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Original Article

Open surgical repair of hip abductor tendon tears

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ABSTRACT

INTRODUCTION. Tendinopathy and tendon tears of the gluteus medius and/or minimus (GMM) insertion at the greater trochanter are increasingly recognised internationally as a cause of recalcitrant lateral hip pain (LHP). The purpose of this study was to report the first Danish results of open surgical repair of GMM tears in female patients.

METHODS. In this retrospective observational study, we included 67 women (68 hips) with a mean (95% confidence interval (CI)) age of 59 (56-61) years who underwent open GMM repair between September 2018 and June 2022. All cases had magnetic resonance imaging before surgery. Pre-, three- and 12-month post-operative testing included LHP (numerical rating scale 0-10), Copenhagen Hip and Groin Outcome Score (HAGOS), Oxford Hip Score (OHS), the EuroQol-Visual Analogue Scale (EQ-VAS) and the Global Rating of Change score (GROC). Responses on GROC were considered successful if patients scored "moderately better" to "very much better". Function of the lower limbs was assessed by the 30-second Chair-Stand-Test (CST).

RESULTS. From pre-testing to 12-month follow-up, LHP at rest and during activity decreased significantly, all HAGOS subgroups improved by 27-35 points, the OHS improved from 22 to 35 points, the EQ-VAS improved from 52 to 72 points and the mean (95% CI) number of repetitions in the CST improved by 2.4 (1.4-3.3). Success on the GROC was reported by 79% of the patients.

CONCLUSION. Open surgical repair of GMM tendon tears in women produced statistically significant improvements in patient-reported outcomes at one-year follow-up.

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Tendinopathy and tendon tears of the gluteus medius and/or minimus (GMM) insertion at the greater trochanter are increasingly recognised internationally as a cause of recalcitrant lateral hip pain (LHP) [1, 2]. Women constitute the majority of patients affected by LHP, and their physical function and quality of life are affected to the level of patients with end-stage hip osteoarthritis [2-4]. The pathology leading to idiopathic tears of the GMM tendons is not fully understood but is primarily believed to be part of an ongoing degenerative process [5], with pathological changes in the shoulder rotator cuff as the most similar degenerative musculoskeletal entity. Iatrogenic GMM tendon tears arise due to former surgery to the hip and femur, i.e. hip arthroplasty, femoral nailing and iliotibial band surgery [1].

While patients with LHP due to GMM tendinopathy, which constitutes the majority of cases, were shown to

benefit from patient education and rehabilitation [2], surgical repair of GMM tears has been reported in international case series during the past two decades with positive short-to-medium-term follow-up outcomes [1, 6, 7]. In September 2017, we initiated protocolled open surgical repair of GMM tears at Horsens Regional Hospital, Denmark.

The purpose of this study was to report the first Danish results of open surgical repair of GMM tears in female patients with recalcitrant LHP with at least one year of follow-up.

METHODS

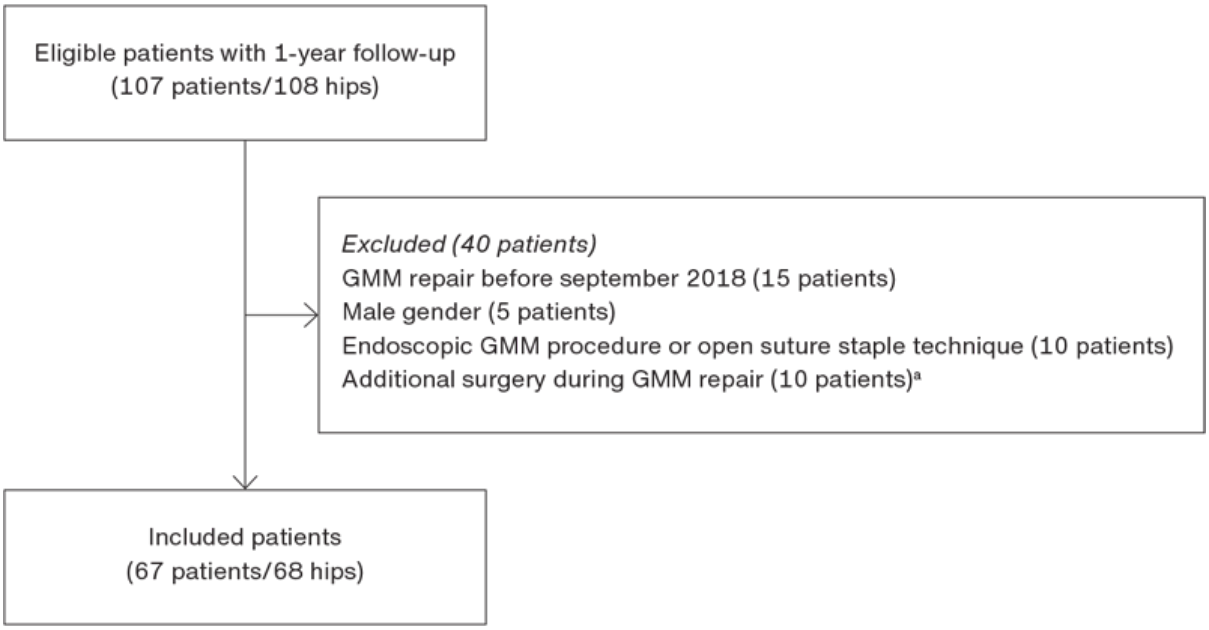
The study was conducted as a retrospective observational study and reported according to the STROBE guidelines. The patients who underwent surgery and participated in this study were part of a larger hip abductor tendon pathology population previously reported [3].

The procedures were performed at a public teaching hospital with a specialised orthopaedic hip preservation surgery clinic. The hip clinic has a local catchment area of approximately 300,000 inhabitants from which the majority of patients were referred. As the hip clinic was the only national site performing protocolled GMM surgeries in the study period, some patients were referred to us from other Danish regions.

Participants

Patients registered as from September 2018 with a GMM surgical procedure (Nordic Medico-Statistical Committee Classification of Surgical Procedures code KNFL 49: suture or reinsertion of tendon of hip or thigh) performed at our hip clinic were assessed for inclusion (**Figure 1** (and Table 1 in the Supplementary **material (https://content.ugeskriftet.dk/sites/default/files/2024-01/A08230526-supplementary.pdf)**). Importantly, none of the patients who had undergone GMM tendon surgery have been lost to follow-up. We included patients of female gender; 18+ years of age; open GMM tendon surgery performed; and a minimum one-year follow-up. We excluded patients who had additional procedures performed during their GMM tendon surgery. We included women only to avoid gender-induced bias as women constituted the vast majority of patients with LHP referred for and subsequently treated by us in the study period (> 95%).

FIGURE 1 Flow chart of the 67 patients included in the study with open gluteus medius and minimus (GMM) surgery.



a) Total hip replacement (5 patients), removal of femoral nail (4 patients), psoastenotomy (1 patient).

Diagnosis, surgery and rehabilitation

Rupture of the GMM tendons was diagnosed by clinical evaluation and confirmed by pre-operative magnetic resonance imaging (MRI). The clinical evaluation included assessment of the origin of known pain related to the trochanteric area, 30-second single leg stance, flexion adduction and external rotation (+resistance) test **[2, 8]**, side-lying abduction test supplemented by Trendelenburg's sign [9] and the internal resistance test [10]. MRI evaluation was performed according to previously published criteria [11, 12].

All patients had to participate in a three-month unsupervised pre-habilitation programme before surgery. The main elements of the programme were de-loading and focused patient education [2].

Two consultant orthopaedic surgeons performed all surgical GMM repairs together (one dedicated hip joint replacement surgeon and one dedicated hip joint preservation surgeon). All repairs were performed using the same protocolled technique (**Figure A in the Supplementary material**). In brief, a direct lateral approach was used and the degree of damage to the GMM tendons was assessed. Anatomical restoration of the tendon complex was performed by use of bone anchors. For an in-debt description of the surgical procedure and **the GMM tear classification,** please see **Textbox 1 + 2 in the Supplementary material.**

Patients were routinely seen by the surgeons at 12 and 52 weeks after surgery. The patients were allowed ambulation with crutches with 20 kg of weight bearing for the first six weeks. Hip adduction was not allowed. We did not apply abduction-restricting orthosis. The patients were strongly encouraged to comply with the first six-week regimen to allow for sufficient primary tendon-bone healing.

The patients followed a standardised rehabilitation regimen. Preoperatively, the patient was instructed by our specialised physiotherapist in very light, non-weight bearing exercises, mainly to ensure oedema prophylaxis. The exercises were to be performed at home during the first six weeks. From week six to 12, rehabilitation was performed at the patient's local physiotherapy guided by our specialised physiotherapist.

Outcomes

The following patient-reported outcomes and physical tests were assessed pre-operatively and at three and 12 months post-operatively:

The Copenhagen Hip and Groin Outcome Score (HAGOS), which consists of six separate subscales (pain, symptoms, physical function in daily living, physical function in sport and recreation, participation in physical activities, and hip- and/or groin-related quality of life). HAGOS is used to assess physically active young-to-middle-aged patients with long-standing hip and/or groin pain (score range: 0 (worst) – 100 (best)).

The Oxford Hip score (OHS) is developed for hip osteoarthritis and assesses hip-specific pain and function in daily activities. The OHS is patient self-administered, and the score ranges from 0 (worst) to 48 (best) [13].

The EuroQol Visual Analogue Scale (EQ-VAS), which records the responder's overall current health on a vertical visual analogue scale, ranges from 0 to 100.

At the three- and 12-month follow-up, the Global Rating of Change score (GROC) was completed. GROC is a patient-administered 11-point Likert scale by which the patient rates the perceived overall change of the hip condition from "very much better" to "very much worse" [14]. GROC responses were considered successful if patients scored "moderately better" to "very much better" [15]. Global improvement was measured as proportion of successful answers.

Furthermore, patients were asked about their average lateral hip pain during the past 14 days in rest and during general activity. Pain was measured on an 11-point numerical rating scale (0: no pain, 10: worst pain imaginable) [16].

The 30-second Chairs-Stand-Test (CST) was used to evaluate lower limb function where the number of sits to stand in 30 seconds is measured [17].

Statistical methods

Parametric data are presented as means with 95% confidence intervals (CI). Non-parametric data are presented as medians and 25-75% interquartile ranges (IQR). Binary data are stated as proportions. Normality was evaluated by plotting the data. Paired T-test was used for paired comparisons between time. A 5% level of significance was applied. Statistical analyses were performed with Stata 16.

Ethical consideration

All patients gave written informed consent to use their data for this study. Data protection approval was obtained from the Central Denmark Region (no. 1-16-02-761-17).

Data sharing

The data that support the findings of this study are available from X but restrictions apply to the availability of these data, which were used under license for the present study and are therefore not publicly available. Data are, however, available from the authors upon reasonable request and with permission from X.

Trial registration: not relevant.

RESULTS

Patient demographics and surgical data

A total of 67 women (68 hips) with a mean age of 59 (95% CI: 56-61) years and a mean BMI of 28 kg/m^2 (95% CI:

27-29) were included (**Table 1**). All patients reported LHP for more than one year prior to the surgical intervention. Nineteen patients had previous surgery to the affected hip or femur (total hip replacement (n = 6), iliotibial band surgery (n = 7), hip arthroscopy (n = 2), femoral fracture (n = 3) and rectus femoris removal (n = 1)). Two patients had former lower-back surgery.

TABLE 1 Age, BMI and surgical findings according to the Horsens Classification[a] of the 67 patients included in the study.

Tear	Horsens grade	Patients, n	Age, median (IQR), yrs	BMI, median (IQR), kg/m²	Duration of surgery, median (IQR), min.	Tissue reinforcement, n	Anchors, median (min.-max), n
Partial	0B	0					
	0C	2	56 (51-61)	28.2 (22.5-33.9)	32 (28-36)		1 (1-1)
	1A	6	54 (49-56)	27.8 (24.0-29.8)	36.5 (29-46)	1	2 (1-2)
	1B	1	56 (56-56)	26.1 (26.1-26.1)	41 (41-41)		2 (2-2)
	1C	8	52,5 (48-66)	28.9 (23.4-32.9)	39 (32.5-48)	1	2 (1-2)
	2A	11	53 (48-61)	25.9 (22.6-31.5)	46 (42-79)	3	2 (1-3)
	2B	4	55 (54-57)	27.2 (22.7-29.4)	41 (33-61)		2 (2-2)
	2C	8	58 (57-65)	29.2 (23.6-33.9)	45 (40.5-56)	4	2 (2-3)
	4A	1	70 (70-70)	30 (30-30)	45 (45-45)		2 (2-2)
Full thickness	3A	10	57 (52-64)	25.3 (22.3-30.5)	59.5 (53-73)	6	3 (2-4)
	3B	0					
	3C	17	67 (58-74)	29.4 (24.8-32.9)	56 (53-63)	6	3 (2-4)

IQR = interquartile range.
a) The Horsens Classification is depicted in the appendix.

The median duration of surgery was 50 (IQR: 41-60) minutes. The GMM tendon attachment was registered as affected in the gluteus minimus in two hips, the gluteus medius in 27 hips and both the gluteus medius and minimus in 38 hips. Isolated tear of the posterior tendon of the gluteus medius was found in one hip. In 21 hips, tissue augmentation was used (at the surgeon's discretion).

All incisions healed uneventfully. Two patients developed superficial surgical site infection managed by removal of skin staples and oral antibiotics. Incisional and subcutaneous tenderness during the first year was a very common finding. Two (3%) re-ruptures were diagnosed at the 12-month follow-up; these re-ruptures were both full-thickness tears at index surgery (type 3C – **see Textbox 2 in the Supplementary material**).

Patient-reported outcomes

From pre-operatively to the 12-month follow-up, lateral hip pain decreased significantly. All HAGOS subgroups improved between 27 and 35 points. The OHS improved from 22.2 to 34.6 points. The EQ-VAS improved from 52 to 72 points (**Table 2**).

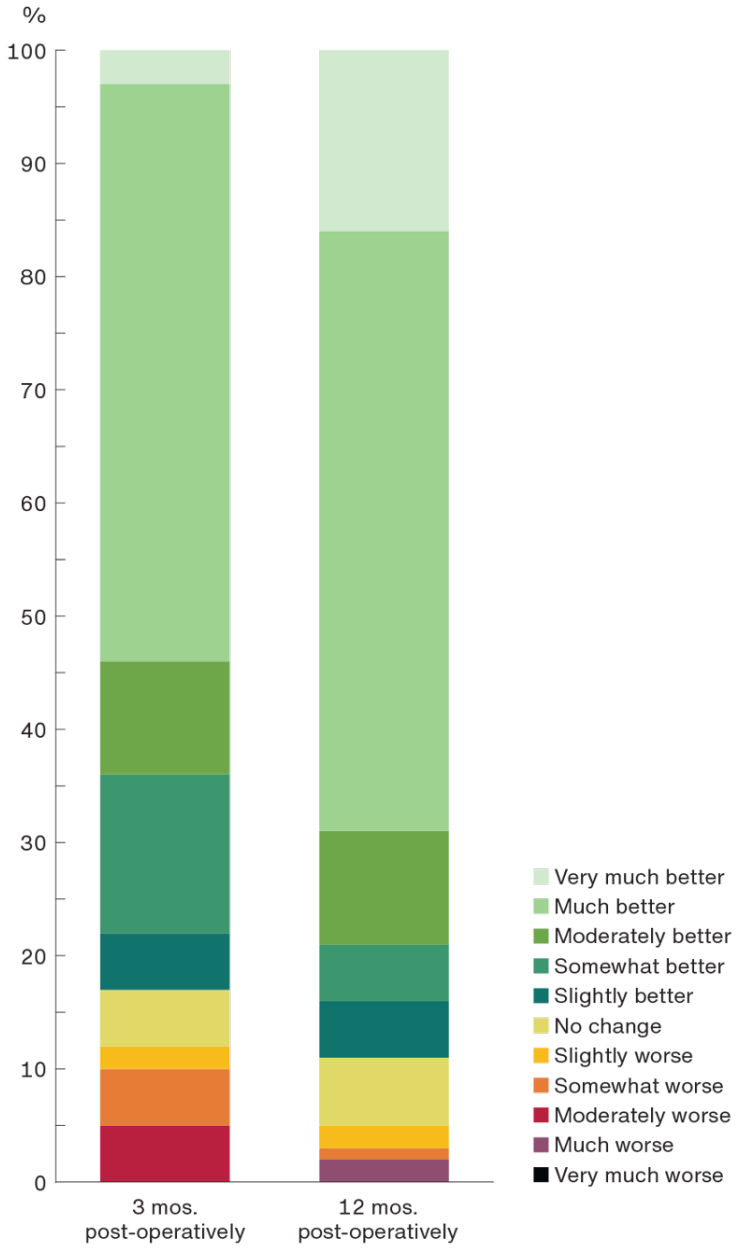
TABLE 2 Patient-reported outcomes of the 67 patients included in the study.

	Pre-operatively		3 mos. post-operatively		12 mos. post-operatively		Difference 0-12 mos.	
	n	mean (± SD)	n	mean (± SD)	n	mean (± SD)	n	mean (95% CI)
LHP: NRS [0-10]								
In rest	59	4.9 (2.8)	58	1.3 (2.0)	50	1.3 (2.1)	57	3.4 (2.6-4.2)
Activity	64	7 (2.4)	63	3.1 (2.5)	44	2.9 (2.9)	56	4.0 (3.2-4.9)
HAGOS [0-100 in each subgroup]								
Symptoms	63	44 (18)	63	70 (14)	62	72 820)	58	28 (23-33)
Pain	62	38 (18)	63	67 (16)	62	69 (21)	58	31 (26-36)
ADL	62	32 (18)	63	60 (20)	62	66 (23)	58	35 (28-39)
Sport	62	20 (16)	63	44 (24)	61	51 (29)	57	32 (24-40)
PA	62	14 (15)	63	30 (26)	61	41 (31)	57	28 (20-37)
QOL	63	23 (12)	63	45 (17)	61	51 (25)	57	27 (21-33)
OHS [0-48]	61	22.2 (6.8)	63	31.6 (7.0)	61	34.6 (9.0)	55	12.5 (10.1-14.9)
EQ-VAS [0-100]	61	52 (25)	62	70 (19)	63	72 (20)	57	19 (13-26)

ADL = activity of daily living; CI = confidence interval; EQ-VAS = The EuroQol Visual Analogue Scale; HAGOS = The Copenhagen Hip and Groin Outcome Score; LHP = lateral hip pain; NRS = numerical rating scale; OHS = Oxford Hip Score; PA = participation in physical activities; QOL = hip and/or groin-related quality of life; SD = standard deviation; Sport = physical function in sport and recreation.

Success on the GROC was reported by 64% at the three-month and by 79% at the 12-month follow-up (**Figure 2**).

FIGURE 2 Global rating of change in hip condition (GROC). Frequency count (%) for GROC categories at 3- and 12-month follow-up. GROC responses were considered successful if patients scored from "moderately better" to "very much better".



Physical function

Median (IQR) number of repetitions completed in the CST improved from 11 (9-13) pre-operatively to 13 (11-16) ($p > 0.0001$) at the 12-month follow-up.

DISCUSSION

This study presented the first Danish results following a protocolled, open GMM tendon repair with a distinct focus on anatomical restoration. We found statistically significant improvements on patient-reported outcomes

and function and with only two cases of clinical re-ruptures identified during the follow-up period. We found the procedure to be safe with two cases of superficial surgical site infection and no serious events such as deep vein thrombosis or lower limb nerve affection.

Our reconstruction is based on current knowledge of the hip abductor complex. Two distinct anatomical insertion sites for the gluteus medius tendon have been described in cadaveric studies, i.e. the superoposterior facet and the lateral facet of the greater trochanter [18]. The posterior segment, which inserts into the superoposterior facet, is a stringlike stout tendon structure embedded within muscle. This structure is very evident on MRI and is rarely torn [12]. The posterior segment glides into the central and anterior segments, which lie superficial to the gluteus minimus. It is of importance for anatomical restoration of gluteus medius tears to understand that the musculo-tendinous portion of the central and anterior segment, which attaches to the lateral facet, has a characteristic fan-like, muscular-infiltrated attachment that extends all the way to the vastus ridge. Furthermore, the long head of the gluteus minimus marks the anterior border of the gluteus medius attachment site on the lateral facet [18] (Figure A **in the** Supplementary **material**). Tendon tears might involve either or both GMM tendons and, importantly, may occur as an undersurface (partial) tear under the central/anterior segment of the gluteus medius insertion, which is not directly visible (see Figure A and Textbox 2 **in the** Supplementary **material**).

Ebert et al. reported on 138 patients undergoing an extensive open surgical reconstruction with a ligament and augmentation reconstruction system with two-year follow-up [19]. They found improvements in all patient-reported outcome measures and reported functional measures similar to the results obtained in our surgical protocol, including a 3% re-tear rate during the first 12 months after surgery. Fox et al. reported on open abductor tendon reconstruction in 165 hips with 5-10-year follow-up [6]. The authors concluded that surgery relieved symptoms in most cases with an average OHS score at follow-up of 40 compared with 22 before surgery. However, follow-up was by telephone. The result by Fox et al. and a recent publication from the Ebert group with a longer follow-up period of 7-10 years on the initial publication indicated sufficient longevity of GMM surgery even in an older patient group with degenerative tendon changes [7].

In the present study, patients improved on all patient-reported outcomes but did not score top points in any of the questionnaires. We believe that this is because tendon ruptures typically occur on a degenerative basis. Hence, the surgery induces healing/scar tissue, which may alleviate pain but does not improve physical function accordingly. As the hip-specific patient-reported outcomes used in this study include both physical function and hip pain, a very high score seems difficult to achieve. Moreover, the OHS is not validated for this patient group and may not be responsive to clinically relevant changes in this patient group. The HAGOS questionnaire, on the other hand, did include a large percentage of patients with lateral hip pain in its initial validation [20].

Our study has several limitations. Firstly, it is a retrospective case series with no control group and as such has inherited information and selection biases that need to be taken into consideration when interpreting the results. The cases are time dependent, meaning that surgeons were on a learning curve in relation to the surgical procedure. The first procedure was performed in September 2017; but for the present study, a one-year diagnostic and procedural learning curve was taken into consideration. How the protocolled treatment algorithm performs beyond our institution remains to be evaluated. We only had a one-year follow-up and cannot evaluate on the longevity of the procedure. We did not perform MRI follow-ups as it is our experience that even after one year, MRI will show massive surgical artefacts and the findings rarely reflect the clinical outcomes, which was also found by others. Moreover, the post-operative regime included six weeks of restricted weight bearing, which may be a strongly contributing factor to the improvements seen.

CONCLUSION

Anatomical reconstruction of GMM tendon tears in middle-aged women led to statistically significant improvements in patient-reported outcomes at one-year follow-up. The longevity of the procedure has yet to be established.

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Conflicts of interest Potential conflicts of interest have been declared. Disclosure forms provided by the authors are available with the article at ugeskriftet.dk/dmj

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