Bachelor of Radiography and Medical Imaging

4th Year Research Paper

The Role of Ultrasound in the Management of Inguinal Hernias

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ABSTRACT

Purpose: The aim of this study was to determine the prevalence and usefulness of ultrasound in the management of hernias and groin related problems referred to a specialist hernia surgeon.

Methods: The cohort comprised of 88 consecutive inguinal hernia repairs in 77 patients from January 2011 to September 2013. Participants presented with either clinically obvious or occult hernias. All patients had undergone ultrasound examinations at various radiology practices prior to clinical examinations and subsequent surgery. Data was collected from the single surgeon's clinical notes, surgical audits and reports. These were compared to ultrasound reports.

Results: Seventy true inguinal hernias were found at surgery. The remainders were mostly lipomas of the cord which contributed to the low accuracy rates of both ultrasound and clinical examinations. Overall, ultrasound was found to be less accurate than clinical examinations (80.7% vs 83.0%). Ultrasound also demonstrated poor accuracy in differentiating direct and indirect inguinal hernias (67.7%).

Conclusion: Ultrasound and clinical examinations had similar accuracy rates as confirmed during surgery of clinically obvious inguinal hernias. This suggests that for clinically obvious hernias, ultrasound was an unnecessary procedure and in some cases, ultrasound could misdiagnose a hernia. Ultrasound and clinical examinations could not differentiate hernias from lipomas of the cord. Ultrasound could not be relied upon to differentiate indirect from direct inguinal hernias either. In some occult type of hernias, ultrasound might have influenced the surgeon's decision regarding surgery. However, our study showed that ultrasound did not have a significant impact on the overall management of inguinal hernias.

Keywords: Ultrasound; Inguinal hernia; Groin; Clinical examination; Diagnosis; Classification

1. INTRODUCTION

Inguinal hernias are common surgical conditions which present with localised groin pain or burning sensations with lumps in the groin [1]. These are usually the first indications of inguinal hernias which may or may not be noted by the patient. Clinical signs include the presence of palpable lumps which may be tender and reducible or irreducible. Occasionally, patients may present with complications such as bowel obstruction and strangulation.

In recent years, ultrasound has become a frequently used imaging modality in the diagnosis of groin abnormalities including inguinal hernias. It is advantageous in providing inexpensive dynamic scanning of soft tissue structures without the use of ionsing radiation. It also permits an overview of neighbouring anatomical structures within the groin to differentiate between pathologies that can mimic the symptoms and signs of inguinal hernias such as femoral hernias, lymph nodes, abscesses, saphenous varix or adductor tendonitis. However, ultrasound is heavily operator-dependent. Other limitations include positioning difficulties with the elderly, language barriers, patient cooperation and body habitus of the patients. Hence the accuracy of ultrasound can be variable and findings may contradict with clinical findings leading to difficulties in management decisions. Previous studies found variable accuracy rates particularly amongst patients with clinically obvious inguinal hernias and occult inguinal hernias, which are hernias that have indeterministic or insubstantial corroborative findings on examination [2]. Studies of patients with clinically obvious hernias recorded sensitivity values of 97-100% [3, 4] and those with clinically occult hernias found sensitivity values of 33-95% [5-7] and positive predictive values of 73-100% [1, 2, 6, 7].

The use of ultrasound for clinically obvious hernias according to surgeons is unnecessary and appears to be an overuse of resources as discussed in O'Rourke et al's review where the

authors stated that ultrasound had a "minimal role" in the diagnosis of inguinal hernias as its sensitivity and specificity were low in every day practice [8]. Furthermore, the common ultrasound finding of a hernia when no hernia is clinically palpable poses a quandary for the need for surgery.

Management decisions are based on clinical examinations, general health of the patients and necessity for surgery rather than the ultrasound findings. Modern surgical hernia techniques using mesh have led to a reduced recurrence rate following surgery. However there has been concern regarding the development and possible increased incidence of post-operative chronic pain. As a result, surgeons are increasingly reluctant to operate solely on the basis of an ultrasound finding of a hernia when no hernia is clinically apparent. The fear is that repairing these ultrasound diagnosed but clinically occult or small hernias may not cure the pain. Many believe these are actually lipomas of the cord and are a red herring, leading to uncertainty in the patient's and surgeon's minds. Lipomas may be found in association with inguinal hernias at operation. In some instances, lipomas are the sole finding and can mimic symptoms of a hernia. Lipomas can also be misleading on ultrasound as the fat within lipomas cannot be distinguished from the fat of omentum within hernia sacs.

Despite the prevalence of these issues in every day practice, there has been limited studies which directly correlate ultrasound and clinical examinations to assess the role of ultrasound in the management of inguinal hernias. The main purpose of our study was to investigate the role of ultrasound in the management of inguinal hernias. The frequency of ultrasound referrals from general practitioners prior to surgical consultations and the number of patients who had a positive ultrasound but did not proceed to surgery were recorded. The accuracy of ultrasound compared to

clinical findings in the diagnosis of clinically occult and obvious inguinal hernias and the accuracy of ultrasound in classifying direct and indirect inguinal hernias were investigated.

2. MATERIALS AND METHODS

Permission for this study was granted by Monash University Human Research Ethics Committee (MUHREC) in September 2013.

2.1. Study design and enrollment criteria

This study involved a retrospective analysis of patients managed by a hernia specialist at Masada Private Hospital in Melbourne, Australia from January 2011 to September 2013. The surgeon has performed over 9000 hernia operations.

The cohort consisted of patients with symptoms of groin pain or lumps referred, by their general practitioners, for ultrasound examinations before consultation with the surgeon. Ultrasounds were performed at various radiology practices depending on the affiliations of the general practitioners. During clinical consultation with the surgeon, signs and symptoms were evaluated. The decisions to operate were based on the level of patient discomfort, the size of the palpable lumps, general health of the patient and operation risks. Open surgical hernia repairs were performed by the single surgeon. All patients underwent surgery using the Tension Free Lichtenstein Technique with local anaesthesia and standard mesh, thus allowing a better assesssment of the presence of hernia sacs and posterior wall weaknesses [9]. Operative reports were recorded and all findings were contemporaneously noted on an audit form.

2.2. Patients (Fig 1)

Patients aged 21 or above with clinically occult or obvious inguinal hernias were included. Patients who did not have operations or ultrasound examinations were excluded. A total of 447 patients were referred with groin problems or suspected inguinal hernias. Of these, 153 (34.2%) had ultrasounds prior to surgical consultation and only 77 (50.3%) of these patients underwent

surgery. These patients were included in this study and the ultrasound reports, clinical notes, and surgical records of this cohort (N=77) were reviewed. The demographic characteristics of these patients, including the age, gender, the side operated upon and hernia size as found during surgery, were recorded. (Table 1)

Seventy-six (49.7%) patients with a positive ultrasound findings for inguinal hernias were not operated upon mostly due to negative clinical diagnoses as well as associated risks of surgery and possibilities of developing post-operative chronic pain [9]. These patients were excluded from the study.

2.3. Clinical report analysis

Data was collected from the surgeon's clinical notes and his letters to the referring doctors.

Clinical examination reports consistently recorded the symptoms and signs of the patients. These include pain, discomfort, palpable lumps, cough impulses and hernia sac reducibility as observed by the surgeon. These signs were used to classify inguinal hernias into two types – clinically obvious or clinically occult inguinal hernias. Patients with symptoms of groin pain and palpable lumps were defined as clinically obvious. Those displaying groin pain and had no definite palpable lumps on clinical examinations were considered as clinically occult. On clinical examinations, the surgeon did not differentiate hernias into direct or indirect types because these classifications were considered unreliable and had no implication to management decisions.

2.4. Sonographic report analysis

Ultrasound reports consistently reported the presence or absence of inguinal hernias. A positive ultrasound diagnosis was defined as the presence of an inguinal hernia and a negative ultrasound

finding was defined as the absence of an inguinal hernia. Classifications of inguinal hernias into direct and indirect types were reported in most ultrasound reports and these were also analysed.

2.5. Surgical report analysis

Data was collected from the operation reports and the audit sheet which the surgeon completed contemporaneously in the operating theatre. The audit sheets included patient demographics, clinical symptoms, surgical appearance of the hernias in terms of their classifications, size and reducibility, surgical presence of lipomas and the surgical approach. At operation, inguinal hernias were defined as the presence of hernia sacs within the inguinal canals. Lipomas were recorded if they were the sole abnormality found during surgery.

2.6. Statistical analysis

Results were divided into five subsets:

1. Ultrasound versus surgical findings in the overall diagnosis of inguinal hernias.
2. Clinical examinations versus surgical findings in the overall diagnosis of inguinal hernias.
3. Ultrasound and clinical results versus surgical findings in the diagnosis of clinically obvious inguinal hernias.
4. Ultrasound and clinical results versus surgical findings in the diagnosis of clinically occult inguinal hernias.
5. Ultrasound versus surgical findings in the classification of direct and indirect inguinal hernias.

Sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV) and overall accuracy values were calculated.

3. RESULTS

Seventy-seven patients were included in this study. Amongst these patients, a total of 88 groins were operated upon (11 bilateral and 66 unilateral). Seventy-nine of these were categorised as clinically obvious inguinal hernias and nine were clinically occult. During surgery, 70 were confirmed as inguinal hernias with hernia sacs. No hernia sac was found in 18 groins. Thirteen were lipomas, one of which was a lipoma with posterior wall weakness, three were only posterior wall weaknesses, one was a meshoma from previous laparoscopic inguinal hernia repair and one was a femoral hernia.

3.1. Ultrasound findings versus surgical findings (Table 3)

Ultrasound found 69 true positives, 16 false positives, two true negatives and one false negative. Of the 16 false positive cases, 11 were lipomas, three were posterior wall weakness, one was a meshoma and one was a femoral hernia. The false negative finding was the misdiagnosis of an inguinal hernia on ultrasound as a femoral hernia. Of the two true negative cases, both were lipoma found in surgery and were reported as being groins without hernia sacs on ultrasound. Both of these patients were operated because of the clinical diagnosis of inguinal hernias and symptoms. If lipomas were considered as a type of inguinal hernia because of their symptoms and management, then the accuracy of ultrasound would be 81 of 88 (92%).

3.2. Clinical findings versus surgical findings (Table 3)

Clinical examinations found 69 true positives, 14 false positives, four true negatives and one false negative. False positive results were identified as 12 lipomas, one wall weakness, and one meshoma during surgery. In one of the four true negative cases, the patient insisted on surgery because of the positive ultrasound report and symptoms of escalating chronic pain. Surgical result

for this patient was posterior wall weakness only. Another was a femoral hernia, correctly diagnosed by the surgeon. Of the remaining two, one was a posterior wall weakness and another was posterior wall weakness with a lipoma; both were correctly diagnosed pre-operatively. The false negative result was a small direct inguinal hernia diagnosed as a posterior wall weakness. If lipomas were considered as inguinal hernias, the accuracy would be 82 of 88 (93%).

3.3. Ultrasound and clinical findings versus surgical findings for clinically obvious inguinal hernias

Seventy-nine inguinal hernias were classified as being clinically obvious. Of these, 63 inguinal hernias were confirmed as hernias during surgery. No inguinal hernia sac was found in 16 groins. Of these 16 groins, 13 were significant sized lipomas, one was a meshoma, one was a posterior wall weakness and one was a femoral hernia. Correct diagnosis of inguinal hernias using ultrasound were reported in 62 groins. Two groins were reported as negative on ultrasound and no hernia was found in surgery. There were 14 false positives and one false negative found. Ultrasound yielded sensitivity values of 98.4%, specificity of 9.5%, PPV of 81.6%, and NPV of 66.7%. If lipomas were considered as inguinal hernias, the accuracy would be 93.6% (N=74/79). Clinical examinations demonstrated 63 true positives, two true negatives and 14 false positives in correlation to surgical findings with resulting sensitivity of 100%, specificity of 12.5%, PPV of 81.8%, and NPV of 100%. If lipomas were considered as inguinal hernias, then the accuracy would be 96.2% (N=76/79).

3.4. Ultrasound and clinical findings versus surgical findings for clinically occult inguinal hernias.

A total of nine clinically occult inguinal hernias were operated. During surgery, seven were identified as true inguinal hernias and two were posterior wall weaknesses. No lipomas were found. Ultrasound diagnosed seven true positives and two false positives. The sensitivity and PPV of ultrasound were 100% and 77.8% respectively. The specificity and NPV were both 0% attributed to the lack of true negative results. Clinical examinations found six true positive results, two true negative and one false negative result. Clinical examinations had a sensitivity of 85.7%, specificity of 100%, PPV of 100% and NPV of 66.7%. Overall, clinical examinations were more accurate than ultrasound and accuracy values were 88.9% and 77.8% respectively.

3.5. Ultrasound findings versus surgical findings for direct and indirect inguinal hernias.

Sixty-five of 88 inguinal hernias were classified as direct or indirect inguinal hernias in the surgical reports. There were 22 direct inguinal hernias and 43 indirect inguinal hernias. Ultrasound correctly identified 31 out of 43 (72.1%) indirect inguinal hernias and 13 out of 22 (59.1%) direct inguinal hernias. Overall, the accuracy of ultrasound was 67.7%.

4. DISCUSSION

In recent years, ultrasound has become widely used to diagnose soft tissue abnormalities. In Australia, patients with groin pain, suspected inguinal hernias or clinically obvious inguinal hernias are frequently referred for ultrasound examinations prior to surgical referrals. However, the necessity and value of ultrasound is questionable, particularly in the diagnosis of clinically obvious hernias [8]. Ultrasound can often be misleading, diagnosing an inguinal hernia when there is no clinical evidence of a hernia [5, 6]. This may lead to difficulties in the management of patients which, for surgeons, is currently the most pressing problem with ultrasound.

The results of this study demonstrated similar accuracy values of ultrasound and clinical examinations (83.0% vs 80.7%). However, both had low sensitivity (11.1% in ultrasound and 22.2% in clinical examinations) mostly because of the difficulty in differentiating hernias from lipomas of the cord.

Further division of the cohort according to the signs and symptoms found similar results. Clinical examinations were only marginally more accurate in diagnosing clinically obvious hernias (accuracy values of 82.3% vs 81.0%) and clinically occult hernias (accuracy values of 88.9% vs 77.8%). Despite the limited number of clinically occult hernias included in the study (N=9), our results were comparable to the retrospective analysis by Light et al where ultrasound diagnosed 85 of 116 (73.3%) patients [6].

Overall, our results indicated that although ultrasound provided an accurate assessment of palpable inguinal hernia, it was slightly less accurate than a proper clinical examination carried out by the surgeon. Our results are not in keeping with the prospective study of Kraft et al where clinical examinations and ultrasound findings were correlated with laparoscopic surgery for the diagnosis of inguinal hernias [4]. They found that although the accuracy values were similar, ultrasound was slightly more accurate than clinical examinations (94% vs 93%) [4]. However, the authors concluded that ultrasound should only be used as an aid for surgeons in the managment of inguinal hernias but not as a deterministic diagnostic tool [4]. Similarly, from the evidence presented in our study, it was advised that ultrasound should be used as an adjunct to a thorough clinical examination and history taking only when clinical signs were not clear.

In our study, there was a high incidence of lipomas found during surgery. This suggested that there might be a similar or higher number of lipomas in those who did not undergo surgery. A retrospective study by Lilly et al reported significant incidences of lipomas arising from the spermatic cord and round ligament (63/280, 22.5%) [10]. Lipomas were found to be the cause

hernia type symptoms, mimicking true inguinal hernias [10]. Lipomas can also be the etiology of significant symptoms and can even become strangulated, hence requiring surgical intervention. Therefore, Lilly et al did not routinely attempt to differentiate between lipomas and inguinal hernias [10, 11].

In our study, patients were operated upon when medium to large palpable lumps were confirmed. Our results showed poor differentiation clinically between lipomas and inguinal hernias as only one of 13 lipomas (7.7%) was correctly diagnosed. Similarily for ultrasound, our results indicated that it was poor in distinguishing lipomas as only two of 13 lipomas (15.4%) had been diagnosed correctly. This is largely because fat within lipomas and inguinal hernias containing peritoneal fat have similar appearances. Additionally, simultaneous occurence of inguinal hernias and lipomas, which are common findings at surgery, are rarely reported on ultrasounds. This finding can lead to better understanding of the way in which hernias develop. It may be possible for lipomas to lead up to the formation of inguinal hernias by weakening the deep ring.

The classification of inguinal hernias into direct and indirect types using ultrasound was not accurate. The accuracy rate of ultrasound found in our study were reflected in Kraft et al's and Lilly et al's studies which reported values of 62% and 85% respectively [4,11]. The classifications of inguinal hernias were not mandatory for their management. These findings did not influence the indications for surgery particularly in open surgery as the surgical approaches of indirect and direct inguinal hernias were identical.

A large percentage of patients (76/153, 49.7%) did not undergo surgery despite positive ultrasound findings. These patients did not undergo surgery because no clinical hernias were

found and because their age and health contraindicated surgery. These circumstances have become a common issue in practice.

The results of our study indicate that ultrasound findings have the potential to be red herrings in the management of patients presenting with groin symptoms. Hence, surgeons are still encouraged to rely on clinical examinations of the groin and surrounding areas such as the hip, adductor tendons, back and scrotum for differential diagnosis with ultrasound being used as an adjunctive diagnostic tool as opposed to a primary method of diagnosis.

Surgical management may not be suitable for all patients. One of the factors which can influence a surgeon's decision to operate is the risk of developing postoperative chronic pain [9]. The incidence of chronic pain, according to some surgeons, has increased with the use of mesh during surgical hernia repairs [9]. Thus, surgery of ultrasound diagnosed hernias without a hernia found on clinical examination is discouraged.

4.1. Limitations

Limitations of this study include interpretation bias in clinical examinations because the surgeon was not blinded to the ultrasound findings. However this depicts every day practice in private clinics where ultrasound examinations are often performed prior to consultations with surgeons.

The small sample size (N=9) of clinically occult hernias also contributed to bias. Additionally, there was a considerable number of patients who had a positive ultrasound but did not proceed to surgery. This group of patients were not assessed in this study due to the lack of surgical correlation. The inclusion of these patients would have reported more pronounced differences between ultrasound and clinical findings. They may be assessed through long term follow-up in future studies.

Interobserver variability of the ultrasound reports contributed to bias as the ultrasound examinations were performed at various radiology practices. Hence, as this was a retrospective study, the quality of ultrasound between observers could not be controlled.

5. CONCLUSION

This study of referral patterns confirmed that there was a significant use of ultrasound in the diagnosis of inguinal hernias (153/447, 34.2%). Of the patients diagnosed with inguinal hernias on ultrasound, 49.7% did not undergo surgery as a majority of these patients did not have hernias clinically. Of those who proceeded into surgery, 89.8% were clinically obvious inguinal hernias and the surgeon did not require ultrasound in the management of these patients.

Overall, our study showed that ultrasound had an accuracy rate of 80.7% for diagnosis of inguinal hernias, 67.7% for the classification of direct and indirect hernias, and 15.4% for the differentiation of lipomas. Ultrasound had a high sensitivity but considerably low specificity. Therefore, caution is advised when using ultrasound in the management of inguinal hernias.

Ultrasound is most accurate in the identification of clinically obvious inguinal hernias. However, in these circumstances, the necessity of ultrasound is questionable. It may be useful in the setting of general practice to aid diagnosis and referrals but for a specialist surgeon it has limited diagnostic value.

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TABLES

Table 1: Demographic characteristics of patients with inguinal hernias (N=77)

Age x (± SD)	56.7 (± 15.9)	
Gender male	69/77	(89.6%)
Operation site		
Left	30/77	(39.0%)
Right	36/77	(46.8%)
Bilateral	11/77	(14.3%)

Table 2: Classifications of surgical findings (N = 88)

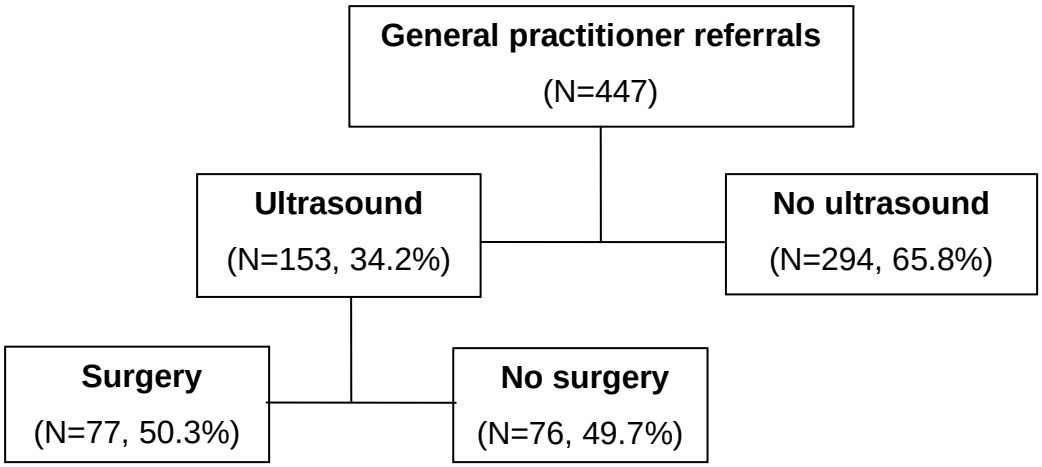
Signs and symptoms		
Obvious (groin pain and palpable lump with or without cough impulse)	79/88	(89.8%)
Occult (groin pain only)	9/88	(10.2%)
Surgical diagnosis		
Inguinal hernia	70/88	(79.5%)
Lipoma	13/88	(14.8%)
Other		
Wall weakness	3/88	(3.4%)
Femoral hernia	1/88	(1.1%)
Meshoma	1/88	(1.1%)
Inguinal hernia size		
Small (< 4cm)	21/88	(23.9%)
Medium (4 - 8cm)	35/88	(39.8%)
Large (> 8cm)	14/88	(15.9%)
Inguinal hernia classifications		
Direct	22/88	(25%)
Indirect	43/88	(48.9%)
Not specified	5/88	(5.7%)
No hernia	18/88	(20.5%)

Table 3: Ultrasound and clinical examinations vs surgical findings in the diagnosis of inguinal hernias (N=88)

	Ultrasound	**Clinical examination**
Specificity	98.6%	98.6%
Sensitivity	11.1%	22.2%
PPV*	81.2%	83%
NPV*	66.7%	80%
Accuracy	80.7%	83%

PPV* = Positive predictive value, NPV* = Negative predicative value

FIGURES



*** N = number of patients**

Fig 1: Flow chart of patients referred to Masada Private Hospital from January 2011 to September 2013 with inguinal hernias.

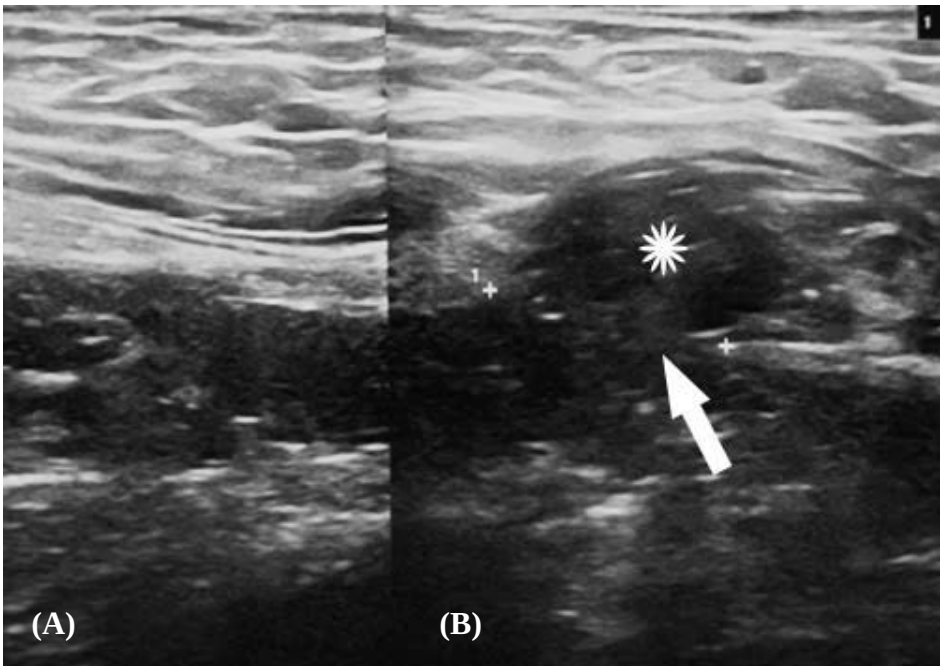


Fig 2: The ultrasound image with the patient at rest (A) and straining (B). A direct inguinal hernia with a hernia sac (asterisk) protruding into the inguinal canal through a defect from the posterior aspect (white arrow) is demonstrated during abdominal strain.

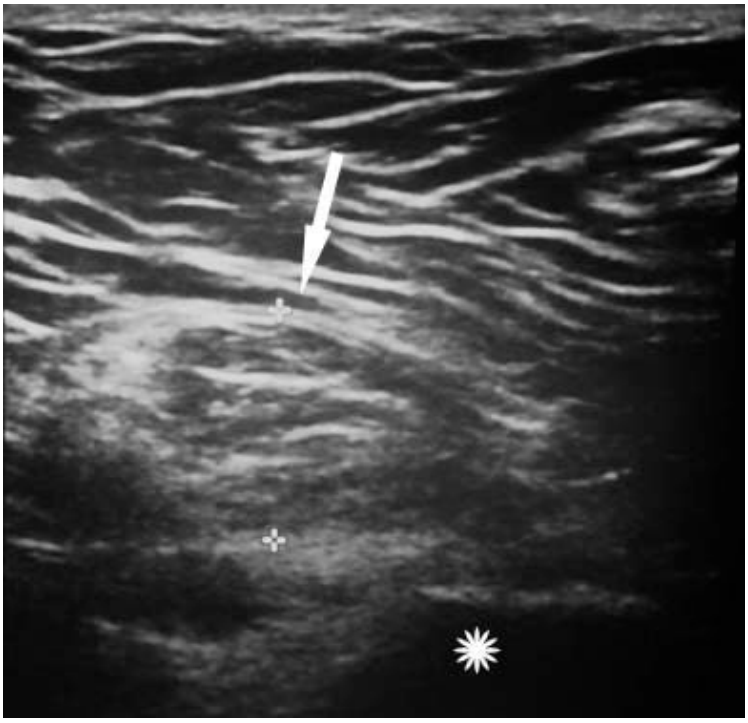


Fig 3: Ultrasound image of the right groin demonstrating an indirect inguinal hernia with a hernia sac (white arrow) in the external inguinal ring of the inguinal canal. The pubic tubercle (asterisk) is the landmark of the external inguinal ring.

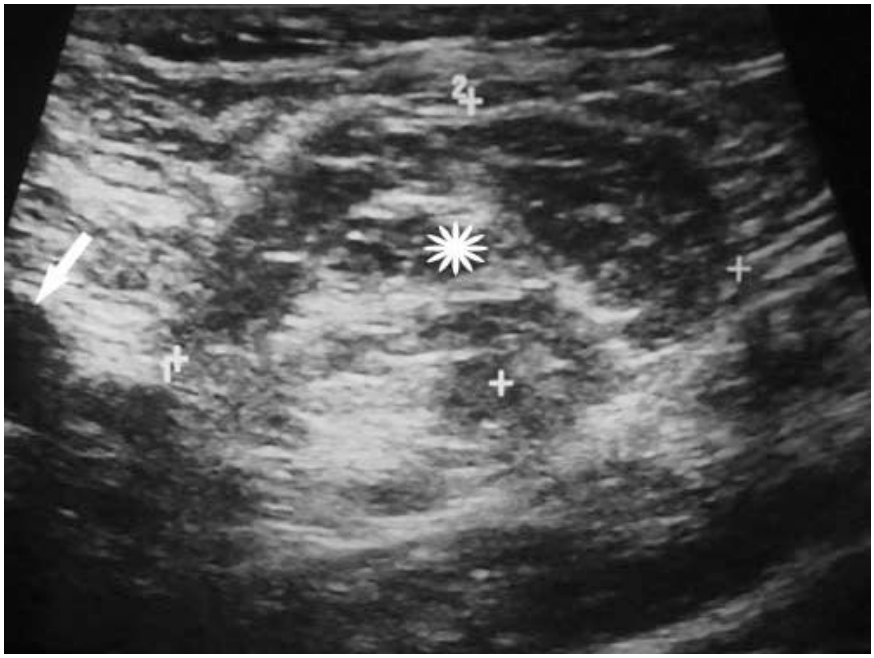


Fig 4: Ultrasound image of the right groin shows a lump (asterisk) on the medial aspect of the femoral vessel (white arrow). The ultrasound reported an irreducible right inguinal hernia but it was found to be a femoral hernia during surgery.

DIARY

10th July	Research discussion and introduction to topic at Masada Private Hospital
12th July	Research discussion with Michal at Monash University
16th July	Aim, hypothesis, and ethics application discussion at Masada Private Hospital
22nd July	Hernia operation observation at Masada Private Hospital
27th July	Hernia operation observation at Masada Private Hospital
30th July	Aim and hypothesis, and ethics application write up at Masada Private Hospital
31st July	Groin ultrasound observation at Victoria House
	Research discussion after at Masada Private Hospital
2nd August	Data collection at Masada Private Hospital
8th August	Data collection at Masada Private Hospital
22nd August	Check on progress with literature review at Masada Private Hospital
3rd September	Data collection at Masada Private Hospital
9th September	Data collection at Masada Private Hospital
11th September	Literature review discussion/check at Masada Private Hospital
16th September	Data collection and literature review at Masada Private Hospital
18th September	Data collection at Masada Private Hospital
25th September	Data collection at Masada Private Hospital
10th October	Results discussion at Masada Private Hospital
14th October	Results discussion at Masada Private Hospital
16th October	Data collection and results discussion with Michal at Monash University
21st October	First draft shown to Maurice at Masada Private Hospital
30th October	Research paper discussion at Masada Private Hospital
31st October	Research paper discussion with Maurice and Michal at Monash University