Large increase in arthroscopic meniscus surgery in the middle-aged and older population in Denmark from 2000 to 2011

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Background — Arthroscopic meniscal surgery is the most common orthopedic procedure, and the incidence has increased in Denmark over the last 10 years. Concomitantly, several randomized controlled trials have shown no benefit of arthroscopic procedures including arthroscopic partial meniscectomy in middle-aged and older individuals suffering from knee pain with or without knee osteoarthritis. We examined the annual incidence of meniscal procedures together with age, sex, and diagnosis for patients who underwent meniscal procedures in the period 2000–2011 in Denmark.

Methods — Data on age, sex, diagnosis, and surgical procedures were extracted from the Danish National Patient Register for the years 2000–2011, for all records containing meniscal surgery as a primary or secondary procedure.

Results — The overall annual incidence of meniscal procedures per 100,000 persons in Denmark doubled from 164 in 2000 to 312 in 2011 (i.e. 8,750 procedures to 17,368 procedures). A 2-fold increase was found for patients aged between 35 and 55, and a 3-fold increase was found for those older than 55. Middle-aged and older patients accounted for 75% of all 151,228 meniscal procedures carried out between 2000 and 2011.

Interpretation — The incidence of meniscal procedures performed in Denmark doubled from 2000 to 2011, with the largest increase in middle-aged and older patients. This increase contrasts with the mounting evidence showing no added benefit of arthroscopic partial meniscectomy over non-surgical treatments. Our observations illustrate the long delay in the dissemination, acceptance, and implementation of research evidence into the practice of arthroscopic surgery.

About 1 million arthroscopic knee procedures were performed in 2006 in the USA, of which at least 700,000 were meniscal resections (Cullen et al. 2009). Numbers from Sweden confirm that meniscal procedures are the most common arthroscopic knee procedures (Roos and Lohmander 2009). The Danish media have reported an increased frequency of meniscal procedures over recent years in Denmark, but the precise numbers, sex, and age distribution of the patients and underlying diagnoses have not been reported. In the same time period, several large, high-quality randomized controlled trials (Moseley et al. 2002, Herrlin et al. 2007, Kirkley et al. 2008) have failed to show any benefit of arthroscopic procedures including arthroscopic partial meniscectomy (APM) for middle-aged and older patients suffering from knee pain with or without concomitant features of radiographic knee osteoarthritis (OA) (Table 1).

Previous reports on the frequency of meniscal procedures have either been based on estimation from a number of hospitals (Cullen et al. 2009) or from insurance databases (Abrams et al. 2013). In Denmark, on the other hand, there is a national database on all healthcare procedures performed in public and private hospitals and clinics (Lynge et al. 2011). In addition, all Dasnish residents are registered in the Civil Registration System (Pedersen 2011) and population demographics are publicly available on the internet through Danish Statistics. This allows calculation of annual incidence rates for meniscal procedures based on the entire Danish population.

We examined the number of meniscal procedures performed in Denmark in the years between 2000 and 2011. We also examined age and sex distribution and the diagnosis registered for the patients undergoing these procedures, using data from the Danish National Patient Register.

Patients and methods

The Danish National Patient Register

All patient contacts with public and private hospitals and clin-

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Table 1. Randomized controlled trials comparing arthroscopy including arthroscopic partial meniscectomy with non-surgical interventions

Author and year	Age and OA entry criteria	Intervention groups (n)	Baseline age, mean (SD)	Results (primary outcome)
Moseley et al. 2002	≤ 75 y, OA (ACR criteria)	1) Arthroscopic lavage (61) 2) Arthroscopic debridement including APM (59) 3) Placebo surgery (60)	51.2 (10.5) 53.6 (12.2) 52.0 (11.1)	No difference between groups on Knee-Specific Pain Scale Score at 24-month follow-up
Herrlin et al. 2007 Herrlin et al. 2013	45–64 y, OA grade 0 or 1 (Ahlbäck classification)	1) APM + exercise (47) 2) Exercise (43)	54 57	No difference between groups in KOOS scores at 6-month follow-up No difference between groups in KOOS scores at 60-month follow-up
Kirkley et al. 2008	≥ 18 y, OA grade ≥2 (K&L classification)	1) Arthroscopic surgery including APM + physical and medical therapy (92) 2) Physical and medical therapy (86)	58.6 (10.2) 60.6 (9.9)	No difference between groups in WOMAC scores at 24-month follow-up
Katz et al. 2013	≥ 45 y, OA on MRI (defined as cartilage defects) or radiographs	1) APM + physical therapy (161) 2) Physical therapy (169)	59.0 (7.9) 57.8 (6.8)	No difference between groups in WOMAC physical-function score at 6-month follow-up
Yim et al. 2013	No age criteria, OA grade 0 or 1 (K&L classification)	1) APM + home exercise program (50) 2) 3 weeks supervised rehabilitation program + home exercise program (52)	54.9 (10.3) 57.6 (11.0)	No difference between groups in Lysholm score at 24-month follow-up
Sihvonen et al. 2013	35–65 y, OA grade 0 or 1 (K&L classification)	1) APM (70) 2) Placebo surgery (76)	52 (7) 52 (7)	No difference between groups in Lysholm score, WOMET score, and knee pain after exercise at 12-month follow-up

ACR: American College of Rheumatology; APM: Arthroscopic Partial Meniscectomy; K&L: Kellgren and Lawrence; KOOS: Knee Injury and Osteoarthritis Outcome Score; OA: Osteoarthritis; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; WOMET: Western Ontario Meniscal Evaluation Tool.

ics in Denmark are registered in the Danish National Patient Register (DNPR) (Lynge et al. 2011). Administrative data include the unique personal identification number (the Central Person Register (CPR) number (Pedersen 2011), given to all residents of Denmark and registered in the Civil Registration System), hospital identification, date and time of activity, and patient's municipality (among other characteristics). Clinical data include types of surgical procedures (according to the Nordic Classification of Surgical Procedures (NCSP)) and diagnosis (International Classification of Diseases (ICD-10)). A unique record number can be used to identify each patient contact with the hospital. This record number can be combined with the CPR number to track individual patient contacts within the hospital system.

Since 2000, the DNPR has formed the basis of payment of public and private hospital services via the Diagnostic Related Group (DRG) system (Lynge et al. 2011). It is assumed that registration is complete for public hospitals since 2000. For private hospitals and clinics, however, it is known that reporting is not complete, even though this has been mandatory since 2003. In 2008, it was estimated by the Danish National Board of Health that 5% of all private operations were missing in the DNPR (Lynge et al. 2011). Registration of orthopedic procedures has been reported to be correct in 92% of a sample of cases (inpatients and outpatients), and even better for outpatients alone, whereas numbers were lower for registration of diagnoses (primary diagnoses 83% and secondary diagnoses 77%), but again with better numbers for outpatients (Lass et al. 2006).

Study sample

Data were extracted from the DNPR on all record numbers containing a procedure code(s) for meniscal surgery (KNGD and all sub-codes) as the primary procedure or as part of other surgery in the twelve-year period 2000–2011. For each record, information was extracted on age, sex, diagnosis (primary and secondary), and surgical procedures in addition to meniscal surgery. The CPR number was used to track patients with several meniscal operations (defined as surgery on separate dates) during the study period. For patients with several surgery dates, it could not be determined whether surgery was carried out on the same knee—as left or right side is not registered systematically in the DNPR.

Definitions

Primary surgical procedure: meniscal surgery was considered the primary surgical procedure if the procedure was coded as "V" (V = most important surgical procedure in a finished contact) or "P" (P = most important procedure during a given surgery). Secondary surgical procedure: meniscal surgery was considered a secondary surgical procedure if it was coded as "D" (D = secondary procedure, part of a surgery without being the primary procedure). Thus, several surgical procedures could be conducted at the same surgery. Primary diagnosis:

Table 2. Number of meniscal procedures (all codes) and incidence rate of meniscal procedures per year from 2000 through 2011, gender distribution, and mean age at surgery per year

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Procedures:													
< 35 years, n	3,085	3,020	3,210	3,124	3,036	2,963	2,987	2,971	2,860	3,440	3,706	3,622	38,024
35–55 years, n	4,155	4,440	5,038	5,408	5,567	5,765	5,792	6,399	6,547	8,493	8,765	8,636	75,005
> 55 years, n	1,510	1,675	2,121	2,335	2,468	2,846	2,966	3,482	3,703	4,682	5,301	5,110	38,199
Total, n	8,750	9,135	10,369	10,867	11,071	11,574	11,745	12,852	13,110	16,615	17,772	17,368	151,228
Men, %	64	62	63	62	61	61	60	60	59	60	58	59	60
Women, %	36	38	37	38	39	39	40	40	41	40	42	41	40
Mean age at surgery	41	42	43	43	44	44	45	46	46	46	47	47	45
CI	41–42	41–42	42–43	43–44	43–44	44–44	44–45	45–46	46–46	46–46	46–47	46–47	45-45
Incidence rate (per 10^5 persons/year):													
< 35 years	129	127	136	133	129	126	128	127	122	147	158	155	
upper CI limit	124	122	131	128	125	122	123	123	118	142	153	150	
lower CI limit	133	131	140	137	134	131	132	132	127	152	163	160	
35–55 years	256	272	309	333	344	357	358	394	401	519	535	526	
upper CI limit	248	264	300	324	335	347	349	384	392	508	524	515	
lower CI limit	263	280	317	342	353	366	367	404	411	530	546	538	
> 55 years	114	124	154	166	172	195	200	232	243	303	339	322	
upper CI limit	109	118	147	159	165	188	193	224	235	295	330	313	
lower CI limit	120	130	160	172	179	202	207	239	251	312	348	331	
Total	164	170	193	202	205	214	216	235	239	301	320	312	
upper CI limit	160	167	189	198	201	210	212	231	235	296	316	307	
lower CI limit	167	174	197	205	209	217	220	239	243	305	325	316	

CI: 95% confidence intervals.
Annual incidence rates calculated as number of meniscal procedures performed per 100,000 registered Danish inhabitants.

diagnosis coded as "A" (A = action diagnosis, the diagnosis that best describes the condition of a finalized contact) was considered the primary diagnosis. Secondary diagnosis: diagnosis coded as "B" (B = secondary diagnosis, diagnosis that supplements the description of an ended contact).

Incidence rates

Information on numbers of registered inhabitants in Denmark was retrieved from Danish Statistics (www.statistikbanken.dk). As mid-year data was not available, we estimated the mid-year population from numbers at the beginning and the end of each year in the period from 2000 to 2011. These numbers were used to calculate annual incidence rates per 100,000 persons in the age groups: 0–34 years, 35–55 years, and older than 55 years.

Statistics

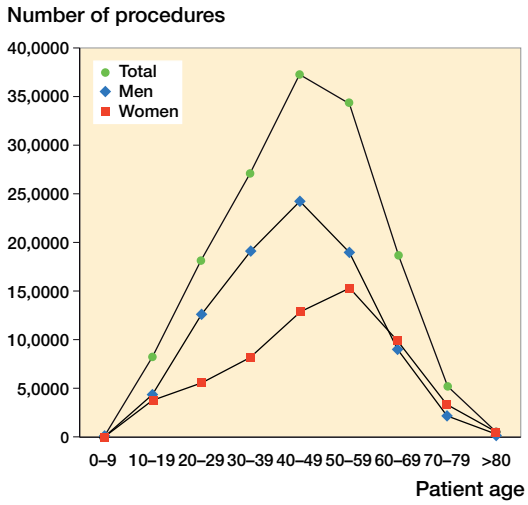
We used chi-square test to assess differences in proportions of meniscal procedures performed on men and women as well as the defined age groups in 2000 as compared to 2011. A 2-sided unpaired Student's t-test, assuming equal variances, was used to assess differences in mean age (with 95% confidence intervals (CIs)) of individuals undergoing meniscal procedures in 2000 as compared to 2011.

Ethics

Data were extracted from the DNPR with approval from Statens Serum Institut (study ID: FSEID 00000526), which is the Danish authority responsible for the DNPR. In addition, the study was approved by the Danish Data Protection Agency (study ID: 2013-41-1792), which must approve all extractions of personal data for research purposes from the DNPR. As the study only pertained to registry-based data, it could be conducted without permission from the Ethics Committee according to Danish legislation (Committee Act § 1, paragraph 1).

Results

The incidence of meniscal procedures per 100,000 persons almost doubled between 2000 and 2011, with a particularly large increase (26%) observed from 2008 to 2009. While the incidence rate was stable in patients younger than 35 years, a doubling was observed for the middle-aged patients between 35 and 55 years of age. For those older than 55, we found a 3-fold increase in incidence rate between 2000 and 2011 (Table 2). This was reflected in a lower proportion of younger patients and a higher proportion of older patients in 2011 compared to 2000 ($p < 0.001$), which also showed in the increase in mean age of patients who underwent meniscal procedures—from 41 (CI: 41–42) in 2000 to 47 (CI: 46–47) in 2011 (Table 2). Middle-aged patients accounted for 50% of the total number of meniscal procedures in the years 2000–2011; the remaining procedures were equally divided between younger (25%) and older patients (25%). Meniscal procedures were carried out in men more frequently than in women (Figure),



Number of meniscal procedures in Denmark (all codes) divided into age groups for the years 2000–2011. Blue: men; red: women; and green: men + women.

but the proportion of women increased from 2000 to 2011 ($p < 0.001$) (Table 2).

The 151,228 meniscal procedures registered between 2000 and 2011 were performed on 148,819 individual patients. Most patients had 1 surgery with 1 meniscal procedure performed, while 1,863 patients had 2 or more meniscal procedures performed at the same operation. Furthermore, 520 patients had more than 1 operation involving procedures to the meniscus within the period 2000–2011. The majority of meniscal procedures (124,363, or 82%) were performed as the primary surgical procedure.

2 NCSP procedure codes accounted for 99% of all 151,228 meniscal procedures. These were KNGD11 (i.e. arthroscopic partial resection of meniscus in knee joint) and KNGD21 (i.e. arthroscopic re-insertion of meniscus in knee joint)—accounting for 92% and 7%, respectively. For those patients with meniscal procedures performed as a secondary surgical procedure (26,865 patients) the most common primary procedures (accounting for 87%) were: anterior cruciate ligament reconstruction (30%: KNGE45*, KNGE51, KNGE55), arthroscopic exploration (28%: KNGA11), synovectomy (18%: KNGF01, KNGF11), and cartilage resection (11%: KNGF31).

Five common diagnoses (i.e. old meniscal tear, traumatic meniscal tear, unspecific knee problems, osteoarthritis, and lesion/rupture of cruciate ligament) represented 80% of all primary diagnoses. Notably, the numbers of diagnoses of "old meniscus tear" and "traumatic meniscus tear" were similar in 2000 (i.e. 2,070 and 2,252, respectively), whereas the diagnosis "old meniscus tear" (n = 5,563) predominated over the diagnosis "traumatic meniscus tear" (n = 3,035) as the primary diagnosis in 2011. Six diagnoses represented 74% of all the secondary diagnoses (Table 3).

Table 3. Most common primary and secondary diagnoses for patients undergoing procedures to the meniscus in the period 2000–2011 in Denmark

	Primary diagnosis	Secondary diagnosis
Old meniscus tear [a]	44,885	9,927
Traumatic meniscus tear [b]	29,163	7,167
Unspecific knee problems [c, d]	28,311	3,277
Osteoarthritis [e, f]	10,860	15,020
Lesion/rupture of cruciate ligament [g, h]	7,999	5,021
Synovitis [i]	–	6,732
Sum of diagnoses above	121,218	47,144
Total number of diagnoses given	151,228	63,618

[a] Primary and secondary diagnosis—old meniscus tear, procedure code DM232.
[b] Primary and secondary diagnosis—traumatic meniscus tear, procedure code DS832.
[c] Primary diagnosis—unspecific knee problems, procedure codes DM23, DM235, DM238, DM239.
[d] Secondary diagnosis—unspecific knee problems, procedure codes DM235, DM238, DM239, DM241.
[e] Primary diagnosis—osteoarthritis, procedure codes DM17, DM170, DM171, DM171A, DM172, DM173, DM175, DM179, DM190, DM199.
[f] Secondary diagnosis—osteoarthritis, procedure codes DM170, DM171, DM171A, DM172, DM173, DM179.
[g] Primary diagnosis—lesion/rupture of cruciate ligament, procedure codes DS835, DS835A, DS835B, DS835E, DS835F.
[h] Secondary diagnosis—lesion/rupture of cruciate ligament, procedure codes DS835, DS835B, DS835E.
[i] Secondary diagnosis—synovitis, procedure codes DM658, DM659, DM659B, DM672, DM673, DM678.

Discussion

The incidence of arthroscopic meniscal procedures in Denmark almost doubled between 2000 and 2011. The largest relative increase in meniscal procedures (i.e. a 3-fold increase in incidence rate) was observed in patients older than 55, whereas the largest absolute increase (i.e. 4,481 procedures) occurred in the middle-aged population between 35 and 55 years of age. In contrast, the incidence rate of meniscal procedures in young patients under 35 was stable. These data suggest that the increased incidence of arthroscopic meniscal surgery mainly involved patients with degenerative meniscal tears, a condition known to be associated with an increased risk of knee osteoarthritis.

Coverage and validity is an important issue for all registries. The validity of registration of orthopedic procedure codes in Denmark has been reported to be good (correct in more than 92% of cases for outpatients), whereas numbers are less precise for diagnosis codes (Lass et al. 2006). It is generally assumed that registration has been complete for public hospitals since 2000, but it is known that reporting is not complete for private hospitals (5% of operations have been estimated to be missing in the DNPR by the Danish National Board of Health) even though this has been mandatory since 2003

(Lynge et al. 2011). In 2005, it was estimated that private payments accounted for around 15% of all healthcare expenses in Denmark (Folketinget 2007). Thus, the numbers in our study may have been underestimated, and some of the changes observed may have been due to variable completeness of reporting. Nevertheless, in comparison to other studies that have reported incidence rates of surgical procedures (Cullen et al. 2009, Abrams et al. 2013), the unique registration of all hospital contacts and concomitantly performed procedures in Denmark, along with the Danish population data, enable reliable estimation of time-related trends in surgical procedures.

Meniscal tears are often associated—by both healthcare professionals and lay-persons—with traumatic sports injuries in young, active individuals (Englund et al. 2012). However, reports from Sweden and the USA show that APM is most often performed in individuals between 45 and 64 years of age (Cullen et al. 2009, Roos and Lohmander 2009, Abrams et al. 2013) Other reports have shown that meniscal tears are also common in asymptomatic knees (Zanetti et al. 2003, Boks et al. 2006, Englund et al. 2007, 2008). Thus, meniscal tears as well as other structural abnormalities characteristic of knee OA (i.e. osteophytes, bone marrow lesions, cartilage damage, etc.) are common incidental findings at MRI examination of both asymptomatic and painful knees of middle-aged and older patients (Englund et al. 2008, Guermazi et al. 2012). Incidental meniscal lesions in these age groups are often of the "degenerative" type and frequently occur in the absence of a distinct trauma but in the presence of other structural joint changes characteristic of knee OA (Englund et al. 2008, 2009).

Taken together, these reports suggest that in the middle-aged and older population, any association between meniscal damage and the development of frequent knee pain exists because both pain and meniscal damage are related to knee OA and not because of a direct link between meniscal tears and pain (Englund et al. 2007, 2008). In our study, only about 17% of those treated with APM had knee OA as the primary or secondary diagnosis. However, the validity of this proportion is limited by the lack of clear diagnostic criteria for OA in the DNPR database, and perhaps also in clinical practice. It is notable that the most frequent primary diagnosis was "old meniscus tear", which commonly occurs in the presence of osteoarthritic joint changes. This primary diagnosis increased 2.7 fold between 2000 and 2011, while the diagnosis of traumatic meniscal tear increased only by a factor of 1.3 in the same time period. Only 1 in 4 of the primary diagnoses were represented by "traumatic meniscus tear" or "anterior cruciate ligament tear".

Consistent with the results from Sweden and the USA (Cullen et al. 2009, Roos and Lohmander 2009), we observed that middle-aged and older individuals accounted for 75% of all meniscal procedures in Denmark between 2000 and 2011. Of the 8,618 additional procedures performed in 2011 compared to 2000, essentially the entire increase was in those aged 35–55 years (4,481 procedures) and in those older than 55 (3,600 procedures). The increasing incidence of APM in the middle-aged and older groups between 2000 and 2011 is surprising, in light of the 3 high-quality randomized controlled trials (RCT) published in the same time period that failed to show any benefit of arthroscopic interventions including APM over and above that of placebo surgery, physiotherapy alone, or physiotherapy in combination with other medical treatments for patients in the same age groups, with or without features of knee osteoarthritis (Moseley et al. 2002, Herrlin et al. 2007, Kirkley et al. 2008) (Table 1). Further consolidating these results, 3 more recent RCTs and an extended follow-up of a previous RCT (Herrlin et al. 2013) showed no additional benefit of APM in combination with physiotherapy compared to physiotherapy alone for patients with meniscal tears and knee osteoarthritis (Katz et al. 2013), no superior effect of APM in comparison to 3 weeks of supervised exercise for middle-aged patients with meniscal tears (Yim et al. 2013), and no difference between APM and placebo surgery in middle-aged patients with meniscal tears and no features of knee OA (Sihvonen et al. 2013) (Table 1). The recent study by Sihvonen et al. (2013) extended previous findings by showing that there was no benefit of APM for middle-aged or older patients with "degenerative" meniscal tears even in the absence of radiographic signs of osteoarthritis. Other studies comparing APM to placebo surgery (Hare et al. 2013) and APM to exercise (ClinicalTrials.gov Identifier: NCT01002794) are under way and may provide further information.

Arthroscopic surgery of the knee is considered to be low-risk surgery. However, the procedures discussed here have been reported to be associated with a 2–3% frequency of adverse events, including deep venous thrombosis, infections, surgical complications, cardiovascular events, pulmonary embolism, and death within 3 months (Noble et al. 1998, Wai et al. 2002, Salzler et al. 2013, Valdes et al. 2013). Some of these adverse events may represent avoidable harm.

In conclusion, a large increase in the incidence of arthroscopic meniscal procedures in middle-aged and older individuals occurred between 2000 and 2011 in Denmark. This increase took place in spite of increasing high-level evidence for a lack of added benefit provided by APM over other treatments in middle-aged and older individuals with and without features of knee OA. Our observations emphasize the long delay in the dissemination, acceptance, and implementation of high-level clinical evidence into the practice of arthroscopic surgery.

JBT and LSL conceived the study. JBT and KBH were responsible for the collection and analysis of data, and all the authors contributed to the interpretation of the data. JBT drafted the manuscript, which was critically revised by KBH and LSL. All the authors approved the final version of the manuscript.

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