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Inappropriate use of arthroscopic meniscal surgery in degenerative knee disease

An observational study from Switzerland

Leander L S MUHEIM¹, Oliver SENN¹, Mathias FRÜH², Oliver REICH², Thomas ROSEMANN¹, and Stefan M NEUNER-JEHLE¹

¹ Institute of Primary Care, University of Zurich, Zurich, Switzerland; ² Department of Health Sciences, Helsana Group, Zurich, Switzerland
Correspondence: leander.muheim@usz.ch
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Background and purpose — Current evidence suggests that arthroscopic knee surgery has no added benefit compared with non-surgical management in degenerative meniscal disease. Yet in many countries, arthroscopic partial meniscectomy (APM) remains among the most frequently performed surgeries. This study quantifies and characterizes the dynamics of the current use of knee arthroscopies in Switzerland in a distinctively non-traumatic patient group.

Methods — We assessed a non-accident insurance plan of a major Swiss health insurance company for surgery rates of APM, arthroscopic debridement and lavage in patients over the age of 40, comparing the years 2012 and 2015. Claims were analyzed for prevalence of osteoarthritis, related interventions and the association of surgery with insurance status.

Results — 648,708 and 647,808 people were examined in 2012 and 2015, respectively. The incidence of APM, debridement, and lavage was 388 per 10⁵ person-years in 2012 and 352 per 10⁵ person-years in 2015 in non-traumatic patients over the age of 40, consisting mostly of APM (96%). Between years, APM surgery rates changed in patients over the age of 65 ($p < 0.001$) but was similar in patients aged 40–64. Overall prevalence of osteoarthritis was 25%. Insurance status was independently associated with arthroscopic knee surgery.

Interpretation — APM is widely used in non-traumatic patients in Switzerland, which contrasts with current evidence. Many procedures take place in patients with degenerative knee disease. Surgery rates were similar in non-traumatic middle-aged patients between 2012 and 2015. Accordingly, the potential of inappropriate use of APM in non-traumatic patients in Switzerland is high.

Arthroscopic knee surgery has represented a cornerstone of orthopedic surgery since the late 1970s. In recent years, however, its use in meniscal injuries has become increasingly controversial (Jarvinen and Guyatt 2016, Lohmander et al. 2016). Current evidence suggests that arthroscopic knee surgery has no added benefit compared with non-surgical management in degenerative meniscal disease (Thorlund et al. 2015). In the absence of compelling evidence, young patients with distinct trauma and an acutely locked knee have traditionally been assumed to benefit from surgery. On these grounds, the indication for surgery was expanded to older patients and patients without trauma, although the prevalence of asymptomatic degenerative meniscal tears in such patients is high and rising with age (Bhattacharyya et al. 2003, Englund et al. 2008). In fact degenerative meniscal tears are increasingly considered an early sign of osteoarthritis without any influence on pain by themselves (Englund et al. 2007, Englund et al. 2016, Tornbjerg et al. 2017). Of 8 major randomized controlled trials (RCTs) assessing surgical treatment of degenerative meniscal disease in patients with or without osteoarthritis (Moseley et al. 2002, Kirkley et al. 2008, Herrlin et al. 2013, Katz et al. 2013, Sihvonen et al. 2013, Yim et al. 2013, Kise et al. 2016) only 1 found a minimal and non-lasting benefit for surgery (Gaufin et al. 2014). In the years preceding 2010, before most of the studies challenging the efficacy of surgery were published, rates for arthroscopic knee surgery were high or increasing in several countries, especially among middle-aged patients (Pellegrini and Kohler 2014, Thorlund et al. 2014). In Switzerland, APM was the most frequent orthopedic procedure and the fifth most frequent of all surgical procedures according to inpatient data from 2013 (Federal Statistical Office).

This study aims to assess the dynamics and the appropriateness of arthroscopic knee surgery in non-traumatic patients in the most recent years. Most non-traumatic patients are expected to suffer from degenerative meniscal disease or osteoarthritis, which does not qualify for surgery according to current evidence. We hypothesize that the use of arthroscopic knee surgery remained unchanged and inappropriate to a major extent. We therefore examined and compared arthroscopic knee surgery rates and related patient characteristics in a sizeable non-traumatic population in 2012 and 2015 in Switzerland.

Methods

Study design

We used claims data to analyze the incidence of APM, arthroscopic debridement and lavage of the knee in patients over the age of 40, comparing the years 2012 and 2015.

Data source

The data we used are based on claims of a major Swiss health insurance company (“Helsana group”) which covers approximately a 6th of the overall Swiss population within the study period (Federal Statistical Office 2016).

All individuals registered in Switzerland are obliged by law to choose general health insurance. They are thereby granted equal access to the full range of medical treatments, regardless of insurance status. Supplementary private insurance is available for an additional premium. It encompasses benefits regarding accommodation and free choice of specialists. Importantly, Swiss law requires additional mandatory accident insurance for all citizens, which is recorded separately. Traumatic and non-traumatic injuries are therefore covered by different insurance policies.

Data collection

We extracted data from the health insurance company’s claims database. Procedures performed were identified using the corresponding Swiss coding systems for surgical interventions in inpatients, called CHOP-codes (Swiss Classification of Operations) and TARMED codes for outpatients (tarif médical; Swiss Classification for outpatient medical services). To identify the relevant surgery codes, classification catalogues were screened both manually and automatically for the terms “menisk”, “arthroskop”, and “Knie” (knee). Results were presented to a senior clinical orthopedic surgeon and confirmed as the relevant codes in clinical routine.

We used International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes to assess diagnostic information. These codes became available to insurance companies only from 2012 with the establishment of the Swiss DRG (Diagnosis Related Groups), a “flat rate per case”-based billing system. Consequently, we compared data from 2012 and 2015, the earliest and latest year for which data were

available. For data involving the incidence of an event after or before knee surgery (i.e. total knee arthroplasty after 2 years), we used 2013 data.

Inclusion criteria

We included all claims of patients over the age of 40, who underwent either APM, debridement, or lavage in 2012 and 2015. CHOP codes 80.6X.10 (Meniscectomy knee, arthroscopically, partial) and 80.86.11 (Debridement knee joint) for inpatient surgeries and TARMED codes 24.5710 (Knee arthroscopy with resection meniscus med/lat, part/tot) and 24.5700 (Knee arthroscopy with meniscal lavage) for outpatient procedures were employed. Validity of our sample was confirmed by assessing the presence of ICD-10 codes for meniscal damage (M23.2; Derangement of meniscus due to old tear or injury, M23.3 Other meniscus derangements, and M23.9 Internal derangement of knee, unspecified) in inpatients who underwent APM.

If surgery involved APM, it was categorized as such, regardless of additional codes present. Correspondingly, cases with codes for debridement and lavage qualified as such, if they did not exhibit a code for APM (i.e. if all codes were present simultaneously, the case was categorized as APM).

Measurements

We collected sociodemographic factors (sex, age), as well as the treatment setting (in-/outpatient), osteoarthritis as concomitant diagnosis (code ICD-10 M17.x; including all subgroups, due to availability only in inpatients), pain medication (if more than 2 prescriptions within 6 months prior to surgery, according to Anatomical Therapeutic Chemical Classification System (WHO 2011), outpatient physiotherapy (within 6 months before and after surgery), MRI of the knee (within 6 months before surgery; codes TARMED; 39.5180, CHOP; 88.94.14), total knee arthroplasty (within 12 and 24 months after surgery), supplementary private insurance (including all semi-private and private models), high deductible class (copayment by patient up to ≥ 1000 Swiss Francs; insurance covers cumulative yearly costs exceeding this sum) and number of concomitant chronic diseases according to pharmaceutical cost groups (Lamers and Vliet 2003).

Statistics

Data were grouped into 2 groups according to age, henceforth referred to as middle-aged (age 40–64) and elderly (age ≥ 65) patients. If no age group is declared, we refer to all included patients (i.e. age > 40).

Descriptive statistics were used to provide characteristics of the predefined surgical populations. Percentages and mean values were used for categorical and nominal data, respectively. For comparison of surgery rates, the Wald test was used and the p-value was calculated from the incidence rate ratios. To explore possible associations between surgery and variables, we performed a multivariable, multilevel logistic

regression. The following variables were chosen by their availability and their relevance from a health services research perspective: “sex”, “age” (centered by the median; “age squared” was added to account for the bowing course of incident rates), “supplementary private insurance”, “high deductible class”, “chronic diseases”, and “pain medication” as fixed variables. To account for the regional differences in surgery rates, we included “canton” (i.e. Swiss regions) as a random variable. Results of regression analysis were presented as odds ratios with 95% confidence intervals (95% CI). Statistical analyses were conducted with “R” version 3.3.0.

Ethics, funding and potential conflicts of interest

No ethical authorization was required for this type of study according to Swiss law. Access to our dataset was granted by the Helsana group. Since data were completely anonymized, no patient consent was necessary.

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Results

648,708 and 647,808 patients were examined in 2012 and 2015 respectively. The mean age of all included (i.e. surgically treated) patients was 62 (SD 6.2) years in 2012 and 61 (SD 6.1) years in 2015. Of those 53% and 51% were female. On average, 68% of all patients who underwent APM, debridement, and lavage were inpatients.

APM accounted for 96% and 95% of procedures in 2012 and 2015 (Table 1).

Osteoarthritis was diagnosed in 28% and 22% of inpatients undergoing APM in 2012 and 2015, respectively. Prevalence of osteoarthritis was highest (33.4%) in elderly patients undergoing APM in 2012. This age group also accounted for the biggest reduction, falling to 25% in 2015. Prevalence of osteoarthritis was lowest in patients undergoing debridement or lavage, regardless of patient age or year. Prevalence of osteo-

Table 1. Arthroscopic knee surgery in 2012 and 2015

Age group Type ^a	Number of patients		Incidence rates (CI) per 10 ⁵ person-years		IRR ^b	p-value ^c
	2012	2015	2012	2015		
Age 40–64						
APM	1,413	1,366	358 (340–377)	355 (336–374)	0.9	0.8
inpatients	905	877				
osteoarthritis ^d	205	178				
DEB	52	73	13 (10–17)	19 (15–24)	1.4	0.05
inpatients	29	45				
osteoarthritis ^d	2	9				
Age ≥ 65						
APM	1,008	802	397 (373–422)	305 (285–327)	0.8	< 0.001
inpatients	739	605				
osteoarthritis ^d	247	149				
DEB	47	41	19 (14–25)	16 (11–21)	0.8	0.4
inpatients	36	36				
osteoarthritis ^d	8	8				

^a DEB—debridement and lavage, APM—arthroscopic partial meniscectomy.
^b IRR = Incidence Rate Ratio
^c of incidence rate ratios
^d ICD-10 codes M17.x among inpatients.

Table 2. Arthroscopic knee surgery and the incidence of related interventions

Variable	n (%)
Total knee arthroplasty within 12 months after surgery	151 (7.2)
Total knee arthroplasty within 24 months after surgery	211 (10)
Physiotherapy within 6 months before surgery	630 (30)
Physiotherapy within 6 months after surgery	1,396 (67)
Pain medication (> 2 prescriptions/6months)	236 (11)
MRI within 6 months prior to surgery	1,594 (76)

n = 2,089, all patients ≥ 40 with APM or DEB, year 2013.

arthritis was consistently higher among elderly patients than among middle-aged patients (29% vs. 21%).

Among all patients over the age of 40, the proportion of patients who received outpatient physiotherapy before undergoing arthroscopic knee surgery was 30% as compared with 67% after surgery. Proportions of interventions related to arthroscopic knee surgery are listed in Table 2.

Overall, surgical activity decreased from 2012 to 2015. This difference was largely driven by a statistically significant reduction of APM in elderly patients from 397 to 305 cases per 10⁵ person-years. There was no significant change in surgery rates among the group of middle-aged patients undergoing APM. Difference in incidence rates for debridement or lavage were borderline-significant for middle-aged and non-significant for elderly patients (Table 1).

Male sex, supplementary private insurance, and number of chronic diseases were associated with higher odds of undergoing arthroscopic knee surgery, whereas high deductible class and the use of pain medication conferred lower odds. Higher

Table 3. Association of insurance status variables and arthroscopic knee surgery (multivariable regression analysis)

Variable	OR ^a (95% CI)
Male sex	1.1 (1.001–1.2)
Age ^b	1.0 (0.995–1.004)
Age squared ^c	1.0 (1.0–1.0)
Supplementary private insurance	1.2 (1.1–1.3)
High deductible class (\geq 1000 Swiss Francs)	0.65 (0.58–0.74)
Number of chronic diseases	1.07 (1.04–1.1)
Pain medication (> 2 prescriptions/6months)	0.75 (0.64–0.88)

^a 2015, all patients \geq 40
^b continuous variable
^c to account for bowing course of incidence rate

age was associated with only minimally lower odds. Results of multivariable, multilevel logistic regression analysis are given in Table 3.

Discussion

APM accounted for the vast majority of arthroscopic knee surgeries in non-traumatic patients in Switzerland in 2012 and 2015. Most patients undergoing arthroscopic knee surgery were middle-aged and surgery rates did not change for middle-aged patients comparing years 2012 and 2015. Our findings for patients over the age of 40 correspond to 388 and 352 procedures per 10⁵ patient-years in 2012 and 2015, respectively.

Our study population represented 15% of the Swiss population in 2012 and 14% in 2015 (Federal Statistical Office 2016). Most patients in our sample underwent surgery as inpatients. This contrasts with data from the United States where less than 1% of patients were hospitalized (Kim et al. 2011). This is most likely explained by differences in the organization of the health care system in Switzerland. Possible reasons are inpatient cases being subsidized by regional governments (which cover about 50% of total costs) or certain patients yielding a substantially higher reimbursement (e.g. those with supplementary private insurance) when treated as inpatients. Inevitably, such distortions must play a role in creating a less competitive outpatient sector.

Incidence rates for arthroscopic partial meniscectomy in Switzerland were comparable to other countries with a high amount of arthroscopic knee surgery. An additional analysis of all ages (i.e. including patients < 40 years) resulted in approximately 210 procedures per 10⁵ person-years in Switzerland in non-traumatic patients. This figure outnumbers traumatic cases, which, although on the rise throughout the last 3 decades, remain on a substantially lower level (accident-insurance cases amount to roughly a third of all APM procedures in 2014 according to our own estimate based on preliminary data from SUVA, the biggest accident insurance company

of Switzerland, personal communication). According to this measure, our rate of non-traumatic patients is somewhat lower than the rate of 312 per 10⁵ person-years reported from Denmark in 2011. However, it does not contain traumatic tears, cruciate ligament procedures, and other unspecified knee procedures (Thorlund et al. 2014). Focusing on older patients, our incidence rates (397 per 10⁵ person-years, age \geq 65) exceed those in Denmark in 2011 (322 per 10⁵ person-years, age \geq 55). Moreover, adding traumatic cases to our incidence rates would likely lead to a similar result in middle-aged patients. A steep decline in procedures for degenerative knee disease from a very high level to about 250 procedures in 10⁵ person-years was described in Finland. In another Scandinavian country, remarkably lower rates were observed: Sweden reported a stable 100 procedures per 10⁵ person-years of arthroscopic procedures in osteoarthritis and degenerative meniscal disease between 2001 and 2012 (Mattila et al. 2016). Debridement and lavage accounted only for a small share of performed surgeries, which is in line with international observations and earlier evidence that these procedures do not benefit patients with osteoarthritis (Potts et al. 2012).

Prevalence of osteoarthritis was substantial among patients undergoing APM. About 1 in 4 middle-aged patients and almost 1 in 3 elderly patients featured a corresponding diagnostic code in 2012. The extent to which arthroscopy was performed in patients with meniscal tears and osteoarthritis has been questioned previously (Bergkvist et al. 2016). Arthroscopic knee surgery was shown to provide no additional benefit for osteoarthritis of the knee (Moseley et al. 2002, Kirkley et al. 2008). More importantly, meniscal tears in patients with concurrent osteoarthritis are likely to be a sign of osteoarthritis itself (Englund et al. 2003, 2007), do not increase pain (Englund et al. 2008) and predict a worse prognosis after surgery. Our results show that this evidence has not yet been implemented in daily practice.

Only a minority of patients had physiotherapy prior to arthroscopy according to reimbursement claims. Even fewer obtained regular pain medication. Present guidelines from the Osteoarthritis Research Society International (McAlindon et al. 2014), the European League Against Rheumatism (Fernandes et al. 2013), the National Institute of Health and Care Excellence (2014), or initiatives like Choosing Wisely (2014) regard non-operative management including patient education, exercise, and weight loss as first-line treatment in degenerative knee disease. Patients with debilitating mechanical symptoms have long been thought to be exempt from such strategies, therefore qualifying for surgery (Lyman et al. 2012). However, recent evidence challenges this assumption (Sihvonen et al. 2016a, 2016b). As most of our patients were prescribed physiotherapy only after surgery—indicating that this variable is a valid proxy for symptomatic knee disease—it seems that many patients did not get first-line treatment but underwent surgery right away. Of note, high-quality evidence supporting physiotherapy after surgery is scarce. Although the

cost-effectiveness of physiotherapy as an alternative treatment for surgery has yet to be demonstrated, it is at least as effective as (Kise et al. 2016) and less hazardous than surgery. MRI on the other hand was used abundantly, although it is known to be of limited help in ascertaining the need for surgery and may trigger inappropriate procedures, especially in osteoarthritic knees (Bhattacharyya et al. 2003, Katz et al. 2014). Beyond that, 1 in 10 patients underwent total knee arthroplasty within a relatively short time span of 2 years after APM, further highlighting the substantial prevalence of osteoarthritis in this patient group.

Multivariable regression analysis showed a higher association with surgery for patients with supplementary private insurance. This is in line with previous reports (Hare et al. 2015). While our regression analysis itself cannot confirm causality, selection of a more demanding patient group and higher financial rewards from privately insured patients could be explanations for this association. The finding of chronic diseases being positively associated with surgery is unclear. One might hypothesize that surgery rates increase with a higher exposure to the health care system. Conversely, substantially fewer surgeries occurred in patients with a higher deductible class. Less exposure to physicians and more self-reliance might thus reduce health care services that feature a higher degree of preference-sensitivity. The use of pain medication was associated with a substantially lower probability of undergoing surgery. This finding is not entirely clear but suggests that patients undergoing surgery are experiencing either less pain or are less willing to take pain medication.

Some of the previous studies have been criticized as lacking adequate accuracy in discriminating traumatic from non-traumatic patients, supposedly relying on arbitrary surgical coding. An important strength of our sample is that traumatic injuries are reliably excluded not only by history, but also by competing insurance systems, safeguarding correct categorization based on all clinical information available. For example, whenever a reported accident seems of low relevance for the diagnosis, patients are reimbursed by the health insurance company and not by the accident insurance company (and vice versa). Consequently, our sample can be regarded as devoid of traumatic cases. As such, it reflects a population similar to those studied in the trials that found APM to be ineffective (Sihvonen et al. 2013, Thorlund et al. 2015). Of note, the clinical value of this differentiation is unclear. There is no high-quality evidence on the effectiveness of surgical treatment for traumatic tears (Howell and Handoll 2000). A recent study showed that patients with a history of trauma do no better 1 year after surgery than those with a history indicating degenerative tears (Thorlund et al. 2017). Another strength is the presumably high representativeness of our sample with regard to the Swiss population.

An important limitation of our study is the lack of first-hand clinical information within our data. We had no access to information such as specific symptoms, detailed patient histories,

or distinct reasons why patients underwent surgery. Furthermore, the examined time horizon was relatively short due to limited availability of data. Another limitation is the fact that ICD-10 codes (for osteoarthritis) were available only for inpatient cases. Outpatient cases might have a lower prevalence of osteoarthritis. However, they account for only a minority of all patients who underwent APM in Switzerland. As regards the regression results, it should be noted that they do not confirm or predict any causal relationship.

In summary, our results suggest that there is a high potential for inappropriate use of APM in Switzerland. In a fee-for-service system such as in Switzerland, every service is rewarded separately. Surgical action is thus financially encouraged while patients bear costs only partially. It appears that this hinders the timely implementation of new evidence. Policy-makers should be aware of this and align existing reimbursement structures with patients' interests and existing evidence. Patients with suspected degenerative meniscal injuries should be evaluated with respect to degeneration and treated accordingly.

TR, OS, OR and LM conceived the study. OR and MF were responsible for the collection and analysis of data. LM, SNJ, OS, and TR contributed to the interpretation of the data. LM drafted the manuscript, which was critically revised by SNJ, OR, OS, and TR. All the authors approved the final version of the manuscript.

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Bergkvist D, Dahlberg L E, Neuman P, Englund M. Knee arthroscopies: Who gets them, what does the radiologist report, and what does the surgeon find? An evaluation from southern Sweden. *Acta Orthop* 2016; 87 (1): 12-16.

Bhattacharyya T, Gale D, Dewire P, et al. The clinical importance of meniscal tears demonstrated by magnetic resonance imaging in osteoarthritis of the knee. *J Bone Joint Surg Br* 2003; 85-A: 4-9.

Choosing Wisely; American Medical Society for Sports Medicine 2014. Avoid recommending knee arthroscopy as initial/management for patients with degenerative meniscal tears and no mechanical symptoms, <http://www.choosingwisely.org/clinician-lists/american-medical-society-sports-medicine-knee-arthroscopy-for-degenerative-meniscal-tears/>

Englund M, Roos E M, Lohmander L S. Impact of type of meniscal tear on radiographic and symptomatic knee osteoarthritis: A sixteen-year follow-up of meniscectomy with matched controls. *Arthritis Rheum* 2003; 48 (8): 2178-87.

Englund M, Niu J, Guermazi A, Roemer F W, Hunter D J, Lynch J A, Lewis C E, Torner J, Nevitt M C, Zhang Y Q, Felson D T. Effect of meniscal damage on the development of frequent knee pain, aching, or stiffness. *Arthritis Rheum* 2007; 56: 4048-54.

Englund M, Guermazi A, Gale D, Hunter D J, Aliabadi P, Clancy M, Felson D T. Incidental meniscal findings on knee MRI in middle-aged and elderly persons. *N Engl J Med* 2008; 359: 1108-15.

- Englund M, Haugen I K, Guermazi A, Roemer F W, Niu J, Neogi T, Aliabadi P, Felson D T. Evidence that meniscus damage may be a component of osteoarthritis: The Framingham study. *Osteoarthritis Cartilage* 2016; 24: 270-3.
- Federal Statistical Office (Bundesamt für Statistik): Medizinische Statistik der Krankenhäuser 2013, <https://www.bfs.admin.ch/bfs/de/home/statistiken/gesundheit/erhebungen/ms.html#1042039266>
- Federal Statistical Office (Bundesamt für Statistik): Bevölkerungsdaten im Zeitvergleich 2016, <https://www.bfs.admin.ch/bfs/de/home/statistiken/bevoelkerung.assetdetail.300189.html>
- Fernandes L, Hagen K B, Bijlsma J W, et al., European League Against Rheumatism. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Ann Rheum Dis* 2013; 72 (7): 1125-35.
- Gauffin H, Tagesson S, Meunier A, Magnusson H, Kvist J. Knee arthroscopic surgery is beneficial to middle-aged patients with meniscal symptoms: A prospective, randomised, single-blinded study. *Osteoarthritis Cartilage* 2014; 22: 1808-16.
- Hare K B, Vinther J H, Lohmander L S, Thorlund J B. Large regional differences in incidence of arthroscopic meniscal procedures in the public and private sector in Denmark. *BMJ Open* 2015; 5 (2): e006659.
- Herrlin S V, Wange P O, Lapidus G, Hällander M, Werner S, Weidenhielm L. Is arthroscopic surgery beneficial in treating non-traumatic, degenerative medial meniscal tears? A five year follow-up. *Knee Surg Sports Traumatol Arthrosc* 2013; 21: 358-64.
- Howell J R, Handoll H H. Surgical treatment for meniscal injuries of the knee in adults. *Cochrane Database Syst Rev* 2000; (2): Cd001353.
- Jarvinen T L, Guyatt G H. Arthroscopic surgery for knee pain. *BMJ* 2016; 354: i3934.
- Katz J N, Brophy R H, Chaisson C E, et al. Surgery versus physical therapy for a meniscal tear and osteoarthritis. *N Engl J Med* 2013; 368: 1675-84.
- Katz J N, Brownlee S A, Jones H. The role of arthroscopy in the management of knee osteoarthritis. *Best Pract Res Clin Rheumatol* 2014; 28 (1): 143-56.
- Kim S, Bosque J, Meehan J P, Jamali A, Marder R. Increase in outpatient knee arthroscopy in the United States: A comparison of National Surveys of Ambulatory Surgery, 1996 and 2006. *J Bone Joint Surg Am* 2011; 93 (11): 994-1000.
- Kirkley A, Birmingham T B, Litchfield R B, Giffin J R, Willits K R, Wong C J, Feagan B G, Donner A, Griffin S H, D'Ascanio L M, Pope J E, Fowler P J. A randomized trial of arthroscopic surgery for osteoarthritis of the knee. *N Engl J Med* 2008; 359 (11): 1097-107.
- Kise N J, Risberg M A, Stensrud S, Ranstam J, Engebretsen L, Roos E M. Exercise therapy versus arthroscopic partial meniscectomy for degenerative meniscal tear in middle aged patients: Randomised controlled trial with two year follow-up. *BMJ* 2016; 354: i3740.
- Lamers L M, Vliet R C. Health-based risk adjustment: Improving the pharmacy-based cost group model to reduce gaming possibilities. *Eur J Health Econ* 2003; 4 (2): 107-14.
- Lohmander L Stefan, Thorlund Jonas B, Roos Ewa M. Routine knee arthroscopic surgery for the painful knee in middle-aged and old patients: Time to abandon ship. *Acta Orthop* 2016; 87: 2-4.
- Lyman S, Oh L S, Reinhardt K R, Mandl L A, Katz J N, Levy B A, Marx R G. Surgical decision making for arthroscopic partial meniscectomy in patients aged over 40 years. *Arthroscopy* 2012; 28: 492-501.e1.
- Mattila V M, S Raine, Paloneva J, Felländer-Tsai L. Changes in rates of arthroscopy due to degenerative knee disease and traumatic meniscal tears in Finland and Sweden. *Acta Orthop* 2016; 87: 5-11.
- McAlindon T E, Bannuru R R, Sullivan M C, Arden N K, Berenbaum F, Bierma-Zeinstra S M, Hawker G A, Henrotin Y, Hunter D J, Kawaguchi H, Kwok K, Lohmander S, Rannou F, Roos E M, Underwood M. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthritis Cartilage* 2014; 22 (3): 363-88.
- Moseley J B, O'Malley K, Petersen N J, Menke T J, Brody B A, Kuykendall D H, Hollingsworth J C, Ashton C M, Wray N P. A controlled trial of arthroscopic surgery for osteoarthritis of the knee. *N Engl J Med* 2002; 347: 81-8.
- National Institute of Health and Care Excellence (NICE). Guidelines CG177, Osteoarthritis: care and management 2014, <https://www.nice.org.uk/guidance/cg177>
- Pellegrini S, Kohler D. Switzerland: Geographic variations in health care. In *Geographic variations in health care: What do we know and what can be done to improve health system performance?* Paris: OECD Publishing, 2014.
- Potts A, Harrast J J, Harner C D, Miniaci A, Jones M H. Practice patterns for arthroscopy of osteoarthritis of the knee in the United States. *Am J Sports Med* 2012; 40 (6): 1247-51.
- Sihvonen R, Paavola M, Malmivaara A, Itälä A, Joukainen A, Nurmi H, Kalske J, Järvinen T L N. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *N Engl J Med* 2013; 369: 2515-24.
- Sihvonen R, Englund M, Turkiewicz A, Järvinen T L N. Mechanical symptoms as an indication for knee arthroscopy in patients with degenerative meniscus tear: A prospective cohort study. *Osteoarthritis Cartilage* 2016a; 24: 1367-75.
- Sihvonen R, Englund M, Turkiewicz A, Järvinen T L N, Group Finnish Degenerative Meniscal Lesion Study. Mechanical symptoms and arthroscopic partial meniscectomy in patients with degenerative meniscus tear: A secondary analysis of a randomized trial. *Ann Intern Med* 2016b; 164: 449-55.
- Thorlund J B, Hare K B, Lohmander L S. Large increase in arthroscopic meniscus surgery in the middle-aged and older population in Denmark from 2000 to 2011. *Acta Orthop* 2014; 85: 287-92.
- Thorlund J B, Juhl C B, Roos E M, Lohmander L S. Arthroscopic surgery for degenerative knee: Systematic review and meta-analysis of benefits and harms. *BMJ (Clinical research ed.)* 2015; 350: h2747.
- Thorlund J B, Englund M, Christensen R, Nissen N, Pihl K, Jorgensen U, Schjerning J, Lohmander L S. Patient reported outcomes in patients undergoing arthroscopic partial meniscectomy for traumatic or degenerative meniscal tears: Comparative prospective cohort study. *BMJ* 2017; 356: j356.
- Tornbjerg S M, Nissen N, Englund M, Jorgensen U, Schjerning J, Lohmander L S, Thorlund J B. Structural pathology is not related to patient-reported pain and function in patients undergoing meniscal surgery. *Br J Sports Med* 2017; 51(6): 525-30.
- Yim J-H, Seon J-K, Song E-K, Choi J-I, Kim M-C, Lee K-B, Seo H-Y. A comparative study of meniscectomy and nonoperative treatment for degenerative horizontal tears of the medial meniscus. *Am J Sports Med* 2013; 41: 1565-70.