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Twelve-year outcomes of watchful waiting versus surgery of mildly symptomatic or asymptomatic inguinal hernia in men aged 50 years and older: a randomised controlled trial

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Summary

Background Inguinal hernia belongs to the most common surgical pathology worldwide. Approximately, one third is asymptomatic. The value of watchful waiting (WW) in patients with asymptomatic or mildly symptomatic inguinal hernia has been established in a few randomised controlled trials (RCTs). The aim of this study was to assess long-term outcomes of a RCT comparing WW and elective surgery.

Methods In the original study, men aged ≥50 years with an asymptomatic or mildly symptomatic inguinal hernia were randomly assigned to WW or elective repair. In the present study, the primary outcome was the 12-year crossover rate to surgery, secondary outcomes were time-to-crossover, patient regret, pain, quality of life and incarceration. Dutch Trial Registry: NTR629.

Findings Out of 496 originally analysed patients, 488 (98.4%) were evaluable for chart review (WW: n = 258, surgery: n = 230), and 200 (41.0%) for telephone contact (WW: n = 106, surgery: n = 94) between November 2021 and March 2022 with a median 12 years follow-up (IQR 9–14). After 12 years, the estimated cumulative crossover rate to surgery was 64.2%, which was higher in mildly symptomatic than in asymptomatic patients (71.7% versus 60.4%, HR 1.451, 95% CI: 1.064–1.979). Time-to-crossover was longer in asymptomatic patients (50% after 6.0 years versus 2.0 years, p = 0.019). Patient regret was higher in the WW group (37.7 versus 18.0%, p = 0.002), as well as pain/discomfort (p = 0.031). Quality of life did not differ (p = 0.737). In the WW group, incarceration occurred in 10/255 patients (3.9%).

Interpretation During 12-year follow-up, most WW patients crossed over to surgery, significantly earlier with mildly symptomatic hernia. Considering the relatively low incarceration rate, WW might still be an option in asymptomatic patients with a clear preference and being well-informed about pros and cons.

Funding The initial trial was funded by the Netherlands Organisation for Health Research and Development (ZonMW). This long-term study did not receive funding.

Keywords: Inguinal hernia; Watchful waiting; Herniorrhaphy; Recurrence; Crossover

Introduction

Inguinal hernia is one of the most common surgical pathologies worldwide.[1] Annually, more than twenty million procedures are performed.[2] Symptoms that can arise due to inguinal hernias include bulging, discomfort and pain, and a yearly hernia incarceration rate of 0.4% (range 0.2%–2.7%) have been reported.[3] Traditionally, surgery is the mainstay of treatment of inguinal

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Research in context

Evidence before this study

Inguinal hernia is one of the most common surgical pathologies worldwide. Approximately, one third of patients with inguinal hernia is asymptomatic or mildly symptomatic. Traditionally, surgery is the mainstay of treatment of inguinal hernias. However, randomised controlled trials have shown that watchful waiting is a justifiable treatment option since risk of incarceration is low, but inguinal hernias might become increasingly symptomatic in due course.

Earlier findings from randomized controlled trials and meta-analyses demonstrated that watchful waiting is a justifiable alternative to primary surgery for asymptomatic or mildly symptomatic inguinal hernia. However, many patients crossover to surgery and long-term data is scarce. The HerniaSurge guidelines state that: "the majority of these individuals will eventually require surgery; therefore, surgical risks and the watchful waiting strategy should be discussed with patients. Surgical treatment should be tailored to the surgeon's expertise, patient- and hernia-related characteristics and local/national resources."

We can conclude that there is no strict consensus regarding this topic, and it does not render the watchful waiting strategy inferior to primary surgery.

A systematic computerized literature search was performed until January 2023, with the keywords "inguinal hernia", "asymptomatic", "watchful waiting". We did not restrict our search by language. Two researchers reviewed all records independently. We included prospective randomised controlled trials that enrolled patients aged 18 years or older with asymptomatic or minimally symptomatic hernia. All records were independently reviewed by two researchers. Only prospective randomized controlled trials were included if these met the following inclusion criteria: patients aged ≥18 years, asymptomatic or minimally symptomatic inguinal hernia, watchful waiting versus surgery.

In total, 3 randomized controlled trials and two follow-up studies were evaluated. Two studies only included middle aged men and one study included all ages. Watchful waiting was a viable alternative in the three randomized controlled trials, however a fairly high number of patients crossed over to surgery in the two follow-up studies. One study determined the watchful waiting regimen to be obsolete, the other study did not.

Added value of this study

Overall, the findings of the long-term follow-up of the INCA trial is the first study to show that mildly symptomatic men crossover significantly earlier than asymptomatic men with very low chance on perpetual inguinal complaints.

Incarceration rate is 3.9% and a high rate of crossover after watchful waiting strategy is seen. This study is the first to show that significantly more patients had regret of their watchful waiting strategy. However, since delayed crossover surgery still seems a safe treatment, it is a valid option for asymptomatic, comorbid elderly patients or patients deterring surgery during a shared decision-making process with the surgeon.

Implications of all the available evidence

The long-term follow-up of the INCA trial provides valuable data for surgeons in their shared decision-making processes in men with asymptomatic or mildly symptomatic inguinal hernia. If the patient is well informed, the surgeon does not have to doubt its decision for primary surgery. Together with the previously published RCTs, it provides final level-1 evidence.

hernias.[2] This is due to the availability of relatively safe surgical procedures in an elective setting. Even more, with contemporary laparoscopic techniques, reported mortality is around 0.2%, while in an emergency setting the mortality rate increases to 4% as found by the INCA Trialists' Collaboration.[3]

Surgery for asymptomatic or mildly symptomatic inguinal hernia might lead to postoperative or even chronic pain. For this reason, watchful waiting (WW) was introduced as an alternative to elective surgery. The INCA trial by our research group[4] as well as similar randomised studies by O'Dwyer et al.[5] and Fitzgibbons et al.[6] were conducted to determine the optimal treatment approach. These trials revealed that asymptomatic or mildly symptomatic hernias might become increasingly symptomatic in due course, but risk of incarceration is low (<5%). Based on three-year follow-up of the INCA trial, it was concluded that WW is a justifiable treatment option in men aged fifty years and older with asymptomatic or mildly symptomatic inguinal hernia.[4]

The main purpose of this study was to assess the long-term crossover rate of WW to surgery in the experimental arm of the INCA trial. Secondarily, we aimed to assess time to crossover, patient regret having received assigned treatment, risk of incarceration, long-term inguinal pain/discomfort, and Quality of Life (QoL). In addition, risk factors for crossover and characteristics and outcomes of delayed surgery after WW were determined.

Methods

Study design

The INCA trial was registered in the Dutch Trial Register and is found in the ICTRP search portal ID number: NTR629. The design and methodology of the INCA trial and primary outcome data have been

previously published in detail.[4] In brief, 35 centres across the Netherlands and Belgium included men aged fifty years and older with asymptomatic or mildly symptomatic inguinal hernia between 2006 and 2012. Age criteria were chosen since men aged fifty since they might benefit less from primary surgery than men of young age. Patients were randomly assigned to WW or elective repair. Inguinal hernia diagnosis was performed by physical examination and in doubt by ultrasound. Exclusion criteria were bilateral, scrotal or femoral hernia, or an American Society of Anaesthesiologist (ASA) class 4.[7] After they had given informed consent, patients were randomised to WW or elective surgery. Primary outcome was the mean difference in the 4-point pain/discomfort score regarding the affected inguinal area after 24 months. Patients who crossed over from the WW strategy to surgery were referred to as 'crossover patients'.

For the present study, all available medical records were assessed by visiting the participating centres. Patients allocated to the WW arm of the INCA trial were reviewed for possible crossover, time to crossover, and characteristics and perioperative outcomes of delayed surgery. Patients who were randomised into the surgery group were reviewed for possible recurrences diagnosed by the attending surgeon. Last out-patient visit was recorded as last date of follow-up. Survival status was checked before contacting patients. Next to the chart review, patients still alive were asked for participation in telephone follow-up, which could be declined through returning a prepaid post letter. During telephone follow-up between November 2021 and March 2022, patients were interviewed about complaints of the inguinal area, crossover, worries about the WW strategy, and potentially perceived hernia recurrence. In addition, the EQ-5D QoL questionnaire was completed by telephone.[8]

Complaints related to the inguinal area were assessed through the 4-point pain/discomfort score as used in the original trial which comprised the following categories.

0 No pain or discomfort due to the hernia when working, exercising or performing any of a patient's usual activities.
1 Mild pain or discomfort due to the hernia when working and exercising that does not prevent a patient from performing his usual activities.
2 Moderate pain or discomfort due to the hernia when working, exercising, and performing any of a patient's usual activities.
3 Severe pain or discomfort due to the hernia when working, exercising, and performing any of a patient's usual activities.

Patients were considered asymptomatic with a score of 0, and mildly symptomatic with 1.

Primary and secondary outcomes

The primary outcome was the cumulative crossover rate in patients who were initially randomised in the WW group at twelve years from randomisation. Secondary outcomes comprised time to crossover, patient regret having received assigned treatment, incarceration rate, the 4-point pain/discomfort score as reported during telephone contact, and QoL as assessed by the EQ-5D questionnaire. Patients were questioned about complaints of their inguinal area with the use of the 4-point pain/discomfort score, whether they were satisfied with the initial treatment allocation, and if they would choose the same treatment regimen if developing another inguinal hernia. If patients responded with no, it was considered that a patient had regretted the treatment allocation. Furthermore, the five questions of the EQ-5D questionnaire were asked.

Hernia details that were collected in case of crossover and/or recurrence(s) consisted of: side, uni- or bilateral, and type (medial or lateral). Surgical characteristics included operative time, technique, type of mesh and type of anaesthesia. Registered complications included hernia-related complications (i.e. incarceration, strangulation), postoperative complications, recurrence and reoperation. Incarceration was defined as an acutely painful groin without possibility of spontaneous hernia reposition. Complications were graded according to the Clavien-Dindo classification.[9]

Statistical analysis

For analysing the primary endpoint, cumulative incidence plots were calculated for estimating the cumulative crossover rate to surgery. Time-to-event was calculated from the date of randomisation until crossover, and patients were censored on the date of their last known in-hospital contact. All patients who died were therefore censored before the date of death. The log-rank test was used to compare the cumulative crossover rate between asymptomatic and mildly symptomatic patients in the WW group.

Baseline characteristics of evaluable patients in the WW group with or without crossover to surgery were analysed using univariable Cox proportional hazard models to identify possible risk factors. Potential risk factors for crossover included age, BMI, smoking, pulmonary disease, health status (i.e. independent or not independent on help in functioning in daily life), asymptomatic or mildly symptomatic hernia at time of randomisation, ASA classification, primary or recurrent inguinal hernia, and reducibility of the inguinal hernia (i.e. spontaneously or not spontaneously). The proportional hazards assumption was assessed visually with Schoenfield residual plots.

Characteristics of patients who were available for telephone contact from the WW and surgery groups were compared using chi-square tests or Fisher exact tests for categorical variables or independent samples *t*

tests or Mann–Whitney tests for continuous variables. Differences found in the 4-point pain/discomfort and treatment evaluation were calculated by crosstabulation and chi-square test, and differences in EQ-5D mean scores by t-test.

A p-value of <0.05 was considered statistically significant. Statistical analysis was performed with SPSS software, version 26.0 (IBM Corp. 2020, Armonk, NY).

Role of the funding source

The initial trial was funded by the Netherlands Organisation for HealthResearch and Development (ZonMW). This long-term study did not receive funding. The funders had no role in study design, conducting of the study, data collection, data analysis, data interpretation, or writing of the report. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Study population

A total of 528 patients were randomised. After exclusion, 496 patients were included in the original trial with three-year follow-up (Fig. 1). Between November 2021 and March 2022, medical records were reviewed in 488 of the 496 (98.4%) men (n = 258 WW, n = 230 surgery). The baseline characteristics of all 496 patients included is shown in Supplemental Table S1. Baseline characteristics were well balanced between treatment groups. During long-term follow-up, 101 (20.6%) men had died, and 200 (41.0%) were available for telephone follow-up (n = 106 WW, n = 94 surgery; Table 1). Median follow-up time from randomisation until the last hospital visit or phone contact was twelve years (IQR 9–14). The flowchart is presented in Fig. 1.

Primary endpoint

In the WW group, 157 of the 258 evaluable patients crossed over to surgery, with a cumulative twelve-year crossover rate of 64.2% (95% CI: 57.7%–70.6%) (Fig. 2). Kaplan–Meier analysis estimated that 50.0% of patients crossed over to surgery after 5 years (95% CI: 3.6–6.3) from randomisation, and 73.1% (95% CI: 80.9–65.8%) after 15 years of follow-up (Supplemental Table S2). When comparing asymptomatic with mildly symptomatic patients (144 vs 114), the cumulative twelve-year crossover rate was 71.7% versus 60.4% (HR 1.456 (95% CI 1.065–1.989), and the median time-to-crossover was 2.0 years (95% CI: 1.8–4.2) and 6.0 years (95% CI: 2.9–9.1; p = 0.019), respectively (Fig. 3).

Reasons for crossing over are depicted in Table 2. The most prevalent reason was increased pain or discomfort (79.6%). No mortality was recorded and patients recovered without lasting sequelae. Ten patients developed incarceration (3.9%), which occurred within two years in 6, after three years in 1, and in between 9 and 13 years in 3 patients. All patients who presented themselves with an incarceration were scheduled for emergency surgery.

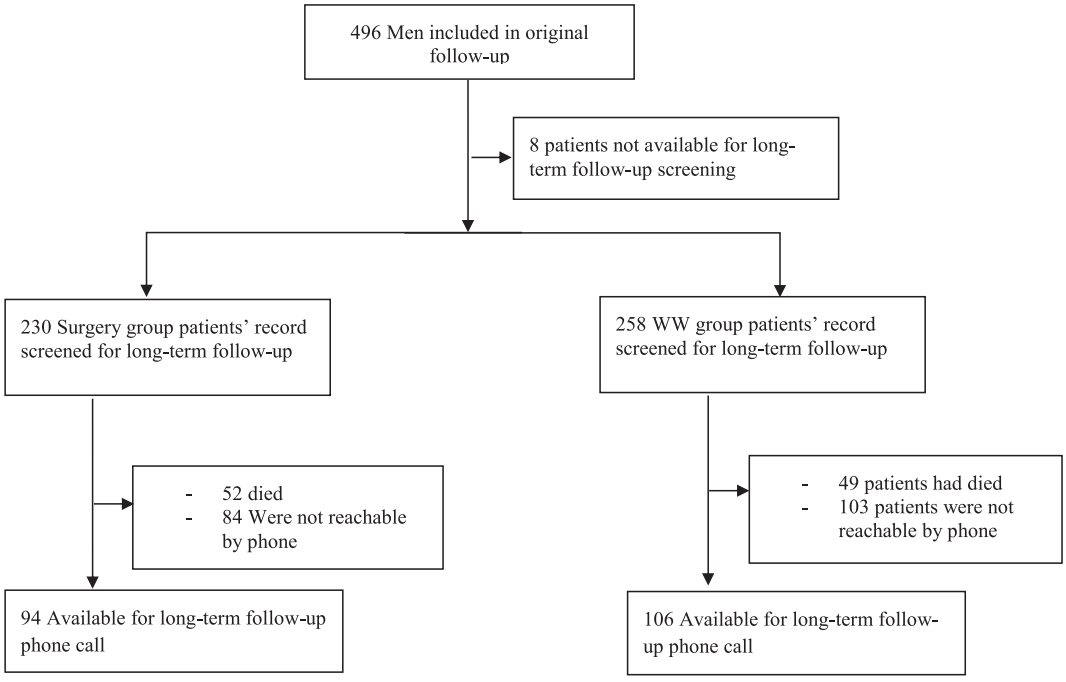

Fig. 1: **Flowchart of long-term follow-up.**

Characteristic	Watchful waiting (n = 106)	Elective repair (n = 94)	p-value
Age–yr (mean, SD)	65.6 (6.64)	61.3 (6.4)	0.154
BMI[a]–kg/m^2 (mean, SD)	24.5 (2.5)	24.6 (2.6)	0.734
Smoking–n (%)			
Current	19 (18.8)	18 (19.8)	0.622
Former	42 (41.6)	43 (47.3)	
None	40 (39.6)	30 (33.0)	
Packyears–yr (median, range)	5.0 (60.0)	6.0 (90.0)	0.891
ASA[a] classification–n (%)			0.156
1	68 (63.0)	71 (75.5)	
2	38 (35.2)	22 (23.4)	
3	2 (1.9)	1 (1.1)	
Cardiovascular system–n (%)			0.620
Angina	2 (1.9)	1 (1.0)	
Hypertension	15 (13.9)	14 (14.6)	
MI[a]	0	2 (2.1)	
Cardiac arrhythmia	7 (6.5)	5 (5.2)	
Other	1 (0.9)	0	
TIA[a] or stroke–n (%)	5 (4.6)	–	0.062
Diabetes Mellitus–n (%)	7 (6.5)	5 (5.2)	0.773
Medication–n (%)			
Aspirin	12 (11.2)	2 (2.1)	**0.013**
Anticoagulants	11 (10.2)	3 (3.2)	0.057
Pulmonary system–n (%)			
COPD[a]	5 (4.6)	1 (1.0)	0.396
Chronic cough	2 (1.9)	1 (1.0)	
Other	1 (0.9)	2 (2.1)	
Gastro-intestinal system–n (%)			
Liver cirrhosis	–	–	
Constipation	1 (0.9)	–	1.0
Back problems–n (%)	7 (6.5)	7 (7.3)	1.0
Urinary tract–n (%)			0.610
Prostate cancer	2 (1.9)	2 (2.1)	
BPH[a]	6 (5.6)	5 (5.2)	
Urinary complaints	2 (1.9)	–	
Health status–n (%)			0.266
Independent	105 (99.0)	94 (100.0)	
Partly dependent	1 (1.0)	–	
Totally dependent	–	–	
Hernia symptoms–n (%)			0.375
Asymptomatic	62 (58.5)	48 (51.1)	
Mildly symptomatic	44 (41.5)	44 (46.8)	
Hernia reducibility–n (%)			0.411
Spontaneous	72 (67.9)	66 (70.2)	
Not spontaneous	34 (32.1)	24 (25.5)	

Statistically significant values are indicated in bold. [a]BMI = Body Mass Index, ASA = American Society of Anesthesiologists, MI = Myocardial Infarction, TIA = Transient Ischemic Attack, COPD = Chronic Obstructive Pulmonary Disease, BPH = Benign Prostate Hyperplasia.

Table 1: **Baseline characteristics of patients available for telephone contact at time of inclusion.**

In univariable Cox regression analysis (Table 3), preoperative pain was the only significant characteristic for crossover to surgery. Tests of the proportional hazards' assumption showed no violation for each independent variable.

Crossover surgery after WW

The hernia and surgical characteristics of the patients who crossed over to surgery are depicted in Table 4. Lichtenstein was the most often used technique (65.0%), and most surgeries were performed under general anaesthesia.

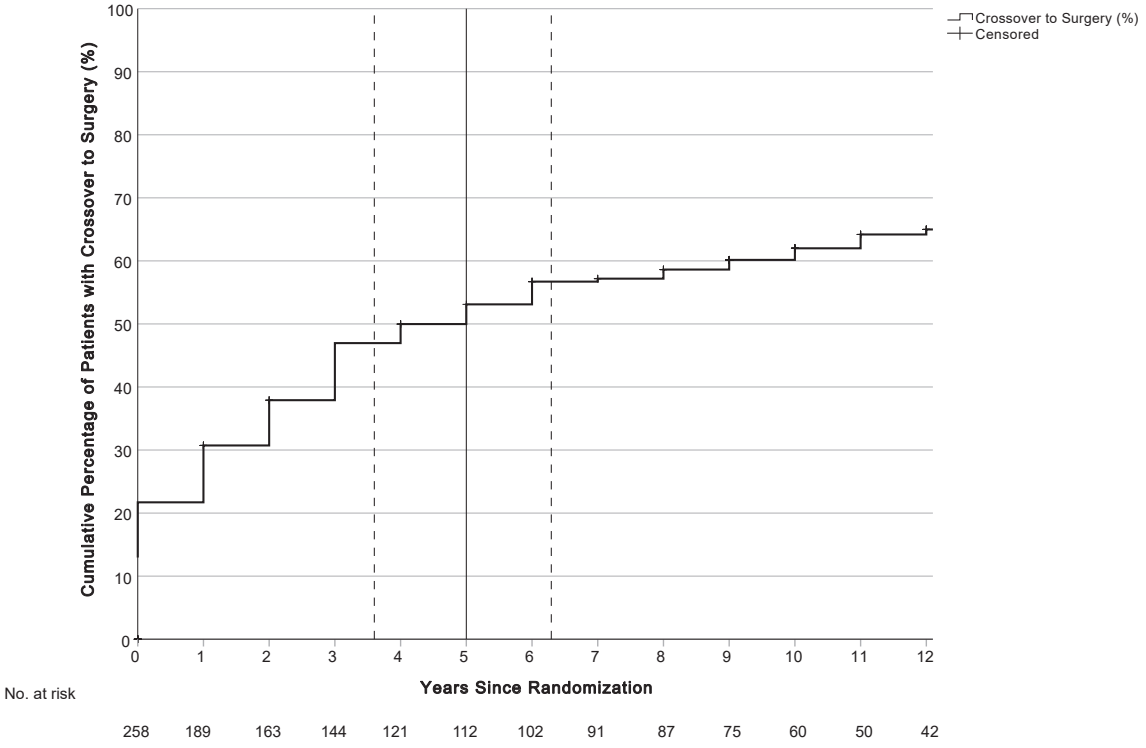

Fig. 2: Cumulative crossover rate of patients with WW with median time to crossover and 95% CI (vertical lines).

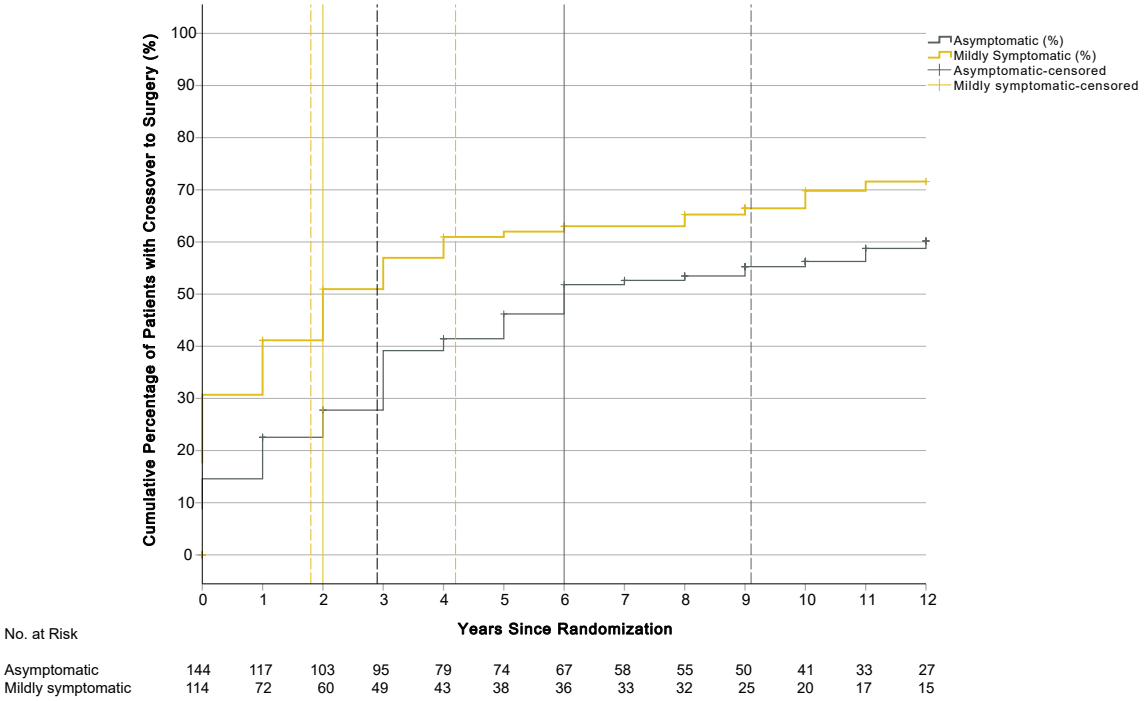

Fig. 3: Cumulative crossover rate of asymptomatic versus mildly symptomatic patients with median time to crossover and 95% CI (vertical lines).

	All crossovers to surgery N = 157 (%)
Reason for crossing over	
Increased pain	60 (38.2)
Increased discomfort	65 (41.4)
Incarceration	10 (6.4)
Other reason	21 (13.4)

Table 2: **Reasons for crossover from WW to surgery.**

Postoperative complications occurred in 15/157 (9.5%) patients (Table 4). Grade II complications consisted of wound infections treated by antibiotic. One patient underwent debridement of haematoma (Grade IIIa), and another patient underwent re-exploration because of active bleeding (grade IIIb). After a median of eleven years (IQR 7–13) from surgery, sixteen (10.2%) recurrences were found.

Telephone questionnaire

The outcomes of the telephone questionnaire are shown in Table 5. Median follow-up time from randomization to telephone contact was 13 years (IQR 11.3–14.0). In the surgery group, 90.4% of patients reported to have no pain or discomfort of their inguinal area, compared to 80.2% who were randomised to WW (p = 0.031). When asked whether patients would choose the same treatment strategy again if developing a new inguinal hernia, significantly more patients (37.7% versus 18.0%) in the WW group answered that they would not choose the same strategy again (p = 0.002). Thirty-three (82.5%) out of the forty patients in the WW group who answered 'no' to choosing the same strategy again crossed over to surgery.

In the WW group, twelve patients (11.3%) reported that they had moderate concerns about their inguinal hernia, with three patients (2.8%) reporting to have been very concerned. One of these very concerned patients suffered from an incarcerated hernia. Mean QoL score per EQ-5D questionnaire was similar between WW and surgery (p = 0.737). When comparing patients who crossed over with patients who did not, EQ-5D scores were also non-significant (p = 0.614).

Discussion

The present study found an estimated cumulative crossover rate to surgery of 64.4% after twelve years in men aged fifty years and older with asymptomatic or mildly symptomatic inguinal hernia who were originally assigned to a WW strategy. Interestingly, a substantial difference in time-to-crossover between the asymptomatic and mildly symptomatic patients was found, while the cumulative proportion of crossover differed only 11%. Incarceration occurred in 3.9% of WW patients. Regret about the assigned treatment was significantly higher in the WW group.

The current study indicates that patients with mildly symptomatic inguinal hernia, crossover more often and earlier than patients with an asymptomatic inguinal hernia. Patients with a mildly symptomatic inguinal hernia should be well informed about the likelihood of crossover to surgery. The rate of crossover in this group is as high as 50% within two years and after 12 years appears to be 71.7%.

In a recently published article by Fitzgibbons and colleagues evaluating the available evidence for WW, the

Characteristics	Univariable analysis	
	HR (95% CI)	p-value
Age group (<65 or ≥65 years)	0.891 (0.648–1.226)	0.478
BMI (kg/m^2)	1.018 (0.958–1.083)	0.561
Smoking (yes/no)	0.832 (0.549–1.263)	0.389
Pulmonary disease (yes/no)	0.935 (0.626–1.398)	0.745
Health Status[a] (independent/not independent)	1.377 (0.565–3.360)	0.482
ASA Classification		
I	Ref	
II	1.056 (0.757–1.473)	0.750
III	1.079 (0.544–2.140)	0.827
Cardiovascular disease (yes/no)	1.011 (0.717–1.425)	0.950
Diabetes (yes/no)	0.738 (0.362–1.503)	0.399
Neurological diseases (yes/no)	0.916 (0.467–1.797)	0.799
Musculoskeletal disease (yes/no)	1.680 (0.885–3.191)	0.113
Mildly symptomatic (yes/no)	1.456 (1.065–1.989)	**0.019**
Type of hernia (primary/recurrent)	1.349 (0.596–3.053)	0.473
Reducibility of inguinal hernia (spontaneously/not spontaneously)	1.353 (0.977–1.873)	0.069

Statistically significant values are indicated in bold. [a]Independent functioning in daily life or partially/totally dependent on help for functioning in daily life.

Table 3: **Univariable Cox proportional regression analysis of crossover to surgery of the total amount of WW patients (n = 258) and events of crossover (n = 157).**

	N = 157 (%)
Hernia side	
Left	60 (38.2)
Right	80 (51.0)
Left + Right	11 (7.0)
Unknown	3 (1.9)
Type of hernia	
Medial	49 (31.2)
Lateral	52 (33.1)
Medial and lateral	16 (10.2)
Unknown	14 (8.9)
Surgical Technique	
Lichtenstein	102 (65.0)
TEP	29 (18.5)
TAPP	5 (3.2)
Unknown	20 (12.7)
Surgical time (min)	48.8
Type of mesh	
Flat mesh	115 (73.2)
Three-dimensional mesh	15 (9.6)
Not reported	27 (17.2)
Type of anaesthesia	
General	69 (43.9)
Spinal	64 (40.8)
Local	11 (7.0)
Not reported	13 (8.3)
Postoperative complications[a]	
Grade I	7 (4.4)
Grade II	6 (3.8)
Grade IIIa	1 (0.6)
Grade IIIb	1 (0.6)
Recurrence	16 (10.2)

[a]As graded by the Clavien-Dindo classification of postoperative complications.[9]

Table 4: **Hernia and surgical characteristics of the crossover group.**

authors concluded that patients opting for WW should be informed that they probably only delay their surgery rather than avert it.[10] This is also underlined by a recent systematic review comparing WW versus repair in asymptomatic or minimally symptomatic inguinal hernia.[11] However, it cannot be denied that one quarter of the INCA patients included in the WW group did not require surgery after a median of twelve years of follow-up, and 50% of patients did not crossover to surgery before five years. Taking into account all the beneficial aspects (i.e. no postoperative complications, no chronic postoperative pain risk, lower hospital costs), it does not seem justified to conclude that a WW strategy has become obsolete. Furthermore, patients with high age and many comorbidities will probably not gain high QoL from surgery compared to middle aged, active individuals. Given the only 11% difference in crossover, WW with delayed surgery might still be a treatment option in fully informed patients with an asymptomatic hernia.

Risk of incarceration during WW is an often-raised argument in favor of primary surgical treatment. Incarcerations occurred in 3.9%, without associated mortality or substantial morbidity. Despite bowel resections are often required, none of these patients experienced long-term health status deterioration. However, notion should be made that due to densely populated Netherlands, healthcare for these emergency situations is readily available. In more rural parts of the world where people have to travel longer distances to a medical center with surgical capabilities/facilities, these incarcerations could impose a life-threatening complication. For delayed hernia repair after WW overall, a 10% recurrence rate was found, which is rather high. This might partially be explained by a certain proportion of emergency surgery, and likely reflects routine daily practice in non-expert hernia centers with long-term follow-up.

Patient well-being and QoL are also important aspects for decision making in the asymptomatic and mildly symptomatic group. Compared to the WW group, significantly more patients were satisfied with the surgical treatment. This could be due to the fact that people who crossed over to surgery, and did not develop long-term pain complaints, are more likely to be dissatisfied with the WW strategy. Furthermore, patients who crossed over to surgery will likely remember the last period they had their inguinal hernia, which was likely worse than at the at time of randomisation. Patients could not decide for themselves due to treatment allocation in a trial setting. Nevertheless, the difference in self-reported satisfaction is appreciable, and might be indicative for the natural course of inguinal hernia-related complaints.

The finding that QoL did not significantly differ between WW and surgery, and crossover or successful WW during long-term follow-up might be due to senescence. Patients might have developed other more debilitating comorbidities among both treatment groups. In addition, due to the COVID-19 regulations in The Netherlands at the end of 2021, more patients during the telephone consultation mentioned suffering from anxiety or depression symptoms during lockdowns that took place.

One of the limitations of the current study is that 200 of 387 patients were available for phone call, which might have introduced selection bias. However, baseline characteristics of those contacted by telephone were similar. Furthermore, attrition and loss of follow-up data is expected during long-term follow-up. While almost every patients' medical record had been screened, it cannot be ruled out that some patients had their crossover surgery in another hospital. However, 200 patients were available for telephone contact and were asked whether they had undergone hernia surgery from a different institution.

In conclusion, the results of this update of the INCA trial with twelve-year follow-up indicate that a WW strategy for asymptomatic or mildly symptomatic inguinal hernia results in crossover to surgery in about

	WW group n = 35[a] + 71[b] = 106	Surgery group n = 94 (%)	p-value
4-point pain/discomfort score			**0.031**
No pain or discomfort due to the hernia/inguinal area when working, exercising or performing any of a patient's usual activities	85 (80.2)	85 (90.4)	
Mild pain or discomfort due to the hernia/inguinal area when working and exercising that does not prevent a patient from performing his usual activities	20 (18.9)	6 (6.4)	
Moderate pain or discomfort due to the hernia/inguinal area when working, exercising, and performing any of a patient's usual activities	1 (0.9)	1 (1.1)	
Severe pain or discomfort due to the hernia/inguinal area when working, exercising, and performing any of a patient's usual activities	0	2 (2.1)	
Were you worried about your hernia while watchful waiting?			
Not concerned	86 (81.1)		
Moderately concerned	12 (11.3)		
Very concerned	3 (2.8)		
If you would develop a new inguinal hernia, would you choose the same treatment strategy?			**0.002**
Yes	66 (62.3)	77 (82.0)	
No	40 (37.7)	17 (18.0)	
Have you developed any other abdominal wall hernia?			0.089
Yes	7 (6.6)	13 (13.8)	
No	99 (93.4)	81 (86.2)	
Do you feel you have developed a recurrent inguinal hernia?			0.288
Yes	5 (7.1)	11 (11.7)	
No	65 (92.9)	79 (84.0)	
EQ-5D questionnaire			
	0.895 (0.154)	0.887 (0.175)	0.737

Statistically significant values are indicated in bold. [a]Patients that remained in the WW group. [b]Patients that crossed over to the surgery group.

Table 5: **Long-term self-reported outcomes between WW and surgery.**

three-quarters of patients in the long-term, with very low chance on perpetual postoperative inguinal complaints. Incarceration occurred in 3.9% of WW patients with events occurring up to thirteen years of follow-up. Crossover occurs more frequent and significantly earlier when patients present themselves with mildly symptomatic inguinal hernia, when compared to asymptomatic inguinal hernia. Because delayed crossover surgery still seems a safe treatment, WW strategy might still be an option in asymptomatic patients with a clear preference. This should be counseled in a shared decision-making process in which all pros and cons are clearly addressed by the surgeon.

Contributors

LMD, conceptualised the study, curated the data, analysed the data, and drafted the manuscript including all tables and figures. SvE and JH assisted in the data curation and writing of the manuscript. BdG, ARW, GK, PJT, JJ and JFL assisted in the interpretation of the data and helped drafting the manuscript. JFL, JJ, PJT and GK supervised the methodology of the study protocol and supervised the study. BdG, ARW, GK, JJ and JFL were involved in the design of the INCA trial. All authors reviewed and approved the final version of the manuscript. LMD and JR accessed and verified the analyses. All authors had full access to all the data in the study and all authors had final responsibility for the decision to submit for publication.

Data sharing statement

The datasets, pseudonymized individual participant data and a data dictionary defining each field in the set used or analysed during the current study, can be available upon reasonable request to the corresponding author (L.M. van den Dop). Requests for data can be submitted by e-mail (l.vandendop@erasmusmc.nl). The predefined study protocol will be published.

Declaration of interests

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2023.102207.

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