of outpatient PT. Both individual and group-based therapy have been described, as well as non-supervised home-based exercises and even telerehabilitation settings using modern devices to stimulate patients to practice at home (14,17,25). Finally, a lack of evidence is apparent concerning the rehabilitation of highly functioning individuals, who wish to return to sports after KA (28).

In fact we know that before surgery, younger patients (<65 years old) expect to perform better on many activities, including a diverse pattern of sports (40,41). A recent systematic review showed that return to many low- and high impact sports was possible after KA, favouring unicondylar knee arthroplasty (UKA) over total knee arthroplasty (TKA), although in both groups a switch toward lower impact types of sports was found (41). Despite of their expectations, and although several studies have shown that activity levels after KA do not negatively impact outcomes (2,22), current literature shows that nowadays patients are not very active

after KA (23). The exact reason is not fully clear, but advices of healthcare professionals can influence the physical activity level of patients after KA. Surveys amongst orthopaedic surgeons provide some knowledge about their advices to patients (19,20,37). However, physiotherapists actually spent most time with patients during their rehabilitation after surgery. Therefore, their advice is likely of most influence to the patient who wishes to return to sports. Thus, it is extremely important to gain insight in the advice given by physiotherapists concerning return to sports after KA.

The first step in improving postoperative rehabilitation is to gain insight in current rehabilitation standards. Therefore, the aims of the current study are to evaluate what physiotherapists consider to be 'usual care' in rehabilitation after KA and to reveal what physiotherapists recommend KA patients who wish to return to sport.

MATERIALS AND METHODS

We performed a cross-sectional, observational study following the STROBE guidelines (<http://www.strobe-statement.org/index.php?id=strobe-home>). A web-based survey was created and sent to all physiotherapists working in the region of our teaching hospital, where >500 KAs are performed annually. Invitations with individual entrance codes were sent by mail in April 2015, followed by two reminders to physiotherapists who did not respond.

The survey started with questions concerning practice characteristics, such as the total number of physiotherapists working in the practice and number of physiotherapists treating KA patients, number of treated KA patients per year, duration and location of rehabilitation. We then asked questions about general aspects of KA rehabilitation, such as the use of a protocol (and if so, if this protocol is identical for each patient) and if therapists use a form of preoperative training, so called 'pre-rehabilitation' (and if so, what this pre-rehabilitation consists of).

Subsequently, we assessed the importance of certain physiotherapeutic sub-goals that are regularly addressed during rehabilitation. These sub-goals were lessening of swelling, pain reduction, mobility/range-of-motion (ROM), coordination, endurance,

gait pattern, muscle strength, core-stability, coping style and ways to improve self-confidence. First, we asked whether a sub-goal was considered important (yes/no), followed by multiple-response questions, where therapists could select more than one option, to assess how therapists work on reaching these sub-goals.

Finally, we asked to categorise 32 sports activities (both low-, intermediate- and high-impact types of sport) based on the return to sports recommendations after TKA and UKA (36). Physiotherapists were requested to allocate each sport to one of the following categories: 'recommended', 'recommended with experience', 'possible, but not recommended' and 'impossible'. Each sport was assigned to one category, based on the highest percentage of therapists giving that recommendation (37,39). We differentiated between 'possible, but not recommended' and 'impossible' in order to investigate the physiotherapists' view on the possibilities for patients to perform certain (high-impact) sports, and their expected risks to the prosthesis by performing these sports.

We used descriptive statistics to calculate continuous data (SPSS, version 21, Chicago, IL, USA). Response frequencies were calculated for nominal data. Data with a non-normal distribution are presented as medians with the range.

RESULTS

In April and May 2015 we addressed 138 physiotherapists, of whom 86 responded (response rate 62%). One of them partially filled out the survey, but then declared that he did not have

Table I. — Characteristics of 82 participating physiotherapy practices

Total number of physiotherapists, median (range)	6 (1-19)
Number of KA physiotherapists, median (range)	3 (1-8)
Number of treated KA patients per year	N (%)
0-10	28 (35%)
11-20	29 (37%)
21-30	18 (23%)
31-40	2 (2,5%)
> 40	2 (2,5%)
Rehabilitation duration	N (%)
<3 months	7 (9%)
3-6 months	60 (73%)
6-9 months	12 (15%)
9-12 months	3 (4%)
Mode of delivery (multiple-response)	N (%)
Individual, practice	82 (100%)
Individual, home	76 (93%)
Group therapy	22 (27%)
Aquatherapy	3 (4%)
Self-reliant home therapy	74 (90%)

Abbreviations : SD, standard deviation ; KA, knee arthroplasty.

enough experience with KA patients to answer all the questions. Three other physiotherapists declared that they did not want to participate. Hence, 82 complete questionnaires were used for the analyses.

The median number of physiotherapists working in a practice was 6 (range 1-19) with a median of 3 (1-8) physiotherapists treating KA patients. The average number of treated KA patients per year varied, with 35% treating 0-10 patients annually, 37% treating 11-20 patients and 23% treating 21-30 patients. Five percent of the practices treated more than 30 patients annually (Table I).

The duration of postoperative rehabilitation was between three and six months for most practices (73%), while 18% of physiotherapists treat their

Table II. — Frequency of physiotherapy

PT frequency (%)	Week 1-2	Week 3-6	Week 6-12	Month 3-6	Month 6-12
3-6 times per week	51	16	6	0	0
2 times per week	44	80	62	24	9
Once a week	5	3	28	40	14
Once per 2 weeks	0	1	3	22	20
Once per 3-4 weeks	0	0	0	10	15
< Once per month	0	0	1	5	43

Table III. — Outcome of multiple-response questions on current practice

Subgoal	Important Yes, N(%)	Method	N (%)
Gait pattern	81 (100%)	- Walking exercises - Treadmill	71 (87%) 59 (73%)
Muscle strength	81 (100%)	- Closed chain exercises - Open chain exercises - Electrotherapy	72 (89%) 58 (71%) 9 (11%)
Mobility/ROM	80 (99%)	- Exercise therapy - Passive manual stretching - CPM	73 (91%) 65 (81%) 13 (16%)
Self-confidence	79 (98%)	- Expectation management - Instruct family/volunteer caregivers	74 (94%) 51 (65%)
Active coping strategy	79 (98%)	- Demonstrate home exercises - Discuss own abilities - Give work instructions - Involve volunteer caregivers - Questionnaires	67 (85%) 61 (77%) 61 (77%) 18 (23%) 14 (18%)
Lessening of swelling	77 (95%)	- Exercise therapy - RICE-principle - Manual lymphatic drainage - Massage/manual manipulation	63 (82%) 51 (66%) 27 (35%) 14 (18%)
Endurance	77 (95%)	- Home trainer - Treadmill - Outdoor walking - Cross trainer - Rowing machine	69 (93%) 64 (86%) 56 (73%) 42 (55%) 30 (39%)
Coordination	74 (91%)	- Exercise therapy - Knee stability training	57 (77%) 9 (12%)
Pain reduction	72 (89%)	- Exercise therapy - Cryotherapy - Postural training - Massage - Electrotherapy - Dry-needling	64 (89%) 57 (79%) 52 (72%) 19 (26%) 7 (13%) 4 (6%)
Core-stability	59 (73%)	- Plank and bridge exercises - Superman exercise - Specific abdominal exercises	19 (32%) 6 (10%) 6 (10%)

Abbreviations: RICE, rest ice compression elevation; ROM, range of motion; CPM, continuous passive motion

patients for periods up to 12 months and 9% for less than three months. Frequency of therapy varied, but on average therapists see their patients twice a week for the first three months, after which this frequency drops to once every one to two weeks between three to six months. After six months the majority of physiotherapists see their patients less than once a month (Table II).

All 82 (100%) physiotherapists use individual therapy in their practice, 76 (93%) use individual therapy at home, 22 (27%) use group therapy, three (4%) use aquatherapy and 74 (90%) use some form of self-reliant home therapy. We found that 65 (80%) physiotherapists use a protocol for rehabilitation after KA. Of this group, 45 (69%) declared that they adjust this protocol to fit their

patients' individual needs. When they stated to individualize rehabilitation, they mentioned that patient factors such as type of work- and leisure time activities (100%), age (98%), co-morbidities (98%), preoperative condition (93%) and type of prosthesis (TKA or UKA, 81%) play an important role. In 56%, physiotherapists see their patients before surgery. The main objective of this intake is to set rehabilitation goals (91%) based on patient-specific factors, such as work and leisure time activities they used to perform and would like to resume. Furthermore, 38% of physiotherapists perform some type of preoperative rehabilitation, by which they aim to improve muscle strength, endurance and range-of-motion.

Of ten suggested sub-goals, nine goals were considered to be important by $\geq 89\%$ of physiotherapists, i.e. lessening of swelling, mobility/range

of motion, endurance, gait pattern, muscle strength, coping style, ways to improve self-confidence, pain reduction and coordination. The tenth goal, core-stability, was considered to be important by 75% of physiotherapists (Table III).

Improving the *gait pattern* of patients is indicated to be an important sub-goal by 81 (100%) physiotherapists and 71 (87%) use specific walking exercises to improve this. For improvement of *muscle strength*, also indicated as important sub-goal by 81 (100%) physiotherapists, 72 (89%) use closed chain exercises. The improvement of *mobility and range-of-motion* (ROM) is indicated as important sub-goal by 80 (99%) physiotherapists and 73 (91%) use exercise therapy to attain this goal. 79 (98%) physiotherapists try to improve patients' *self-confidence* and try to teach them an *active coping strategy* by respectively helping them to manage

Table IV. — Return to sport recommendations*

Recommended (%)	Recommended with experience (%)	Not recommended (%)	Impossible (%)
Golf (69%)	Cross-country skiing(53%)	Weight-lifting, isokinetic (44%)	Basketball (44%)
(Stationary) cycling (99%)	Fencing (47%)	Rock climbing (37%)	Volleyball (52%)
Swimming (86%)	Table tennis (42%)	Singles tennis (43%)	Soccer (61%)
Walking/speedwalking (96%/49%)	Weight-lifting, free (36%)	Baseball/softball (47%)	Martial arts (57%)
Dancing (62%)	Aerobics (43%)	Handball (44%)	Waterskiing (38%)
Aquarobics (86%)	Hiking (57%)	Jogging/running (43%)	
Bowling (65%)	Horseback riding (44%)		
Rowing (48%)	Ice skating (52%)		
Sailing (53%)	Doubles tennis (54%)		
	Skiing (41%)		
	Rollerblading (41%)		

* In accordance with Vail et al²⁶ we assessed recommendations for 13 low-impact, 10 intermediate-impact and 9 high-impact sports. Each sport was assigned to one category, based on the highest percentage of therapists making that recommendation.

Table V. — Differences in recommendations to TKP and UKP patients

Activity	TKP	UKP
Cross-country skiing	Recommended with experience	Recommended
Table tennis	Recommended with experience	Recommended
Hiking	Recommended with experience	Recommended
Horseback riding	Recommended with experience	Recommended
Tennis, doubles	Recommended with experience	Recommended
Basketball	Not recommended	Recommended with experience
Soccer	Not recommended	Recommended with experience
Weight-lifting	Not recommended	Recommended with experience

expectations (94%) and by demonstrating useful home exercises (85%). 77 (95%) physiotherapists work on *lessening of swelling*, mostly with the use of exercise therapy (82%). Also, 77 therapists try to improve *endurance* and 93% use a home trainer to achieve this. To improve *coordination*, indicated as important sub-goal by 74 (91%) of physiotherapists, 57 (77%) use forms of exercise therapy. *Pain reduction* is an important sub-goal for 72 (89%) therapists and 64 (89%) use exercise therapy to achieve this. Finally, *core-stability* was considered an important sub-goal by 59 (73%) of physiotherapists and they use a variety of exercises to attain this goal, with plank and bridge exercises mentioned most often, by 32%.

Of the low-impact activities, ten suggested activities (77%) were recommended and three (23%) were recommended with experience. Of the intermediate-impact sports, eight activities (80%) were recommended with experience and two activities (20%) were not recommended. Of the high-impact sports, four activities (55%) were not recommended and five activities (45%) were considered to be impossible after KA (Table IV).

Finally, we asked if these recommendations were the same after TKA and after UKA. This was the case for 55 (69%) of the responders, while 25

(31%) physiotherapists give different advice after TKA and UKA. The differences were seen in return to low- (n=2), intermediate- (n=4) and high-impact (n=2) sports activities (Table V). This table shows that physiotherapists are more liberal in their recommendations for patients after UKA than after TKA.

DISCUSSION

The present web-based survey, which was completed by a large number of experienced physiotherapists, revealed a great variety in 'usual care' rehabilitation after KA. The general delivery of physiotherapy after KA was reasonably consistent in terms of duration, frequency and focus : 73% treat patients for 3-6 months, 80% treat patients 1-2 times per week and 100% treat patients individually at their practice. In contrast, considerable practice variance existed in timing, program content and modalities used to achieve sub-goals. Concerning recommendations for return to sports, most low-impact sports (77%) were recommended and most intermediate-impact sports (80%) were only recommended with experience. In contrast, none of the high-impact sports were recommended and in 45% of high-impact sports participation

was even considered impossible after KA. Lastly, physiotherapists are more liberal in their return to sports recommendations after UKA than after TKA.

Concerning the attainment of certain sub-goals, we observed several remarkable findings indicating that existing evidence is not always incorporated in daily practice. In our survey, 66% of therapists report the use of RICE for lessening of swelling and 79% use cryotherapy to reduce pain. The term RICE was coined in 1978, but recently its use in KA surgery, as well as the use of cryotherapy, has been under discussion, with new evidence suggesting that RICE may not be very effective (1,7,8). We also assessed the use of continuous passive motion (CPM) to improve ROM, and found that 16% of our respondents use CPM. However, literature showed that the use of CPM does not have clinically important effects on knee pain or function (18). Physiotherapists also reported the use of electrotherapy to reduce pain (13%), but contradictory results exist concerning the analgesic effect of Transcutaneous Electrical Nerve Stimulation (TENS), and its general use is not recommended (31). In contrast, only 11% of physiotherapists used some form of electrotherapy for muscle strengthening, while new evidence suggests that Neuromuscular Electrical Stimulation (NMES) to improve quadriceps muscle strength and functional performance could be useful after KA (13,31,35). Hence, it can be concluded that the observed variety in utilisation of several treatment modalities showed that physiotherapists are not generally aware of the available evidence for these treatments.

Gait training is generally considered to be important in 100% of our respondents. This is in line with a survey of Peter et al. in which 95% of respondents provide gait training after KA (33). In a study by Westby et al. gait training was considered 'appropriate and somewhat important' by $\geq 80\%$ of respondents (clinicians, researchers and patients) (38). In contrast, in an Australian survey of physiotherapists only 57% of therapists reported the provision of gait retraining (32). These contrasting findings indicate a lack of consensus concerning the use of gait training after KA and more research is needed. Core-stability was the only sub-goal that was not indicated as important by $>89\%$ of therapists

(73%) in our survey. In line with our results, Westby et al. found that core stability training after KA was the only intervention not considered 'appropriate and somewhat/very important' by $\geq 80\%$ of respondents (38). Thus, expert opinion indicates that core-stability does not have to be a main concern in rehabilitation after KA, but again, evidence-based recommendations are lacking.

Regarding preoperative visits (56% of PT practices), 91% use them to establish rehabilitation goals, but 98% state that they also train muscle strength and endurance (89%) or even (try to) improve ROM (64%) before surgery. From the literature we know that improving the physical state of patients preoperatively is only considered useful in patients with a poor functional status. Improvement of the endurance may accelerate postoperative recovery only in these patients (21). Until convincing evidence suggests otherwise, preoperative rehabilitation should therefore be considered with caution as it might produce more discomfort than benefit.

With respect to recommendations of physiotherapists regarding return to sports after KA, we found them mostly in line with literature concerning recommendations of orthopaedic surgeons, but a few differences were found. Healey et al. surveyed members of the Knee Society in 1999 and 2005 (19,20). Respondents completed surveys regarding recommendations for 43 (1999) and 37 (2005) sports activities after KA. From 1999 to 2005, the number of activities 'not recommended' decreased from twelve to five. The number of activities considered 'allowed' or 'allowed with experience' increased from eight to nineteen. These findings indicate that over time the surgeons became more liberal concerning restrictions to several athletic activities. In 2011, Vogel et al. conducted a systematic review regarding recommendations on athletic activity after joint arthroplasty (37). Outcomes showed a comparable trend in favouring a higher level of athletic activity. The general tendency to allow more sports after TKA was found in all studies amongst advices of orthopaedic surgeons and also amongst our surveyed physiotherapists. A different recommendation between surgeons and physiotherapists concerns rowing, which is

recommended by our participating physiotherapists, but according to both Vogel and Healey, orthopaedic surgeons would only recommend this sport with experience. Another remarkable difference is seen in cycling, which is recommended by 99% of our respondents and is also recommended by the respondents in Healey's survey. In contrast, the orthopaedic surgeons in the survey of Vogel et al. only recommend cycling with experience (37). This is remarkable since cycling is seen as one of the safest activities after KA in terms of joint load (16). Part of the explanation can be found in the fact that 84% of the Dutch population cycles on a regular basis (Dutch Cyclists' Union, <http://www.fietsersbond.nl>). In addition to the recommendations after TKA, we also elaborated the recommendations after UKA. Previous studies did not focus on this distinction, but an interesting tendency of less strict recommendations after UKA amongst surveyed physiotherapists was seen, which is in line with a recent systematic review concerning return to sports after KA (41).

To our knowledge this study is the most extensive survey so far describing what 'usual care' physiotherapy rehabilitation after KA exactly consists of and which differences exist between PT practices. Furthermore, we are not aware of any other study reporting on recommendations by physiotherapists concerning return to sports after KA. Also, the distinction between recommendations after TKA and UKA has not been described before. A possible limitation is that extrapolation of the findings in our study to other countries might be difficult. In the Netherlands PT is widely available and standards are high, which might be different in other countries. Another limitation is that the provision of socially desirable answers of the physiotherapists cannot be ruled out, since our study is based on self-report. Furthermore, the fact that our survey contained multiple-response questions may have led to therapists' overestimation of the treatment modalities they actually use.

Practice variation has been described in different healthcare disciplines and has gained more attention in the past few years, because it is a potential source of excessive healthcare costs and outcome variability (30). The American Physical Therapy

Association (APTA) stated that '*quality of physical therapy is threatened by the inappropriate variation in the care delivered*' (15). Preventing practice variation in postoperative KA rehabilitation was stated to be difficult, mostly due to the absence of recent and comprehensive guidelines. The lack of evidence-based clinical guidelines is a problem that exists worldwide (3,32,39). The present study, which is one of few studies that aims to formulate expert opinions of 'usual care' rehabilitation after KA, emphasizes this problem. Because of the great variety in responses, it is hard to formulate a general definition of what 'usual care' consists of. A recent review of Mistry et al. discussed available literature concerning the use of several rehabilitation modalities after TKA, with the aim to provide evidence regarding efficacy and practicality (31). Interestingly, the authors also proposed general recommendations on the rehabilitation after KA of active and obese patients, with the underlying thought that it might be better to individualize rehabilitation strategies. Their general conclusion is that joint strengthening and gradual introduction to a more active lifestyle is important and that, by proper instruction and commitment to rehabilitation, patients might be able to achieve higher activity levels (31). Uniformity in care and harmonisation of outcome measures may improve patient outcomes, while reducing costs at the same time (32). However, individualization of rehabilitation strategies according to more personalized goals seems to be of additional value and is an interesting subject for further research (42).

CONCLUSION

This survey shows that between the surveyed PT practices, the general delivery of physiotherapy after KA is reasonably consistent in terms of numbers, frequency, and focus, but 'usual care' of modalities of delivery and program content varies. Recommendations concerning return to sports by physiotherapists are similar to advice of orthopaedic surgeons and are less strict after UKA than after TKA. In order to evaluate and subsequently improve rehabilitation after KA, evidence-based and more uniform guidelines are required. Also research to

the value of individualization of rehabilitation after KA, based on personalized rehabilitation goals, seems to be important in order to optimise both patient outcomes and cost-effectiveness of this increasingly used intervention.

REFERENCES

1. **Adie S, Kwan A, Naylor Justine M, Harris A et al.** Cryotherapy following total knee replacement. *Cochrane Database Syst. Rev.* 2012.
2. **Ali AM, Pandit H, Liddle AD et al.** Does activity affect the outcome of the Oxford unicompartmental knee replacement? *Knee.* 2016; 23 : 327-30.
3. **Artz N, Dixon S, Wylde V et al.** Physiotherapy Provision Following Discharge after Total Hip and Total Knee Replacement : A Survey of Current Practice at High-Volume NHS Hospitals in England and Wales. *Musculoskeletal Care.* 2013 ; 11 : 31-38.
4. **Artz N, Elvers KT, Lowe CM et al.** Effectiveness of physiotherapy exercise following total knee replacement : systematic review and meta-analysis. *BMC Musculoskelet. Disord.* 2015 ; 16. Available at : <http://www.biomedcentral.com/1471-2474/16/15>.
5. **Barlow T, Griffin D, Barlow D et al.** Patients' decision making in total knee arthroplasty : a systematic review of qualitative research. *Bone Jt. Res.* 2015 ; 4 : 163-169.
6. **Bedair H, Cha TD, Hansen VJ.** Economic benefit to society at large of total knee arthroplasty in younger patients : a Markov analysis. *J. Bone Joint Surg. Am.* 2014 ; 96 : 119-26.
7. **Van Den Bekerom MPJ, Struijs P, Blankevoort L et al.** What is the evidence for rest, ice, compression, and elevation therapy in the treatment of ankle sprains in adults? *J. Athl. Train.* 2012 ; 47 : 435-443.
8. **Bleakley C, McDonough S, MacAuley D.** The use of ice in the treatment of acute soft-tissue injury : a systematic review of randomized controlled trials. *Am. J. Sports Med.* 2002 ; 32 : 251-261.
9. **Bourne RB, Chesworth B, Davis A et al.** Comparing Patient Outcomes After THA and TKA : Is There a Difference? *Clin. Orthop. Relat. Res.* 2010 ; 468 : 542-546.
10. **Bourne RB, Chesworth BM, Davis AM et al.** Patient satisfaction after total knee arthroplasty : Who is satisfied and who is not? *Clin. Orthop. Relat. Res.* 2010 ; 468 : 57-63.
11. **Carr AJ, Robertsson O, Graves S et al.** Knee replacement. *Lancet.* 2012 ; 379 : 1331-1340.
12. **Choong PFM, Dowsey MM.** Update in surgery for osteoarthritis of the knee. *Int. J. Rheum. Dis.* 2011 ; 14 : 167-174.
13. **Demircioglu DT, Paker N, Erbil E et al.** The effect of neuromuscular electrical stimulation on functional status and quality of life after knee arthroplasty : a randomized controlled study. *J Phys Ther Sci.* 2015 ; 27 : 2501-2506.
14. **Fung V, Ho A, Shaffer J et al.** Use of Nintendo Wii Fit™ In the rehabilitation of outpatients following total knee replacement : A preliminary randomised controlled trial. *Physiother. (United Kingdom).* 2012 ; 98 : 183-188.
15. **Goldstein MS, Scalzitti D, Bohmert J et al.** Vitalizing practice through research and research through practice : the outcomes of a conference to enhance the delivery of care. *Phys. Ther.* 2011 ; 91 : 1275-1284.
16. **Hamai S, Miura H, Higaki H et al.** Three-dimensional knee joint kinematics during golf swing and stationary cycling after total knee arthroplasty. *J. Orthop. Res.* 2008 ; 26 : 1556-1561.
17. **Han ASY, Nairn L, Harmer AR et al.** Early Rehabilitation After Total Knee Replacement Surgery : A Multicenter, Noninferiority, Randomized Clinical Trial Comparing a Home Exercise Program With Usual Outpatient Care. *Arthritis Care Res. (Hoboken).* 2015 ; 67 : 196-202.
18. **Harvey LA, Brosseau L, Herbert RD et al.** Continuous passive motion following total knee arthroplasty in people with arthritis. *Cochrane Database Syst. Rev.* 2010 : CD004260.
19. **Healy WL, Iorio R, Lemos MJ.** Athletic Activity after Joint Replacement No author or related institution has received any financial benefit from research in this study. *Am. J. Sports Med.* 2001 ; 29 : 377-388.
20. **Healy WL, Sharma S, Schwartz B et al.** Athletic activity after total joint arthroplasty. *J. Bone Joint Surg. Am.* 2008 ; 90 : 2245-2252.
21. **Hoogeboom TJ, Oosting E, Vriezekolk JE et al.** Therapeutic validity and effectiveness of preoperative exercise on functional recovery after joint replacement : A systematic review and meta-analysis. *PLoS One.* 2012 ; 7.
22. **Jones DL, Cauley JA, Kriska AM et al.** Physical activity and risk of revision total knee arthroplasty in individuals with knee osteoarthritis : a matched case-control study. *J. Rheumatol.* 2004 ; 31 : 1384-1390.
23. **Kersten RFMR, Stevens M, van Raay JJAM et al.** Habitual Physical Activity After Total Knee Replacement. *Phys. Ther.* 2012 ; 92 : 1109-1116.
24. **Klit J, Jacobsen S, Rosenlund S et al.** Total Knee Arthroplasty in Younger Patients Evaluated by Alternative Outcome Measures. *J. Arthroplasty.* 2014 ; 29 : 912-917.
25. **Ko V, Naylor J, Harris I et al.** One-to-one therapy is not superior to group or home-based therapy after total knee arthroplasty : a randomized, superiority trial. *J. Bone Joint Surg. Am.* 2013 ; 95 : 1942-9.
26. **Kort NP, Bemelmans YFL, Schotanus MGM.** Outpatient surgery for unicompartmental knee arthroplasty is effective and safe. *Knee Surgery, Sport. Traumatol. Arthrosc.* 2015.
27. **Kurtz SM, Lau E, Ong K et al.** Future young patient demand for primary and revision joint replacement : National projections from 2010 to 2030. *Clin. Orthop. Relat. Res.* 2009 ; 467 : 2606-2612.

28. **Lorenz DS, Salsbery M.** Return to high-level activity following knee replacement : Literature review and suggested program design. *Top. Geriatr. Rehabil.* 2013 ; 29 : 46-54.
29. **Losina E.** The Dramatic Increase in Total Knee Replacement Utilization Rates in the United States Cannot Be Fully Explained by Growth in Population Size and the Obesity Epidemic. *J. Bone Jt. Surg.* 2012 ; 94 : 201.
30. **Love T, Ehrenberg N, Sapere Research Group.** Addressing unwarranted variation : literature review on methods for influencing practice. 2014.
31. **Mistry J, Elmallah R, Bhave A et al.** Rehabilitative Guidelines after Total Knee Arthroplasty : A Review. *J. Knee Surg.* 2016.
32. **Naylor J, Harmer A, Fransen M et al.** Status of physiotherapy rehabilitation after total knee replacement in Australia. *Physiother. Res. Int.* 2006 ; 11 : 35-47.
33. **Peter WF, Nelissen RGHH, Vliet Vlieland TPM.** Guideline recommendations for post-acute postoperative physiotherapy in total hip and knee arthroplasty : Are they used in daily clinical practice? *Musculoskeletal Care.* 2014 ; 12 : 125-131.
34. **Skou AT, Roos EM, Laursen MB et al.** A Randomized, Controlled Trial of Total Knee Replacement. *N. Engl. J. Med.* 2015 ; 373 : 1597-1606.
35. **Stevens-lapsley JE, Balter JE, Wolfe P et al.** Early neuromuscular electrical stimulation to improve quadriceps muscle strength after total knee arthroplasty : a randomized controlled trial. *Phys. Ther.* 2012 ; 92 : 210-226.
36. **Vail T, Mallon W, Liebelt R.** Athletic Activities After Joint Arthroplasty. *Sports Med. Arthrosc.* 1996 ; 4 : 298-305.
37. **Vogel LA, Carotenuto G, Basti JJ et al.** Physical Activity After Total Joint Arthroplasty. *Sport. Heal. A Multidiscip. Approach.* 2011 ; 3 : 441-450.
38. **Westby MD, Backman CL.** Patient and health professional views on rehabilitation practices and outcomes following total hip and knee arthroplasty for osteoarthritis : a focus group study. *BMC Health Serv. Res.* 2010 ; 10 : 119.
39. **Westby MD, Brittain A, Backman CL.** Expert consensus on best practices for post-acute rehabilitation after total hip and knee arthroplasty : a Canada and United States Delphi study. *Arthritis Care Res. (Hoboken).* 2014 ; 66 : 411-23.
40. **Witjes S, van Geenen RCI, Koenraadt KLM, et al.** Expectations of younger patients concerning activities after knee arthroplasty : Are we asking the right questions? (in press). *Qual. Life Res.* 2016.
41. **Witjes S, Goutteborge V, Kuijer PPFM et al.** Return to Sports and Physical Activity After Total and Unicompartmental Knee Arthroplasty : A Systematic Review and Meta-Analysis. *Sport. Med.* 2016 ; 46 : 1-24.
42. **Witjes S, Hoorntje A, Kuijer PPFM et al.** Does Goal Attainment Scaling improve satisfaction regarding performance of activities of younger knee arthroplasty patients? Study protocol of the randomized controlled ACTION trial. *BMC Musculoskelet. Disord.* 2016 ; 17 : 113.