



www.sciencedirect.com
www.rbmonline.com



ARTICLE

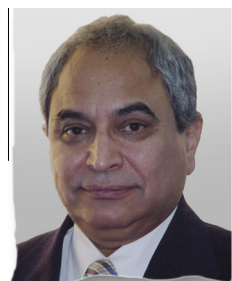
Treatment of adenomyomectomy in women with severe uterine adenomyosis using a novel technique




AboTaleb Saremi ^{a,b,*}, Homa Bahrami ^{a,b}, Pirooz Salehian ^{a,b}, Nasrin Hakak ^a, Arash Pooladi ^{c,b}

^a Sarem Women's Hospital, Tehran, Iran; ^b Sarem Cell Research Center (SCRC), Tehran, Iran; ^c Kurdistan University of Medical Sciences, Sanandaj, Iran

* Corresponding author. E-mail address: saremiat@yahoo.com (A Saremi).



Dr AboTaleb Saremi, born 1947, obtained his MD from Jondishapour and Tehran Universities, Iran in 1975. He trained at the obstetrics and gynaecology department of Munster University, Germany, took a subspecialty in IVF at Vienna University, Austria from 1981 to 1986 and then participated in complementary assisted reproduction courses in the USA and Australia. His specialization includes laparoscopic surgery and his work lead to the birth of the first Iranian assisted reproduction child (by gamete intra-Fallopian transfer) in 1989. He founded his first IVF centre in Iran in 1993 and received the International Federation of Fertility Societies' 30th anniversary recognition award in 1998. He is the president of the Sarem Women's Hospital, which he founded in 2006, and of the Sarem Cell Research Center.

Abstract The advised treatment for severe adenomyosis is hysterectomy, but for patients wishing to preserve their uterus, novel conservative surgery, adenomyomectomy, can be performed. The technique needs to be developed to reduce spontaneous uterine rupture, adhesion and recurrence rates. This study aimed to investigate the safety and therapeutic outcomes of adenomyomectomy. Prospectively, 103 Iranian patients with documented severe adenomyosis were candidates for adenomyomectomy over a period of 7 years (from April 2004 to March 2011). The surgical procedure involved resection of adenomatosis lesions with a thin (≤ 0.5 cm) margin (wedge-shaped removal) after sagittal incision in the uterine body. Reconstruction of the layers was performed and inverted sutures were used for the serosal layer ends. Of 103 patients, 55.34% presented with infertility, 16.50% with IVF failure, 8.74% with recurrent abortion and 19.42% with abnormal uterine bleeding. Of 70 patients who attempted pregnancy, naturally ($n = 21$) or by assisted reproduction treatment ($n = 49$), 30% achieved a clinical pregnancy, and 16 resulted in a full-term live birth. Dysmenorrhoea and hypermenorrhoea were reduced post surgery. Only one patient had relapsed adenomyosis. Adenomyomectomy is a conservative and effective treatment for adenomyosis. This study describes an efficient procedure to treat severe adenomyosis. 

© 2014, Reproductive Healthcare Ltd. Published by Elsevier Ltd. All rights reserved.

KEYWORDS: adenomyomectomy, IVF failure, outcome, severe adenomyosis, surgery

Introduction

Adenomyosis, which is known as 'endometriosis of the uterus', is a benign gynaecological pathology of the uterus in which the endometrium or the endometrial glands and stroma, which should ordinarily be confined to the surface of the inside of the uterine cavity, breaks through the muscle wall of the uterus and grows abnormally deep into the myometrium (Benagiano et al., 2012; Ferenczy, 1998; Taran et al., 2010; Wolters, 1952). If an island of endometrial tissue is contained and circumscribed within the myometrium, it forms a nodule, referred to as an adenomyoma. In most adenomyomas, the border of the lesion merges to a degree with the adjacent myometrium (Tahlan et al., 2006). Adenomyosis is categorized into two forms: diffuse and localized. The ectopic endometrial tissue appears to induce hypertrophy and hyperplasia of the surrounding myometrium, resulting in a diffusely enlarged uterus (Leyendecker et al., 2009; Taran et al., 2010). The endometrial glands passing through the muscular area leads to the symptoms associated with adenomyosis.

Adenomyosis can cause heavy and prolonged menstrual bleeding, dysmenorrhoea, lower abdominal discomfort and menstrual bloating (Cirpan et al., 2008). The condition can be located throughout the entire uterus or localized in one spot. Adenomyosis contributes to infertility and IVF failure (due to implantation failure) (Campo et al., 2012; Louis et al., 2012). The incidence of adenomyosis has not been determined. It is most often diagnosed in middle-aged women and women who have had children (Benagiano et al., 2012; Cirpan et al., 2008; Naphatthalung and Cheewadhanaraks, 2012). The cause of adenomyosis is unknown, but certain studies have suggested that various factors, including hormonal (i.e. oestrogen), genetic, immunological and growth factors, may trigger this condition, and women who have had prior uterine surgery may also be at risk (Benagiano et al., 2012; Naphatthalung and Cheewadhanaraks, 2012).

Until recently, the definitive method for the diagnosis of adenomyosis was hysterectomy using histopathological studies. Imaging technology has made it possible to recognize adenomyosis without surgery. By magnetic resonance imaging or transvaginal ultrasound (TVUS), the characteristics of the disease in the uterus can be visualized (Mounsey et al., 2006; Tahlan et al., 2006). Although ultrasound cannot diagnose adenomyosis with absolute certainty, it assists in eliminating other conditions with similar symptoms, such as uterine fibroids.

The treatment for adenomyosis depends on the symptoms, severity and childbearing circumstances. Mild symptoms may be treated with nonsteroidal anti-inflammatory drugs (NSAIDs) and gonadotrophin-releasing hormone agonists. Certain patients may be candidates for minimally invasive procedures, such as uterine artery embolization and endometrial ablation. The definitive cure for adenomyosis is hysterectomy. This surgery is frequently the treatment of choice for women with significant symptoms (Al Jama, 2011; Koninckx et al., 2012; Levgur, 2007; Mounsey et al., 2006; Wang et al., 2009). An alternative conservative treatment is adenomyomectomy surgery via laparotomy or

laparoscopy (Liu et al., 1998; Takeuchi et al., 2006; Wada et al., 2006).

Previous studies have reported various adenomyomectomy methods that preserve the uterus as conservative surgical techniques to treat severe adenomyosis; the majority of these methods have a high recurrence rate and lead to uterine rupture because of their resection and reconstruction techniques (Hyams, 1952; Levgur, 2007; Wada et al., 2006). Spontaneous uterine rupture can occur during pregnancies with any previous history of uterine surgery. The complete form occurs when a full-thickness disruption of the uterine wall that also involves the overlying visceral peritoneum (uterine serosa) is present. At the beginning of this study, evidence for the efficacy of adenomyomectomy was limited. This innovative surgical method was performed for cultural reasons and at the request of the patients for conservative surgery to preserve the uterus and fertility. The first patients were those with heavy bleeding, and the basis of the pathogenesis and healing process was taken into consideration. Because of the pathogenesis of adenomyosis, surgical treatment by adenomyomectomy must involve the resection of all the altered tissues, leave the thin healthy myometrium intact, reconstruct the uterus in a specific manner with the lowest degree of adhesion and ensure that the sutures allow for efficient blood supply for the repair (Osada et al., 2011). Decreasing ischaemia in the endometrium by removal of the fibrosis tissue is the major purpose of the surgical method.

The aim of this study is to investigate the safety and therapeutic outcomes of a different adenomyomectomy technique with the above characteristics. The aim is to introduce this surgical technique as an alternative treatment option to hysterectomy for uterine adenomyosis, specifically for the patient who wishes to preserve her uterus and perhaps have a child in future.

Materials and methods

This study included 103 Iranian women with symptomatic documented uterine adenomyosis (severe adenomyosis with diameter >1.5 cm by TVUS). All patients had pure adenomyosis verified by abdominal and transvaginal ultrasound and hysterosalpingography (Figure 1). The participants were not being treated with other methods, including medication (e.g. gonadotrophin-releasing hormone). Each patient who wished to preserve her uterus was a candidate for adenomyomectomy surgery. The adenomyosis cases in this study were categorized into the following four groups based on presentation: (i) cases presenting with abnormal vaginal bleeding or abnormal uterine bleeding (i.e. heavy bleeding); (ii) cases presenting with recurrent abortion (defined as three consecutive pregnancy losses prior to 20 weeks from the last menstrual period) with no other reasons; (iii) cases presenting with IVF failures due to implantation failure; and (iv) cases presenting with unexplained infertility.

This prospective study was conducted in Sarem Women's Hospital, Tehran, Iran over a period of 7 years from April 2004 to March 2011. The study was based on the hospital records of the patients, the characteristic and demographic data and the surgical procedure performed. The patients

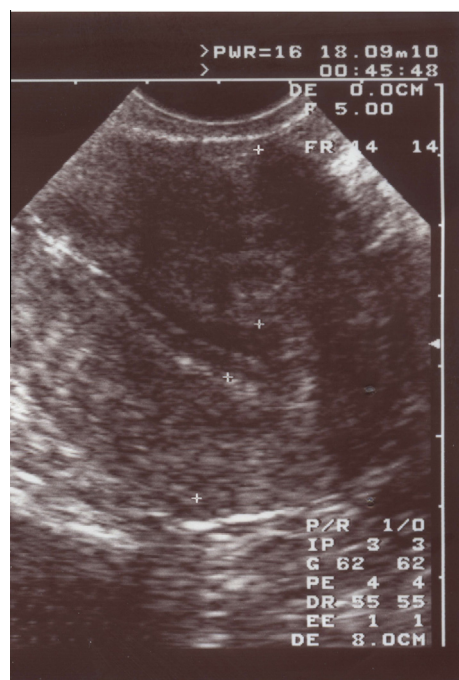


Figure 1 Ultrasound showing adenomyosis in one of the patients prior to surgery, showing adenomyotic tissues in the anterior and posterior walls of the uterus (interval space between '+' signs).

were followed in three steps after surgery to assess the outcomes, such as pregnancy outcome or the post-surgical symptoms. The follow-up schedule was the following: approximately 1 week post surgery for surgery complication assessment; approximately 3 months post surgery for the symptom assessment, especially menstruation and dysmenorrhoea; and approximately 2 years later (range 20–50 months) for outcomes, such as clinical pregnancy (confirmed by both high β -human chorionic gonadotrophin (HCG) and ultrasound confirmation of a gestational sac) and spontaneous abortion (defined as a natural loss of the products of conception before week 20 pregnancy). As shown in [Table 1](#), dysmenorrhoea severity criteria were used to define the severity level of this symptom using a multidimensional scoring system ([Andersch and Milsom, 1982](#)). All the patients were informed regarding the procedure, the aim of the study and the probable surgical complications. Each patient signed a consent form and allowed the surgeon to perform an adenomyomectomy rather than a

hysterectomy. The protocol was approved by the hospital medical ethics committee (reference no. 91012–717, approved 15 February 2004). The IBM statistical software package SPSS version 19.0 was used for all data analyses.

Surgical technique

The aim of the procedure was to remove as much of the adenomyotic lesion as possible. During the surgery, a 'Pfannenstiel' incision – using a transverse suprapubic incision – was performed. In the uterus, a tourniquet was applied to the uterine artery. A vertical incision in the mid-line of the anterior side of the uterus body into the endometrium was accomplished by scalpel or cautery ([Figures 2B and 3A–C](#)). The thickness of the myometrium was measured. The adenomyotic lesion and thick myometrium were resected radically in laminate layers up to 0.5 cm on both the endometrial and serosal sides if needed (only abnormal tissues were resected). The adenomyomectomy was performed lightly in all adenomyosis tissue on both edges of the endometrium and serosa layers by palpating the uterus, as the rigidity of the normal uterine serosa and adenomyosis tissue region was markedly different ([Figures 2E, F and 3D–H](#)).

The bleeding sites were cauterized and the endometrium was sutured end to end with 2–0 vicryl using the simple interrupted suture technique (approximation without overlapping the ends). The suture did not enter the endometrium cavity ([Figure 2H](#)). There was no dead space and haemostasis could be performed. The myometrium layer was sutured with 2–0 vicryl and the continuous horizontal mattress technique. The external serous layer was sutured such that the cutting edges were inverted inside to reduce the adhesion of the incision to the omentum, intestines and peritoneum. For this new layer, 2–0 vicryl sutures with the 'baseball' method or continuous Lembert stitch method were used. The tourniquet was opened and probable bleeding was cauterized. The abdomen and pelvic cavity were washed carefully with 600 ml serum Ringer's solution infused to the abdomen and pelvic cavity to prevent adhesion as in other pelvic surgeries, especially for the younger patients. Then the abdomen wall was sutured (see Supplementary Video S1, available online).

For patients with lesions in both anterior and posterior uterine walls, the technique was performed as follows. First, the anterior wall was opened and the adenomyotic lesions resected (wedge-shaped removal) as previously described. Secondly, the margins and thickness of the

Table 1 Criteria used to assess dysmenorrhoea severity in verbal multidimensional scoring system ([Andersch and Milsom, 1982](#)).

Severity	Clinical manifestation
Grade 0	Menstruation is not painful and daily activity and working ability is unaffected; no systemic symptoms; analgesics are not required
Mild (grade 1)	Menstruation is painful but seldom inhibits normal activity; working ability is rarely affected; analgesics are seldom required; mild pain; no systemic symptoms; continues no more than 7 days
Moderate (grade 2)	Daily activity and working ability is affected; analgesics required and give sufficient relief so that absence from work or school is unusual; moderate pain; few systemic symptoms; persists more than 7 days
Severe (grade 3)	Activity clearly inhibited; poor effect of analgesics; vegetative symptoms (headache, fatigue, vomiting and diarrhoea); severe pain; persists more than 7 days

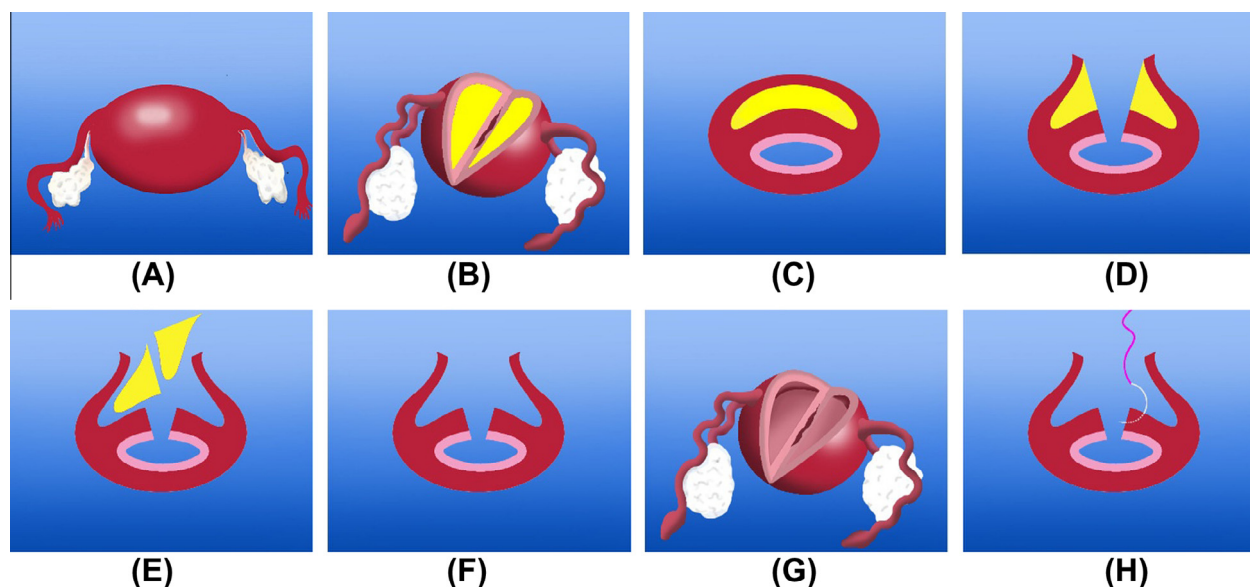


Figure 2 Schematic images of the adenomyomectomy procedure. (A) Uterine body viewed from above. (B) Sagittal incision of the uterus; yellow areas in the myometrium are the adenomyoma tissues. (C) Coronal section. (D–G) Adenomyosis resection steps. (H) Suturing and repair of the uterus without entering the endometrial cavity. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

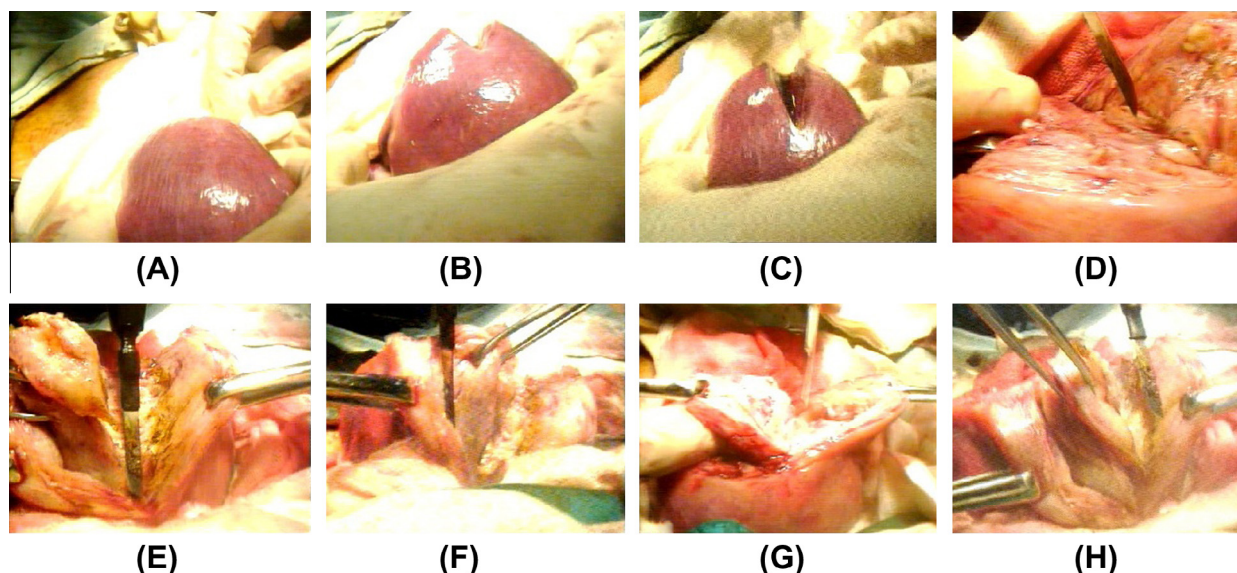


Figure 3 Actual images of the adenomyomectomy procedure. (A) Uterine body. (B and C) Sagittal incision. (D–H) Adenomyosis resection.

lesions on the posterior wall were estimated with the palpation guide and excision with wedge-shaped resection was performed without opening of the endometrium in the posterior wall (see Supplementary Video S2). The removed tissues were confirmed by histopathological assay (Figure 4).

Results

The demographic data of the 103 patients show that 61 (59.2%) were university graduates (secondary or tertiary education level) and the others were in the lower educational

level. In the case of patient occupations, 64 (62.1%) were homemakers and the others were employed.

The age of the 103 patients was (mean \pm SD) 37.46 ± 5.37 years. Table 2 shows patient age according to the main clinical presentation; no significant differences were observed. Of the 57 patients presenting with infertility, 68.4% (39 patients) had primary infertility and 31.6% (18 patients) had secondary infertility. Table 3 shows the occurrence of abnormal bleeding and dysmenorrhoea before surgery. There were 13 patients who had myomectomy, 30 patients had pure adenomyosis and the others had adenomyosis plus leiomyoma.

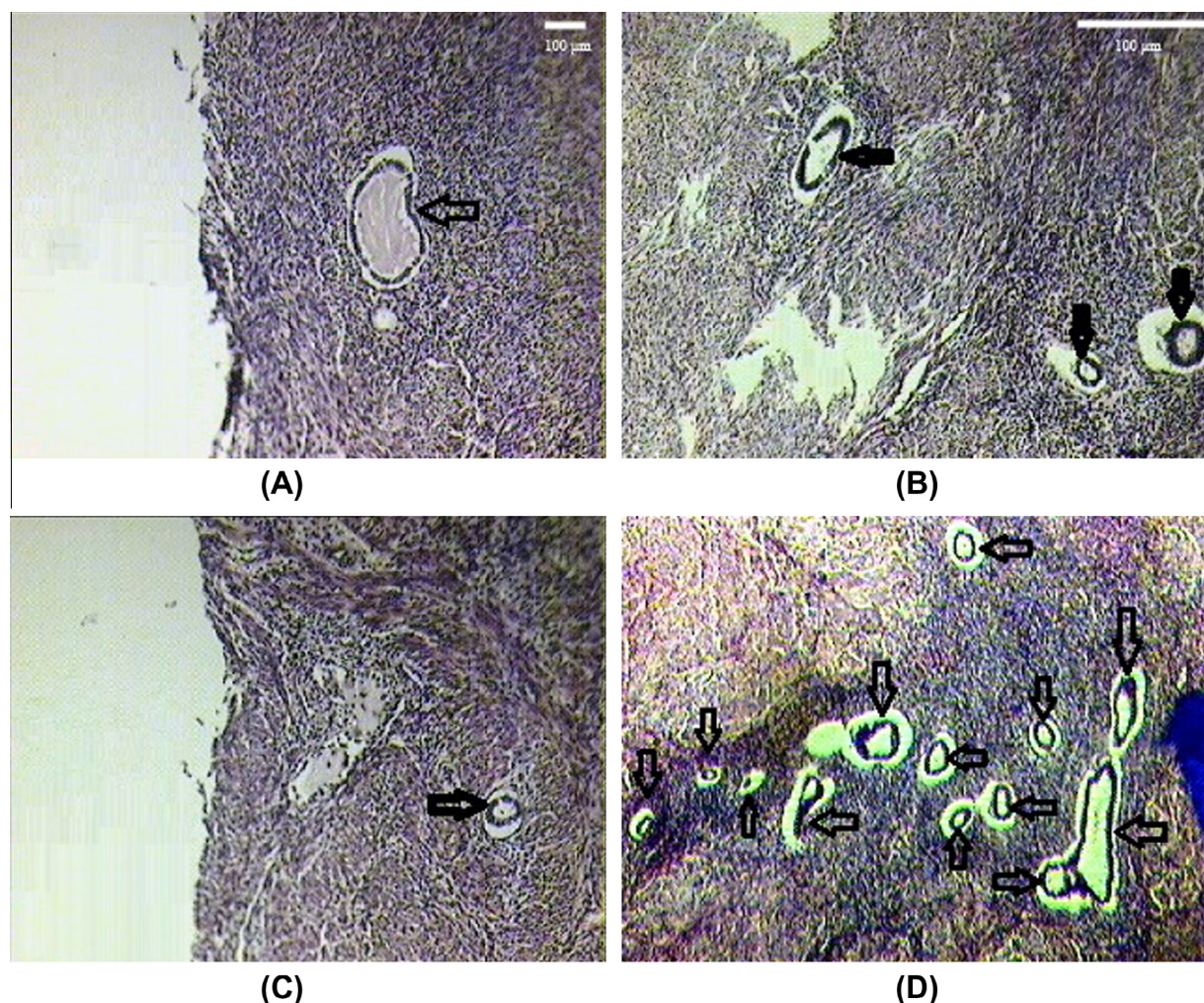


Figure 4 Histopathological images from an adenomyosis patient. Haematoxylin and eosin staining. Arrows indicate endometrial glands in the myometrium. Magnification: $\times 10$ (A and C, bar 100 μm), $\times 40$ (B and D, bar 100 μm).

Table 2 Characteristics of patients presenting with infertility, IVF failure, recurrent abortion and abnormal uterine bleeding.

Characteristic	Infertility	IVF (implantation) failure	Recurrent abortion	Abnormal (heavy) uterine bleeding	Total
Patients	57 (55.34)	17 (16.50)	9 (8.74)	20 (19.42)	103 (100)
Age (years)	36.46 ± 5.38	37.05 ± 5.75	36.88 ± 5.14	40.30 ± 5.70	37.46 ± 5.37
Duration of infertility (years)	6.85 ± 5.66 (1–21)	1.73 ± 0.84 (1–4)	3.32 ± 1.00 (2–5)	—	—

Values are n (%), mean \pm SD or mean \pm SD (range). There were no statistically significant differences in age.

The volume of blood loss during surgery was 365 ± 225 ml. The duration of surgery was 86 ± 41.3 min (the first operations were longer in duration, and the time decreased in later operations). A small number of patients had both anterior and posterior lesions (3/103, 2.9%). Post-operative complications were seen in six patients: in four cases leading to Asherman's syndrome and in two cases leading to spontaneous uterine rupture, one at 37 weeks and the other at 32 weeks of gestation (in both cases the uterus was immediately repaired after delivery). The 37-week pregnancy resulted in a stillbirth and the baby born at 32 weeks

was transferred to the neonatal intensive care unit and survived. One patient had relapsed adenomyosis. There were no infections or adhesions.

Post-surgical pregnancy outcomes are shown in Table 4 and post-surgical dysmenorrhoea and menstrual bleeding are shown in Table 5. The follow-up data for three patients were unavailable. A post-surgical ultrasound image of a uterus is given on Figure 5.

Among the 83 patients, 70 attempted to achieve pregnancy (of whom 49 patients used assisted reproduction treatment) during the study period. The age of the patients

Table 3 Abnormal bleeding and dysmenorrhoea before surgery.

Parameter	Patients (n = 103)
Bleeding status	
Regular	70 (67.96)
Irregular	33 (32.04)
Dysmenorrhoea	
Yes	59 (57.28)
Mild	15 (25.42)
Moderate	32 (54.24)
Severe	12 (20.34)
No	44 (42.72)

Values are n (%).

Table 4 Pregnancy outcomes following adenomyomectomy in patients attempting pregnancy according to reproductive symptom.

Parameter	Patients (n = 70)
Natural	21
Assisted reproduction	49
Clinical pregnancies	21/70 (30.00)
Natural conception	7/21 (33.33)
Assisted conception	14/49 (28.57)
Clinical presentations	
Infertility	46
IVF failure	16
Recurrent abortion	8
Pregnancy outcomes	
Live birth	16 (76.19)
Spontaneous abortion	4 (19.05)
Still birth	1 (4.76)
Pregnancy outcomes according to major symptom	
Infertility	12 (57.14)
Live birth	9
Spontaneous abortion	3
IVF failure	5 (23.81)
Live birth	4
Still birth (with gestational age)	1 (37 weeks)
Recurrent abortion	4 (19.05)
Live birth	3
Spontaneous abortion	1

Values are n or n/total (%).

with a positive clinical pregnancy (34.59 ± 3.28 years) was lower than that of the nonpregnant group (37.66 ± 5.26 years; $P = 0.027$).

All patients with a full-term pregnancy were delivered by Caesarean section. Of the eight patients who returned to the study centre for delivery, two (25%) had mild

post-operational adhesions, two (25%) had moderate post-operational adhesions, one (12.5%) had severe adhesions and three (37.5%) had no significant adhesions. No uterine scar tissues were seen during the Caesarean sections of these patients.

Discussion

The success of the surgical method included: (i) a 30% successful pregnancy rate; (ii) a decrease of approximately 65% in the number of patients with a heavy bleeding pattern; and (iii) a decrease of approximately 41% in the number of patients with dysmenorrhoea symptoms.

Adenomyosis is most frequently diagnosed in middle-aged women (Cirpan et al., 2008; Naphatthalung and Cheewadhanaraks, 2012), and the age in the current study was 37.46 ± 5.37 years. Although the age of the patients presenting with abnormal uterine bleeding was higher (40.3 ± 5.70 years) than that of the other groups, the difference was not statistically significant. In the adenomyomectomy procedure, the surgery duration and the bleeding show a wide range, as seen in the present study, because the lesion extension in the diffused form differs from that in the localized form. There was an association between the pregnancy success rate and patient age.

Theoretically, the complete removal of the adenomyoma lesions in the described surgical procedure can decrease the recurrence risk and create better uterine conditions for pregnancy. The spontaneous uterine rupture rate was significantly reduced because of the sagittal excision of the uterine body, the complete resection of the altered myometrium, the ligature method (which provides the appropriate blood supply and the least ischaemia) and the reconstruction of the excision layer by layer with inverted borders on suturing. Compared with wedge resections performed in previously described adenomyomectomy studies with approximately 69% recurrence (Sun et al., 2011), the current study's recurrence rate was significantly lower (1%). The pregnancy rate compared with previous studies suggests that the success rate is considerable (Hyams, 1952; Liu et al., 1998; Morita et al., 2004; Takeuchi et al., 2006; Wada et al., 2006). To reduce adhesion formation, two strategies were used: one using at least 600 ml Ringer's solution that remained in the abdominal cavity after surgery and the other using inverted border suturing of the serosa layer in the uterus repair stage. A sufficient blood supply was maintained for tissue reconstruction and the healing processes needed for repair of the resected myometrium muscle by uterine stem cells (Fernandez, 2003; Galvez et al., 2010; Gargett, 2007). The reconstruction method can play an important role in achieving a better outcome for the operation. At the beginning of the study, a successful method had not been reported in the literature. Compared with recent studies of modified adenomyomectomy, these results suggest that more removal of the adenomyotic lesions with a thin (≤ 0.5 cm) margin, as reported in the present study, may lead to a lower recurrence rates, similar rupture rates and fertility preservation. However, this technique can cause higher uterine complications in the endometrium such as Asherman's syndrome, if the incision breaks into the uterine cavity (Al Jama, 2011; Dai et al.,

Table 5 Abnormal bleeding and dysmenorrhoea outcomes following adenomyomectomy.

	<i>Post-surgical abnormal uterine bleeding (n = 20)</i>	<i>Post-surgical dysmenorrhoea</i>	
		<i>All patients (n = 100)^a</i>	<i>Patients who had symptom before surgery (n = 59)</i>
Decrease	13 (65.00)	29 (29.00)	24 (40.68)
No effect	6 (30.00)	68 (68.00)	32 (54.24)
Increase	1 (5.00)	3 (3.00)	3 (5.08)

Values are n (%).

^aFollow-up data for three patients were unavailable.

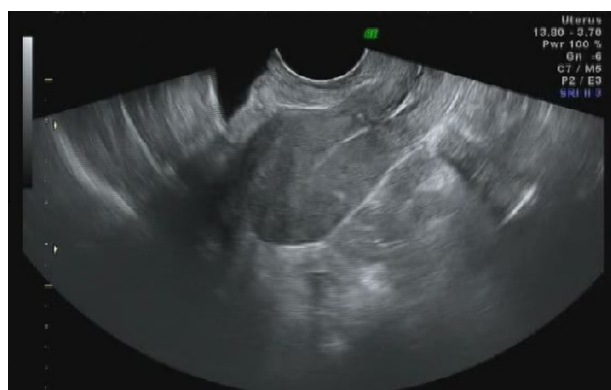


Figure 5 Post-operative ultrasound of an adenomyosis patient, showing normal endometrium and myometrium 2 years after adenomyomectomy. Histological images are shown in Figure 4.

2012; Grimbizis et al., 2008; Osada et al., 2011; Song et al., 2011; Sun et al., 2011). Compared with Osada et al. (2011), the success rate in pregnancy outcome was lower in the present study (61.5% versus 30%); however, the inclusion criteria in these two studies differed because the current patients had complicated and long-term complaints, such as infertility, IVF failure and recurrent abortions and heavy bleeding and patient selection was not only based on dysmenorrhoea severity.

This study shows that adenomyomectomy can be a conservative and effective option to treat adenomyosis, especially in women who seek uterine and fertility preservation. The procedure described in this study can be an efficient procedure to treat severe adenomyosis. This method can be further modified for better outcomes and this study centre is attempting to develop safer and less invasive methods to promote the management of adenomyosis.

Acknowledgements

This study was supported by the Sarem Cell Research Centre (SCRC). The authors would like to express their gratitude to the patients and the staff of Sarem Women's Hospital and

the Sarem Cell Research Centre (SCRC), and special thanks to Mr Iraj Shasti for graphics and video preparation.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.rbmo.2014.02.008>.

References

- Al Jama, F.E., 2011. Management of adenomyosis in subfertile women and pregnancy outcome. *Oman Med. J.* 26, 178–181.
- Andersch, B., Milsom, I., 1982. An epidemiologic study of young women with dysmenorrhea. *Am. J. Obstet. Gynecol.* 144, 655–660.
- Benagiano, G., Habiba, M., Brosens, I., 2012. The pathophysiology of uterine adenomyosis: an update. *Fertil. Steril.* 98, 572–579.
- Campo, S., Campo, V., Benagiano, G., 2012. Adenomyosis and infertility. *Reprod. Biomed. Online* 24, 35–46.
- Cirpan, T., Yeniel, O., Ulukus, M., Ozbal, A., Gundem, G., Ozsener, S., Mete Itil, I., Zekioglu, O., 2008. Clinical symptoms and histopathological findings in subjects with adenomyosis uteri. *Clin. Exp. Obstet. Gynecol.* 35, 48–53.
- Dai, Z., Feng, X., Gao, L., Huang, M., 2012. Local excision of uterine adenomyomas: a report of 86 cases with follow-up analyses. *Eur. J. Obstet. Gynecol. Reprod. Biol.* 161, 84–87.
- Ferenczy, A., 1998. Pathophysiology of adenomyosis. *Hum. Reprod. Update* 4, 312–322.
- Fernandez, H., 2003. New concepts on pathophysiology, diagnosis and treatment of adenomyosis. *J. Gynecol. Obstet. Biol. Reprod.* 32, S23–S27.
- Galvez, B.G., Martin, N.S., Salama-Cohen, P., Lazcano, J.J., Coronado, M.J., Lamelas, M.L., Alvarez-Barrientes, A., Eiro, N., Vizoso, F., Rodriguez, C., 2010. An adult myometrial pluripotential precursor that promotes healing of damaged muscular tissues. *In Vivo* 24 (4), 431–441.
- Gargett, C.E., 2007. Uterine stem cells: what is the evidence? *Hum. Reprod. Update* 13, 87–101.
- Grimbizis, G.F., Mikos, T., Zepiridis, L., Theodoridis, T., Miliaras, D., Tarlatzis, B.C., Bontis, J.N., 2008. Laparoscopic excision of uterine adenomyomas. *Fertil. Steril.* 89, 953–961.
- Hyams, L.L., 1952. Adenomyosis; its conservative surgical treatment (hysteroplasty) in young women. *N. Y. State J. Med.* 52, 2778–2784.
- Koninckx, P.R., Ussia, A., Adamyan, L., Wattiez, A., Donnez, J., 2012. Deep endometriosis: definition, diagnosis, and treatment. *Fertil. Steril.* 98, 564–571.

- Levgur, M., 2007. Therapeutic options for adenomyosis: a review. *Arch. Gynecol. Obstet.* 276, 1–15.
- Leyendecker, G., Wildt, L., Mall, G., 2009. The pathophysiology of endometriosis and adenomyosis: tissue injury and repair. *Arch. Gynecol. Obstet.* 280, 529–538.
- Liu, X., Huang, H., Huang, R., Lian, L., Lang, J., 1998. Clinical observation of conservative surgery for adenomyosis. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* 20, 440–444.
- Louis, L.S., Saso, S., Chatterjee, J., Barsoum, E., Al-Samarrai, M., 2012. Adenomyosis and infertility. *Reprod. Biomed. Online* 24, 586 (author reply 587).
- Morita, M., Asakawa, Y., Nakakuma, M., Kubo, H., 2004. Laparoscopic excision of myometrial adenomyomas in patients with adenomyosis uteri and main symptoms of severe dysmenorrhea and hypermenorrhea. *J. Am. Assoc. Gynecol. Laparosc.* 11, 86–89.
- Mounsey, A.L., Wilgus, A., Slawson, D.C., 2006. Diagnosis and management of endometriosis. *Am. Fam. Physician* 74, 594–600.
- Naphatthalung, W., Cheewadhanaraks, S., 2012. Prevalence of endometriosis among patients with adenomyosis and/or myoma uteri scheduled for a hysterectomy. *J. Med. Assoc. Thai.* 95, 1136–1140.
- Osada, H., Silber, S., Kakinuma, T., Nagaishi, M., Kato, K., Kato, O., 2011. Surgical procedure to conserve the uterus for future pregnancy in patients suffering from massive adenomyosis. *Reprod. Biomed. Online* 22, 94–99.
- Song, H.-S., Im, K.-S., Kwon, Y.-S., 2011. Laparoscopic adenomyomectomy: a highly effective method of adenomyoma excision and suturing. *J. Laparoendosc. Adv. Surg. Tech. Part B: Videoscopy.*
- Sun, A.J., Luo, M., Wang, W., Chen, R., Lang, J.H., 2011. Characteristics and efficacy of modified adenomyomectomy in the treatment of uterine adenomyoma. *Chin. Med. J.* 124, 1322–1326.
- Tahlan, A., Nanda, A., Mohan, H., 2006. Uterine adenomyoma: a clinicopathologic review of 26 cases and a review of the literature. *Int. J. Gynecol. Pathol.* 25, 361–365.
- Takeuchi, H., Kitade, M., Kikuchi, I., Shimanuki, H., Kumakiri, J., Kitano, T., Kinoshita, K., 2006. Laparoscopic adenomyomectomy and hysteroplasty: a novel method. *J. Minim. Invasive Gynecol.* 13, 150–154.
- Taran, F.A., Weaver, A.L., Coddington, C.C., Stewart, E.A., 2010. Understanding adenomyosis: a case control study. *Fertil. Steril.* 94, 1223–1228.
- Wada, S., Kudo, M., Minakami, H., 2006. Spontaneous uterine rupture of a twin pregnancy after a laparoscopic adenomyomectomy: a case report. *J. Minim. Invasive Gynecol.* 13, 166–168.
- Wang, P.H., Liu, W.M., Fuh, J.L., Cheng, M.H., Chao, H.T., 2009. Comparison of surgery alone and combined surgical-medical treatment in the management of symptomatic uterine adenomyoma. *Fertil. Steril.* 92, 876–885.
- Wolters, S.L., 1952. Adenomyosis of the uterus. *Nebr. State Med. J.* 37, 290–293.

Declaration: The authors report no financial or commercial conflicts of interest.

Received 26 May 2013; refereed 13 January 2014; accepted 12 February 2014.