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Animal models for research on endometriosis

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1. ABSTRACT

Endometriosis results from the aberrant growth of endometrium outside the inner lining of the uterine cavity. Similar to humans, the primates also menstruate and hence, the primate models constitute the gold standard for studying the pathogenesis and potential treatment for this disabling disease in women. Due to the expense in carrying endometriosis research in primates, other models have been developed for understanding the pathobiology and potential treatment of endometriosis. This includes explanting human endometrial tissues in athymic nude mice or using homologous mouse models. Here, we examine the murine models of endometriosis, the impact of forced induced inflammation on its development, similarities in the gene expression profile in the endometriotic tissues in such models with that seen in human endometriosis, and the drugs that are being used in such models as potential new treatment for endometriosis.

2. INTRODUCTION

The exact cause of endometriosis is not certain. However, the most commonly accepted explanation is the Sampson hypothesis which suggested viable endometrial tissue flows retrogradely through the fallopian tube and into the peritoneal cavity where it can attach to and invade tissues and organs within the cavity, all of which occured in a process called retrograde menstruation (1). At least 90% of women experience retrograde

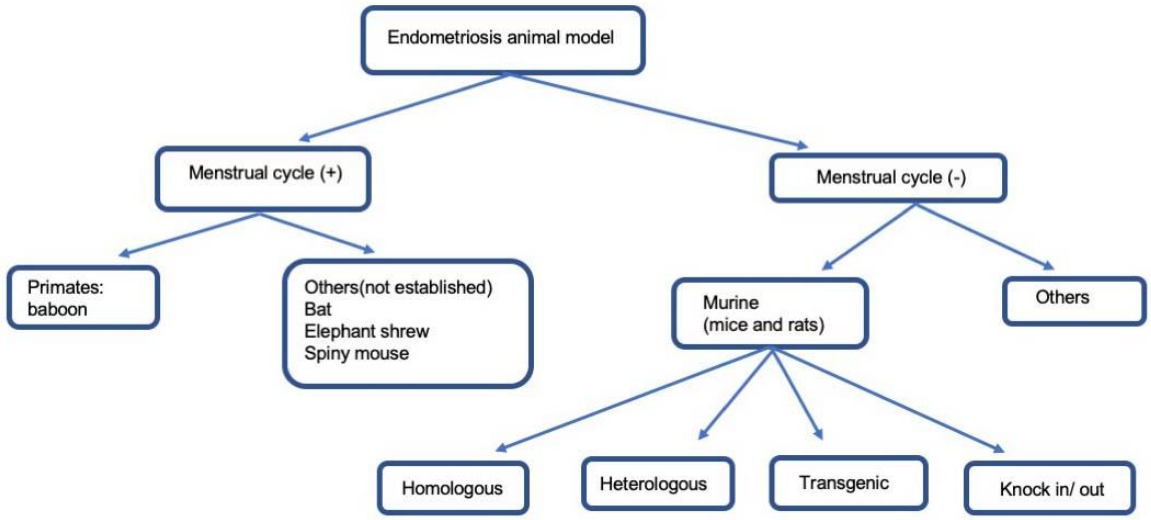

Figure 1. A cascade of animal endometriosis mice model. Endometriosis animal model is divided into 2 groups without and those with cyclical menstruation.

menstruation, but endometriosis occurs in only 10% to 14% of women under reproductive age, suggesting that additional factors impact its etiology (2). Based on the implantation theory, we generated the homologous murine endometriosis models by transplanting uterine tissue to mimic the pelvic environment in human endometriosis and analyzed the efficacy of several drugs (Figure 1, Table 1).

Current medical therapeutic agents such as GnRH agonist, progestins, and androgen supplements are used to decrease the ovarian estrogen production and counteract estrogen effects as this hormone initiates endometriosis (3). However, these therapeutic agents have undesirable side effects that limit their long-term use (2). Likewise, the scope of surgical treatment is also limited by a high recurrence rate, which may eventually lead to extreme measures, such as removal of the uterus and ovaries. Today, as science advances, new potential source of drugs from natural resources—for example plants, which may provide less toxicity and side effects—are explored. Thus, animal models to elucidate the mechanisms of endometriosis and develop therapeutic agents to prevent the progression of the disease are very important.

Animal models, which are used in the early stages of drug development, usually rely on non-menstruating models with the induced endometriosis-like lesions. One of the major limitations in endometriosis research is the paucity of robust animal disease models. Ideally, a disease models should mimic human disease and allow scientific investigation of the effects of both intrinsic factors, such as genes, and extrinsic factors, such as environmental factors on disease progression (4).

Several animal models of endometriosis have been established, most of which consisted of transplantation of endometrium into the peritoneal cavity, which is by far the most common site of the disease. Besides rodents, primates such as monkeys that spontaneously develop endometriosis or that have been intraperitoneally transplanted with endometrium can be used as a good animal model for the development and optimization of drug candidates. As monkeys developed endometriosis spontaneously due to cyclic menstrual periods—this model is undoubtedly the most reliable one (4-16). However, laborious requirements for the maintenance of these primate animal models have inhibited the progression of potential drug developments. This being said, most researchers concentrated their studies on smaller mammalian models, such as rats and rabbit (17-22). Moreover, the murine model was considered as a possible candidate for this purpose, and it may provide

Table 1. Representatives of murine endometriosis models

Drug	Characteristics of models	Reference
Mouse is both the donor and the host		
Not tested for drug development	Syngeneic GFP transgenic mice, retrograde menstruation model	78
Not tested for drug development	Deep endometriosis mouse model	13
Not tested for drug development	Laparoscopic mouse model	33
Not tested for drug development	P-selectin KO, GFP transgenic mice	18
Not tested for drug development	GFP mice	19
Not tested for drug development	Adhesion scoring system	79
Not tested for drug development	Estrogen receptor KO	40
Not tested for drug development	SRC-1 KO	58
Omega-3 polyunsaturated Fatty acids (3-PUFA)	Transgenic Fat-1 mice (high levels of endogenous 3-PUFA)	42
Parthenolide	Large cyst formation	30
Retinoic acid	GFP mice	59
Temsirolimus	Deep infiltrating implants	74
Tricostatin A	Auto-transplant model	65
Bazedoxifene	No description available	31
Celecoxib, Rosiglitazone	No description available	75
Leptin receptor antagonist	No description available	39
Resveratol	No description available	70
Statins	No description available	73
Symvastatin	No description available	9
Vitamin D receptor Agonist	No description available	72
Human is the donor and mouse is the host		
ENMD-1068, a protease-activated receptor 2 antagonist	Noninvasive fluorescent mouse model	77
Pentoxifylline	No description available	76
Cabergoline	Assessment nerve fibers	71
M: mouse; H: human, NM: nude mouse, KO: knock out mouse, GFP: green fluorescent protein		

advantages in terms of new therapeutic approaches (17,18,20,23-29). In recent decades, many knockout or transgenic mice have been generated. The availability of an endometriosis models in mice is crucial because it can be used to investigate some aspects of endometriosis.

3. GENOMIC FUNCTION OF ESTROGEN RECEPTOR β (BETA) IN ENDOMETRIOSIS

Endometriosis is an estrogen-dependent disease. Thus, estrogen receptors play a significant role in the development of the disease. Moreover, among estrogen receptors, Estrogen receptor β (ERβ) showed an association with endometriosis progression. Han *et al.* used mouse models to observe the role of ER β in the development of endometriosis (54). This is based on the study of Burns *et al.* where they concluded that the expression of ERβ was required for endometriosis-like lesion in mice (42). This being said, the study used an ERBOE (ERβ over-expressed) mouse to determine the histologic and immunologic change effects of ERβ. Remarkably, they were able to elucidate that over-expression of ERβ can lead to downregulation of immune response such as Interferons, NF-κB, and other inflammatory response. Note that Interferon also plays a significant role in pregnancy, such as in embryo implantation (55) and NF-κB expression regulates the gene expression profiles for implantation and successful pregnancy (56-59). Notably, NF-κB in mouse plays an important role as its activation promotes implantation of the mouse uterus (60,61). Therefore, downregulation of NF-κB signaling by ERβ can contribute to endometriosis in women by impairing embryo implantation.

The successful utilization of mouse models to observe the effects of ERβ in the development of endometriosis open ERβ over-expressed biomarker for endometriosis. This mouse models also provides ERβ explored ER insights on the better understanding of complex molecular etiology of endometriosis induced by estrogen/ ERβ axis (62,63). Moreover, the availability of female mice (C57BL/6J) and its ease

in animal laboratory handling provide a great advantage compared to other animal models.

4. MURINE ENDOMETRIOSIS MODELS

Mice are the most commonly used animal models capable of investigating the pathophysiology of endometriosis. However, they do not spontaneously develop endometriosis. In order to induce endometriosis in mice, endometrial tissue must be transplanted into the peritoneal cavity using methods (10-13), which can be classified into two basic types, homologous and heterologous. Both models produce comparable phenotypes, which are then morphometrically evaluated.

4.1. Homologous or autologous models

In homologous or autologous models, endometrial tissue is transplanted into the peritoneal cavity of recipient mice and starts to grow in an estrogen-dependent manner. In almost all models, uterine endometrial fragments from a donor mouse are directly introduced *via* injection some by suturing (19,30-32) or inserted laparoscopically (33,34) into the peritoneal cavity of recipient mice. Our studies used a homologous mouse models of endometriosis.(47,48,53).

Care and treatment. According to the implantation theory, we made the readily available murine models which evaluate the development of endometriosis-like lesions (30). Female mice (6 weeks of age, BALB/c) were purchased. Before initiating the experiments, animals were allowed to acclimate to the following conditions for seven days. The mice were put in a controlled temperature range (72–74) on a 12-hour light, 12-hour dark cycle. They were given food and water *ad libitum*. Recipient mice were ovariectomized through two 0.5-cm dorsolateral skin incisions and were then divided into two treatment groups; estradiol valerate (0.5 μg/mouse·wk) in corn oil or only corn oil vehicle. The mice were dosed subcutaneously once per week for two weeks before they were induced experimental endometriosis. The donor uterus was removed *en bloc* after euthanasia, cleaned of excess tissue, and washed thrice in sterile phosphate-buffered saline (PBS). The uterus was slit with a linear incision longitudinally and minced (≤1.5 mm). Recipient mice were anesthetized using isoflurane/oxygen and given buprenorphine (0.1 mg/kg) for pain management. A 0.5-cm right dorsolateral incision was made, minced donor tissue (1:2 donor uterus to host ratio) in 500 μl PBS was injected into the peritoneal cavity of the recipient, and was gently massaged to disperse the tissue. An equivalent amount (~100 mg) of minced tissue was transferred into all recipients. The mice were treated for four additional weeks with estradiol valerate (E2) or the vehicle. After four weeks, the mice were euthanized with CO_2, their peritoneal cavity was opened, and the endometriosis-like lesions were removed. To assess the effects of drug candidates on ectopic uterine tissue, ectopic lesions were photographed to document *in situ* endometriosis-like lesions. Endometriosis-like lesions were visualized, dissected, measured, and weighed. Endometriosis-like lesions were removed and were either fixed in 10% formalin or snap-frozen on dry ice and stored at −80 C until use.

In chapter six, we will describe the efficacy of SR-16234 (SR), a selective estrogen receptor modulator (SERM), parthenolide and BV6, an inhibitor of apoptosis protein inhibitor (IAP) on the murine endometriosis-like lesions by using homologous mouse models.

4.2. Heterologous models

In heterologous models, human endometriotic lesions are transplanted into the peritoneal cavity of immune-deficient mice (35,36), and into the peritoneum of immunocompromised mice (37,38). The xenotransplantation models in the nude mouse is also used but is limited by the lack of a normal immune system. Despite the advantage of being based on human endometrial tissues, the number of endometriotic lesions developed in the heterologous models varies from one animal to another. In both models, with or without suturing the endometrial implant, the drug's influence on the growth of endometrial or endometriotic transplants is evaluated.

However, these established endometriosis models in mice are under discussion. Indeed, mice lack a menstrual cycle and do not develop

spontaneous endometriosis. It should be reviewed whether transplanting normal endometrium into the peritoneal cavity of a non-menstruating species reflects all pathophysiological aspects of human endometriosis.

4.3. Knockout and transgenic murine models

The knockout and transgenic murine models provide a suitable environment to study biological factors such as the role of immune system and hormone balance that may affect endometriosis, which cause unbearable pain and possible infertility. These models also enable the evaluation of molecular mechanisms that are critical for disease initiation (39-42). With the existing limitation, additional and ideal models of endometriosis are needed. In the next section, we demonstrate the results using murine endometriosis model that expanded the capability of conducting both mechanistic and translational research.

4.4. Development of an experimental model of endometriosis using mice that ubiquitously express green fluorescent protein

The search for the most suitable candidate animal models to elucidate the disease mechanisms of endometriosis is still under rigorous evaluation. Although the use of small animals such as rabbit, rat, and mouse were a few of the animal models that are intensively studied, several disadvantages such as lesions sometimes being too unclear to be distinguished from surrounding normal tissues is still an issue to be addressed. This indistinctness makes it difficult to determine the weight of the lesions, which is essential in endometriosis studies. To address this issue, a transgenic mouse was developed. The use of green fluorescent protein (GFP) imaging of tumor growth, metastasis, and angiogenesis in mouse models have provided the new insights into the real-time growth and metastatic behavior of cancer. This study inspired the use of GFP imaging in the evaluation of endometriosis progression in mice. Moreover, the sensitivity of the method eliminates the surrounding normal tissues to metastatic tissue, thus making this transgenic mouse models can be a good candidate for the evaluation of endometriosis. In addition, this effort utilized the technology to quantitatively assess the human endometriotic tissue maintenance and regression in a non-invasive mouse model of endometriosis (54). Notably, they were able to demonstrate the feasibility of visualizing fluorescent endometriosis-like lesions in nude mice in a non-invasive manner.

With these scientific efforts, Hirata *et al.* developed the transgenic mice that ubiquitously express GFP for the evaluation of endometriosis (19). In their study, they provided several advantages of using this animal models; first, its sensitivity. Small endometriotic lesions are often more difficult to be identified by macroscopic examination. However, with the use of GFP-emitted light in the transgenic mice which can be easily detected in dark field, the location of the lesions can easily be discovered. In addition, the level of fluorescence of endometriotic lesions can be used for semi-quantitation of their size. The fluorescence intensity is positively correlated with weight of the lesions. And lastly, this animal models can clearly identify endometriotic cells originating from donor mice in histologic sections. The precise discrimination of endometriotic cells from other cells may have significant implications for the analysis of endometriotic tissues in animal models. However, a great disadvantage of using this model in drug development evaluation is that the GFP interactions to drugs might interfere with the study. Thus, additional evaluation should be conducted to provide a reliable animal model for drug assessment in endometriosis. Nevertheless, this transgenic mouse models can be utilized for the observation of endometriosis development and progression of disease.

4.5. Lipopolysaccharide (LPS)-induced pelvic inflammation

Local inflammatory reaction in the peritoneal environment is also considered one of the contributing factors in the pathogenesis of endometriosis (44). Studies have demonstrated the effects of inflammatory mediators, such as LPS, or combined effects of E2 and LPS on promoting proinflammatory response in pelvis and growth of endometriosis (45,46). As mice with natural estrous

cycle were used to be the innate hormonal environment in juvenile mice, in one study, we also analyzed the influence of LPS-induced inflammation using both recipient and donor mice with natural estrous cycle to avoid excess estrogen environment (47). For four weeks, recipient mice were treated with a single intraperitoneal (i.p) injection of LPS (2mg/kg) or vehicle (saline) twice weekly. We demonstrated that administrating LPS for four weeks significantly increased the total number (LPS: 2.8±0.27 vs. vehicle: 1.6±0.22/mouse), the average weight (65.0±9.7 vs. 30.0±5.2 mg/mouse), and the surface area (11.7±2.3 vs. 4.6±0.6 mm^2/mouse) of endometriosis-like lesions compared with the vehicle group. LPS enhanced mRNA expression of *Ptgs-2, Vegf, Ccl-2, and Il-6* in endometriosis-like lesions. LPS also increased the percentage of Ki67-positive cells and enhanced the intensity and rate of positive cells of CD3, F4/80, and PECAM. Intense expression of phosphor-p65 NF- κB (nuclear factor -kappa B) after LPS administration was observed.

5. ABERRANT GENE EXPRESSION PROFILE IN A MOUSE MODELS OF ENDOMETRIOSIS MIRRORS AS COMPARED TO THE ENDOMETRIOSIS IN WOMEN

Primate models would be the best fit for experimentation, however, the cost and lack of housing facilities provide great disadvantage to the progress of study of endometriosis. As an alternative model system, mice are readily available and comparatively inexpensive, but the relatedness to human endometriosis is an issue to consider for using them as a good animal models for endometriosis. With this, Pelch *et al.* investigated the gene expression profile of mouse models compared to women (32). Remarkably, the result showed that mouse endometriotic lesions resemble lesions in women. Moreover, the work has shown that mouse and human endometriotic tissue progresses from a move to a less biologically active form. In addition, the genes thought to be particularly important to endometriosis were altered in the same directions in both the human study and the use of mouse model study. With the remarkable findings of the study that the gene expression profile in the mouse endometriotic lesion is analogous to women, this makes mouse models a good candidate tool for studying endometriosis pathogenesis, pathophysiology, and treatment.

6. POTENTIAL TREATMENT FOR ENDOMETRIOSIS

6.1. The efficacy of SR-16234 (SR), a selective estrogen receptor modulator (SERM)

In addition to typical estrogen suppressing agents, combined targeting of E2 and LPS could be useful in the treatment of endometriosis. SR is a SERM, which is reported to have estrogen receptor (ER) α antagonistic activity with a weak partial agonist activity to ERβ (47). SERMs have been considered for using in the treatment of endometriosis due to their antiproliferative effects on the endometrium. Compared to other SERMs, which have ERα partial agonistic activity, SR is predicted to yield a superior effect in humans due to its pure antagonistic action on ERα. We investigated the effects of SR on the development of murine endometriosis-like lesions (48) by establishing the endometriosis models as previously described (30). Considering the synergistic effect between E2 and LPS, we also used the LPS to promote the pelvic inflammatory process. After induction, recipient mice were treated with vehicle or LPS (0.05 mg/kg, i.p; twice a week) without SR or with SR (1mg/kg; subcutaneously, daily). We demonstrated that after 4 weeks of treatment, SR effectively suppressed the growth and inflammatory-associated genes expression in endometriosis-like lesions without inducing endometrial growth (48).

6.2. Effects of parthenolide on the murine endometriosis-like lesions

We undertook a study of fever as a potential therapy for endometriosis that illustrated the effectiveness of the murine models. The medical herb feverfew has long been used as a folk medicine for treating fevers, migraine, rheumatoid arthritis, and dysmenorrhea. Parthenolide is considered the primary bioactive compound in feverfew having anti-tumor and anti-inflammatory properties (49). Parthenolide produces anti-tumorigenesis effects

against human acute myeloid leukemia and solid tumors, such as breast and pancreatic cancer (43,50,51). We, therefore, used an experimental mouse models to evaluate the effect of parthenolide as a therapy for endometriosis (30).

We established the models by injecting tissue suspension intraperitoneally. Endometriosis-like lesions had grown in the abdominal cavity of all mice. The deposits appeared as cystic lesions bulging under the serosal coat. Most of the lesions were observed around the abdominal incision, the intestinal membrane, and the renal capsule. The size of lesions ranged from approximately 2 to 8 mm in diameter. Histologic sections stained with hematoxylin and eosin were endometriotic in character. The monolayer epithelial cell lining of the cyst was revealed by hematoxylin and eosin staining (30). We confirmed that cytokeratin (a marker of epithelial cells) and vimentin (a marker of stromal cells) in the mouse endometriosis-like lesions were positive, whereas calretinin (that of mesothelium cells) was negative, indicating that these cystic lesions originated from the injected endometrial tissues, not the peritoneal cells.

In view of the above considerations, we proposed a hypothesis that parthenolide may have an inhibitory effect on the development of endometriosis. After parthenolide treatment for 4 weeks, the total number of lesions (5.8 vs. 3.9/mouse) was significantly reduced, and the average weight (65.6 vs. 29.6 mg/mouse) and the surface area (50.3 vs. 25.7 mm^2/mouse) of lesions decreased by approximately 50% of controls. To evaluate the proliferative activity of lesions, the ratio of Ki67-stained cells was calculated. In endometrial glands epithelia, the percentage of Ki67-positive cells decreased after parthenolide treatment (17.8 vs. 8.5%).

6.3. The role of the inhibitors of apoptosis proteins (IAPs) inhibitor as a new treatment

IAPs are a family of proteins implicated in multiple ways in cell death regulation, ranging from the inhibition of apoptosis to the regulation of cell cycle and inflammation. In the signaling pathway of apoptosis, IAPs have emerged as modulators in a step that involves direct inhibition of the terminal effectors, caspase-3, and -7. We previously reported higher expression of four IAPs (cIAP-1, cIAP-2, XIAP and survivin) in endometriotic tissue and endometriotic stromal cells (ESCs) than in eutopic endometrial tissues and eutopic endometrial stromal cells and demonstrated that IAP antagonist (BV6) repressed ESCs proliferation through NF-κB pathway (52).

To investigate the role of IAPs in the development of murine endometriosis lesions, we established the homologous ovariectomized murine model by transplanting uterine tissue as previously described (30). Recipient mice were treated with a single intraperitoneal injection of BV6 (10 mg/kg) twice weekly. After the treatment with BV6 for 4 weeks, the total number (Veh: 5.0 ± 1.6 vs BV6: 2.5 ± 0.6: $P < .01$), the average weight (Veh: 73.3 ± 27.8 mg vs BV6: 25.5 ± 10.7 mg: $P < .01$), and the surface area (Veh: 43.3 ± 17.1 mm2 vs BV6: 20.4 ± 6.2 mm^2: $P < .01$) of lesions per mouse were significantly less than in the vehicle group. BV6 also decreased the *Vegf, Il-6, Ccl-2, and Lif* mRNA expression in the murine endometriosis-like lesions compared with the vehicle group ($P < .05$). BV6 also repressed the inflammatory and angiogenic activity and phospho-p65 NF-κB expression in endometriosis-like lesions (53).

7. PERSPECTIVE

Convenient and reliable endometriosis animal models are needed to accelerate emerging therapeutic alternatives. According to the Sampson's "implantation theory", we established the syngeneic immunocompetent mice model. In this model, we and the other investigators provided crucial evidence of both the development of endometriosis-like lesion growth and donor tissue responsiveness. Recently, Pelch *et al* described a detailed method of a surgically-induced endometriosis mouse model by auto-transplantation of its uterine tissue (32).

The rodent endometriosis models using mice or rats are widely used in research, but they may have limitations and may not mimic all aspects of human pathophysiology. For example, in homologous rodent models, "healthy'" uterus is cut

into fragments and transplanted into the peritoneum, whereas it has been suggested that the eutopic endometrium of women suffering from endometriosis may already be abnormal (2). Nude mice lacking an intact immune system are employed in the heterologous model, which cannot mimic the inflammatory response normally seen in human endometriotic lesion (36). Although heterologous rodent endometriosis models are responsive to drugs and manipulations that induce a hypoestrogenic state, such as ovariectomy, GnRH agonists, aromatase inhibitors, danazol, and selective estrogen receptor modulators, it may be difficult to analyze novel target families in which, for example, the murine ligand does not bind to the receptor of the human transplant.

Whereas cell-based *in vitro* experiments provide a framework for testing molecular mechanisms, eventually, confirming their role in disease causality *in vivo* can only be accomplished by a suitable animal model. For a disease as diverse as endometriosis, a single animal model would unlikely be sufficient to represent the entire diversity in etiology, pathogenesis, and pathology. Each model has design-related strengths and limitations. For example, a recently described disease model consists of introducing endometrial tissue *via* direct injection into the peritoneal cavity of immunocompetent mice without suturing (28,32,40). In mice, the injected tissue forms cyst-like endometriosis lesions; however, the injection method does not seem to work in rats because the tissue fails to attach to and invade the peritoneal cavity (64). Since all endometriosis lesions in each model attached to the peritoneum and/or mesothelium with or without suturing, evaluating attachment or invasion of lesions would be difficult. Furthermore, in regard to quantifying the injected endometrial fragments, this model may be insufficient to evaluate the endometriotic lesions precisely.

The rodent model is used extensively to study the etiology, pathology, and risk factors of endometriosis (9,19,35,40,65-70) as well as to explore novel therapeutics (30,31,71-77). In conclusion, this model provides an important tool to evaluate a therapeutic approach to the disease. It will help to better understand disease evolution in the living animal and permit faster and more accurate characterization of a drug's effect on experimental endometriosis.

To explain the pathophysiology of endometriosis and observe the endometriosis dispersion as early as possible without sacrificing the mice, we generated endometriosis mice model using transgenic eluc mice (with specific endometriosis genetic expression such as VEGF). Using *in vivo* imaging system (IVIS), the endometriosis disease progression, cell trafficking, and gene expression patterns in living animals can be easily observed. The differences between GFP mice and eluc mice is the endometriotic like lesion can not be detected in a deep intra peritoneum in GFP mice (19). First, it needs a confirmation whether this animal model would become a reliable endometriosis model and whether the efficacy of drugs would be possible to be observed using this model. Our future plan and hope are to develop instruments to detect endometriotic lesions without laparoscopic intervention.

8. ACKNOWLEDGMENTS

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9. REFERENCES

1. John A Sampson: Metastatic or Embolic Endometriosis, due to the Menstrual Dissemination of Endometrial Tissue into the Venous Circulation. Am J Pathol 3(2), 93-110.43 (1927)

2. Linda C Giudice, Lee C Kao: Endometriosis. In: Lancet, 1789-1799 (2004)
DOI: 10.1016/S0140-6736(04)17403-5

3. Erin Greaves , Hilary O.D. Critcley , Andrew W. Horne & Philippa T.K. Saunders: Relevant human tissue resources and laboratory models for use in endometriosis research. Acta Obstet Gynecol Scand 96, (6), 644-658 (2017)
DOI: 10.1111/aogs.13119

PMid:28233896 PMCid:PMC5485163

4. Ioannis Simitsidellis, Douglas A. Gibson: Animal models of endometriosis: Replicating the aetiology and symptoms of the human disorder. Best Pract Res Clin Endocrinol Metab 32,(3), 257-269 (2018)
DOI: 10.1016/j.beem.2018.03.004
PMid:29779580

5. Hareesh B. Nair, Robert Baker, Michael A. Owston, Renee Escalona, Edward J. Dick, John L. VandeBerg and Klaus J. Nickisch: An efficient model of human endometriosis by induced unopposed estrogenicity in baboons. Oncotarget, 10857-10869 (2016)
DOI: 10.18632/oncotarget.7516
PMid:26908459 PMCid:PMC4905444

6. Julie M Hastings and Asgerally T Fazleabas: A baboon model for endometriosis: Implications for fertility. Reprod Biol Endocrinol 4, (Suppl 1),S7 (2006)
DOI: 10.1186/1477-7827-4-S1-S7
PMid:17118171 PMCid:PMC1775067

7. Asgerally T. Fazleabas, Allison Brudney, Bilgin Gurates, Daniel Chai, and Serdar Bulun: A modified baboon model for endometriosis. In: Annals of the New York Academy of Sciences, 308-317 (2002)
DOI: 10.1111/j.1749-6632.2002.tb02791.x
PMid:11949957

8. P. Harirchian, I. Gashaw, S.T. Lipskind, A.G. Braundmeier, J.M. Hastings, M.R. Olson, and A.T. Fazleabas: Lesion kinetics in a non-human primate model of endometriosis. Hum Reprod, 2341-2351 (2012)
DOI: 10.1093/humrep/des196
PMid:22674203 PMCid:PMC3398680

9. Anna Sokalska, MariaPia Anderson, Jesus Villanueva, Israel Ortega, Kaylon L. Bruner-Tran, Kevin G. Osteen, and Antoni J. Duleba: Effects of simvastatin on retinoic acid system in primary human endometrial stromal cells and in a chimeric model of human endometriosis. J Clin Endocrinol Metab, 463-471 (2013)
DOI: 10.1210/jc.2012-3402
PMid:23337719 PMCid:PMC3590479

10. Hugh S. Taylor, Myles Alderman III, Thomas M. D'Hooghe, Asgerally T. Fazleabas and Antoni J. Duleba: Effect of simvastatin on baboon endometriosis. Biol Reprod 97, (1), 32-38 (2017)
DOI: 10.1093/biolre/iox058
PMid:28637327 PMCid:PMC6248548

11. William F. MacKenzie, Harold W. Casey: Animal model of human disease: endometriosis in rhesus monkeys. Am J Pathol (1975)

12. Roger B Scott, Richard W Te Linde , Laurance R Wharton: Further studies on experimental endometriosis. Am J Obstet Gynecol, 1082-1103 (1953)
DOI: 10.1016/S0002-9378(16)38618-5

13. Dingmin Yan, Xishi Liu, Sun-Wei Guo: Nerve fibers and endometriotic lesions: partners in crime in inflicting pains in women with endometriosis. Eur J Obstet Gynecol Reprod Biol 209, 14-24 (2017)
DOI: 10.1016/j.ejogrb.2016.06.017
PMid:27418559

14. David Langoi, Mary Ellen Pavone, Bilgin Gurates, Daniel Chai, Asgerally Fazleabas, and Serdar E. Bulun: Aromatase inhibitor treatment limits progression of peritoneal endometriosis in baboons. Fertil Steril, 656-662 (2013)

DOI: 10.1016/j.fertnstert.2012.11.021
PMid:23257603 PMCid:PMC3746767

15. Dan I. Lebovic, Jason M. Mwenda, Daniel C. Chai, Alessandro Santi, Xiao Xu, and Thomas D'Hooghe: Peroxisome proliferator-activated receptor-gamma-receptor ligand partially prevents the development of endometrial explants in baboons: A prospective, randomized, placebo-controlled study. Endocrinology,1846-1852 (2010)
DOI: 10.1210/en.2009-1076
PMid:20160135 PMCid:PMC2850226

16. Akiyoshi Yamanaka, Fuminori Kimura, Akie Takebayashi, Nobuyaki Kita, Kentaro Takahashi, Takashi Murakami: Primate model research for endometriosis. Tohoku J Exp Med, 95-99 (2012)
DOI: 10.1620/tjem.226.95
PMid:22245765

17. Yukiko Tanaka, Taisuke Mori, Fumitake Ito, Akemi Koshiba, Osamu Takaoka, Hisashi Kataoka, Eiko Maeda, Hiroyuki Okimura, Takahide Mori, Jo Kitawaki. Exacerbation of endometriosis due to regulatory t-cell dysfunction. J Clin Endocrinol Metab, 3206-3217 (2017)
DOI: 10.1210/jc.2017-00052
PMid:28575420

18. Sun-Wei Guo, Ding Ding, Xishi Liu: Anti-platelet therapy is efficacious in treating endometriosis induced in mouse. Reprod Biomed Online, 484-499 (2016)
DOI: 10.1016/j.rbmo.2016.07.007
PMid:27519725

19. Tetsuya Hirata, Yutaka Osuga, Osamu Yoshino, Yasushi Hirota, Miyuki Harada, Yuri Takemura, Chieko Morimoto, Kaori Koga, Tetsu Yano, Osamu Tsutsumi and Yuji Taketani: Development of an experimental model of endometriosis using mice that ubiquitously express green fluorescent protein. Hum Reprod, 2092-2096 (2005)
DOI: 10.1093/humrep/dei012
PMid:15831509

20. Audrey M. Cummings and Joan L. Metcalf: Induction of endometriosis in mice: A new model sensitive to estrogen. Reprod Toxicol, 233-238 (1995)
DOI: 10.1016/0890-6238(95)00004-T

21. Ruth Grummer, Frauke Schwarzer, Katja Bainezyk, Hulger Hess Stumpp, Pedro A Regidor, Adolf F Schindler, Elke Winterhager: Peritoneal endometriosis: validation of an in-vivo model. Hum Reprod, 736-1743 (2001)
DOI: 10.1093/humrep/16.8.1736
PMid:11473975

22. Gabriele Rossi, Edgardo Somigliana Marta Moschetta, Roberta Santorsola Sabrina Cozzolino, Paola Filardo Alessandra Salmaso, Beatrice Zingrillo: Dynamic aspects of endometriosis in a mouse model through analysis of implantation and progression. Arch Gynecol Obstet, 102-107 (2000)
DOI: 10.1007/s004040050005
PMid:10763836

23. Ming Yuan, Dong Li, Min An, Qiuju Li, Lu Zhang, and Guoyun Wang: Rediscovering peritoneal macrophages in a murine endometriosis model. Hum Reprod, 94-102 (2017)
DOI: 10.1093/humrep/dew274
PMid:27816922

24. Claire M King, Cynthia Barbara, Andrew Prentice, James D Brenton and D Stephen Charnock-Jones: Models of endometriosis and their utility in studying

progression to ovarian clear cell carcinoma. J Pathol, (2016)

25. Siomara Hernandez, Myrella L. Cruz, Inevy I. Seguinot, Annelyn Torres-Reveron and Caroline B. Appleyard: Impact of Psychological Stress on Pain Perception in an Animal Model of Endometriosis. Reprod Sci, 1371-1381 (2017)
DOI: 10.1177/1933719116687655
PMid:28093054 PMCid:PMC5933089

26. Shuangge Liu, Xiaoyan Xin, Teng Hua, Rui Shi, Shuqi Chi, Zhishan Jin, Hongbo Wang: Efficacy of anti-VEGF/VEGFR agents on animal models of endometriosis: A systematic review and meta-analysis. PLoS One 11, (11), 1-15 (2016)
DOI: 10.1371/journal.pone.0166658
PMid:27855197 PMCid:PMC5113963

27. Kelsi N. Dodds, Elizabeth A. H. Beckett, Susan F. Evans and Mark R. Hutchinson: Lesion development is modulated by the natural estrous cycle and mouse strain in a minimally invasive model of endometriosis. Biol Reprod, 810-821 (2017)
DOI: 10.1093/biolre/iox132
PMid:29069288

28. Silva J, Silva A, Reis F, Garcia S, Sá M, Nogueira A: Development of an experimental model of endometriosis in rabbits. Int Congr Ser 1271(C), 248-251 (2004)
DOI: 10.1016/j.ics.2004.05.092

29. Song W, Lu H, Hou W, Xu G, Zhang J, Sheng Y, Cheng M, Zhang R: Expression of vascular endothelial growth factor C and anti-angiogenesis therapy in endometriosis. Int J Clin Exp Pathol 7, (11), 7752-7759 (2014)

30. Eri Takai, Fuminori Taniguchi, Kazuomi Nakamura, Takashi Uegaki, Tomio Iwabe, Tasuku Harada: Parthenolide reduces cell proliferation and prostaglandin estradiol synthesis in human endometriotic stromal cells and inhibits development of endometriosis in the murine model. Fertil Steril 100, (4), 1170-1178 (2013)
DOI: 10.1016/j.fertnstert.2013.06.028
PMid:23876538

31. Jaime Kulak, Jr., Catha Fischer, Barry Komm, and Hugh S. Taylor: Treatment with bazedoxifene, a selective estrogen receptor modulator, causes regression of endometriosis in a mouse model. Endocrinology, 3226-3232 (2011)
DOI: 10.1210/en.2010-1010
PMid:21586552 PMCid:PMC3138238

32. Katherine E. Pelch, Kathy L. Sharpe-Timms, Susan C. Nagel: Mouse model of surgically-induced endometriosis by auto-transplantation of uterine tissue. J Vis Exp, 1-8 (2012)

33. Daniëlle P. Peterse, Amelie Fassbender, Dorien F.O, Arne Vanhie, Philippa Saunders, Joris Vriens, M. Mercedes Binda, Thomas M. D'Hooghe: Laparoscopic Surgery: A New Technique to Induce Endometriosis in a Mouse Model. Reprod Sci, 1332-1339 (2016)
DOI: 10.1177/1933719116638178
PMid:26994066

34. Daniëlle Peterse, M. Mercedes Binda, Dorien F. O, Arne Vanhie, Amelie Fassbender, Joris Vriens, Thomas M. D'Hooghe: Of Mice and Women: A Laparoscopic Mouse Model for Endometriosis. J Minim Invasive Gynecol, 578-579 (2018)
DOI: 10.1016/j.jmig.2017.10.008
PMid:29032250

35. Lisa Story and Stephen Kennedy: Animal studies in endometriosis: a review. ILAR J 45, (2)132-138 (2004)
DOI: 10.1093/ilar.45.2.132
PMid:15111732

36. Irene Tirado-González, Gabriela Barrientos, Nadja Tariverdian, Petra C.Arck, Mariana G.García, Burghard F.Klapp, Sandra MBlois: Endometriosis research: Animal models for the study of a complex disease. J Reprod Immunol, 141-147 (2010)
DOI: 10.1016/j.jri.2010.05.001
PMid:20594597

37. Banghyun Lee, Hongling Du, and Hugh S. Taylor: Experimental Murine Endometriosis Induces DNA Methylation and Altered Gene Expression in Eutopic Endometrium 1. Biol Reprod, 79-85 (2009)
DOI: 10.1095/biolreprod.108.070391
PMid:18799756 PMCid:PMC2804809

38. Kaylon L. Bruner -Tran, Esther Eisenberg, Grant R. Yeaman, Ted A. Anderson, Judith MC Bean, and Kevin G. Osteen: Steroid and cytokine regulation of matrix metalloproteinase expression in endometriosis and the establishment of experimental endometriosis in nude mice. J Clin Endocrinol Metab, 4782-4791 (2002)
DOI: 10.1210/jc.2002-020418
PMid:12364474

39. Aaron K. Styer, Brian T. Sullivan, Mark Puder, Danielle Arsenault, John C. Petrozza, Takehiro Serikawa, Sung Chang, Tayyaba Hasan, Ruben R. Gonzalez, and Bo R. Rueda: Ablation of leptin signaling disrupts the establishment, development, and maintenance of endometriosis-like lesions in a murine model. Endocrinology, 506-514 (2008)
DOI: 10.1210/en.2007-1225
PMid:17962343 PMCid:PMC2219296

40. Katherine A. Burns, Karina F. Rodriguez, Sylvia C. Hewitt, Kyathanahalli S. Janardhan, Steven L. Young, and Kenneth S. Korach: Role of estrogen receptor signaling required for endometriosis-like lesion establishment in a mouse model. Endocrinology, 3960-3971 (2012)
DOI: 10.1210/en.2012-1294
PMid:22700766 PMCid:PMC3404357

41. Sun-Wei Guo, Ding Ding, Jian-Guo Geng, Lijing Wang, Xishi Liu: P-selectin as a potential therapeutic target for endometriosis. Fertil Steril, 990-1000.e8 (2015)
DOI: 10.1016/j.fertnstert.2015.01.001
PMid:25681855

42. Jill A. Attaman, Aleksandar K. Stanic, Minji Kim, Maureen P. Lynch, Bo R. Rueda, Aaron K. Styer: The anti-inflammatory impact of omega-3 polyunsaturated fatty acids during the establishment of endometriosis-like lesions. Am J Reprod Immunol, 392-402 (2014)
DOI: 10.1111/aji.12276
PMid:24898804

43. Jun-Wei Liu, Min-Xia Cai, Ying Xin, Qing-Song Wu, Jun Ma, Po Yang, Hai-Yang Xie, Dong-Sheng Huang: Parthenolide induces proliferation inhibition and apoptosis of pancreatic cancer cells in vitro. J Exp Clin Cancer Res, 108 (2010)
DOI: 10.1186/1756-9966-29-108
PMid:20698986 PMCid:PMC2924280

44. Tasuku Harada, Tomio Iwabe, Naoki Terakawa: Role of cytokines in endometriosis. Fertil Steril, 1-10 (2001)

DOI: 10.1016/S0015-0282(01)01816-7

45. Khaleque Newaz Khan, Michio Kitajima, Koichi Hiraki, Naohiro Yamaguchi, Shigeru Katamine, Toshifumi Matsuyama, Masahiro Nakashima, Akira Fujishita, Tadayuki Ishimaru, Hideaki Masuzaki: Escherichia coli contamination of menstrual blood and effect of bacterial endotoxin on endometriosis. Fertil Steril, 2860-2863 (2010)
DOI: 10.1016/j.fertnstert.2010.04.053
PMid:20627244

46. Khaleque Newaz Khan, Michio Kitajima, Tsuneo Inoue, Akira Fujishita, Masahiro Nakashima, Hideaki Masuzaki: 17 Beta-estradiol and lipopolysaccharide additively promote pelvic inflammation and growth of endometriosis. Reprod Sci, 585-594 (2015)
DOI: 10.1177/1933719114556487
PMid:25355803 PMCid:PMC4519769

47. Yukihiro Azuma, Fuminori Taniguchi, Kazuomi Nakamura, Kei Nagira, Yin Mon Khine, Tomoiki Kiyama, Takashi Uegaki, Masao Izawa , Tasuku Harada: Lipopolysaccharide promotes the development of murine endometriosis-like lesions via the nuclear factor-kappa B pathway. Am J Reprod Immunol (2017)

48. Yin Mon Khine, Fuminori Taniguchi, Kei Nagira, Kazuomi Nakamura, Tetsuya Ohbayashi, Mitsuhiko Osaki, Tasuku Harada: New insights into the efficacy of SR-16234, a selective estrogen receptor modulator, on the growth of murine endometriosis-like lesions. Am J Reprod Immunol (2018)

49. Naveen K Jain, Shrinivas K Kulkarni: Antinociceptive and anti-inflammatory effects of Tanacetum parthenium L. extract in mice and rats. J Ethnopharmacol, 251-259 (1999)
DOI: 10.1016/S0378-8741(99)00115-4

50. Monica L. Guzman, Randall M. Rossi, Lilliana Karnischky, Xiaojie Li, Derick R. Peterson, Dianna S. Howard, and Craig T. Jordan: The sesquiterpene lactone parthenolide induces apoptosis of human acute myelogenous leukemia stem and progenitor cells. Blood, 4163-4169 (2005)
DOI: 10.1182/blood-2004-10-4135
PMid:15687234 PMCid:PMC1895029

51. Christopher J. Sweeney,1 Sanjana Mehrotra, Miral R. Sadaria, Suresh Kumar, Nicholas H. Shortle, Yaritzabel Roman, Carol Sheridan, Robert A. Campbell, Daryl J. Murry, Sunil Badve, Harikrishna Nakshatri: The sesquiterpene lactone parthenolide in combination with docetaxel reduces metastasis and improves survival in a xenograft model of breast cancer. Mol Cancer Ther, 1004-1012 (2005)
DOI: 10.1158/1535-7163.MCT-05-0030
PMid:15956258

52. Fuminori Taniguchi, Hiroko Higaki, Masao Izawa, Yukihiro Azuma, Eriko Hirakawa, Imari Deura, Tomio Iwabe, Kohkichi Hata, Tasuku Harada: The cellular inhibitor of apoptosis protein-2 is a possible target of novel treatment for endometriosis. Am J Reprod Immunol 71, (3), 278-285 (2014)
DOI: 10.1111/aji.12193
PMid:24382102

53. Fuminori Taniguchi, Takashi Uegaki, Kazuomi Nakamura, Khine Yin Mon, Takashi Harada, Tetsuya Ohbayashi, Tasuku Harada: Inhibition of IAP (inhibitor of apoptosis) proteins represses

inflammatory status via nuclear factor-kappa B pathway in murine endometriosis lesions. Am J Reprod Immunol, 79 (2018)
DOI: 10.1111/aji.12780
PMid:29105884

54. Audrey M Cummings, Joan M Hedge, Linda S Bimbaum: Effect of prenatal exposure to TCDD on the promotion of endometriotic lesion growth by TCDD in adult female rats and mice. Toxicol Sci, 45-49 (1999)
DOI: 10.1093/toxsci/52.1.45
PMid:10568697

55. Shawn P. Murphy, Chandrakant Tayade, Ali A. Ashkar, Kota Hatta, Jianhong Zhang, B. Anne Croy: Interferon Gamma in Successful Pregnancies 1. Biol Reprod 80, (5), 848-859 (2009)
DOI: 10.1095/biolreprod.108.073353
PMid:19164174 PMCid:PMC2849832

56. A.V.C. Seaward, S.D. Burke, B.A. Croy: Interferon gamma contributes to preimplantation embryonic development and to implantation site structure in NOD mice. Hum Reprod, 829-2839 (2010)
DOI: 10.1093/humrep/deq236
PMid:20813805 PMCid:PMC2957476

57. Anne E.King, Hillary O.D. Chritcley, Rodney W.Kelly: The NF-kappaB pathway in human endometrium and first trimester decidua. Mol Hum Reprod, 175-183 (2001)
DOI: 10.1093/molehr/7.2.175
PMid:11160844

58. Sang Jun Han, Shannon M Hawkins, Khurshida Begum, Sung Yun Jung, Ertug Kovanci, Jun Qin, John P Lydon, Francesco J De Mayo, Bert W O'Malley: A new isoform of steroid receptor coactivator-1 is crucial for pathogenic progression of endometriosis. Nat Med, 1102-1111 (2012)
DOI: 10.1038/nm.2826
PMid:22660634 PMCid:PMC3541027

59. Friedrich Wieser, JuanjuanWu, Zhaoju Shen, Robert N.Taylor, Neil Sidell: Retinoic acid suppresses growth of lesions, inhibits peritoneal cytokine secretion, and promotes macrophage differentiation in an immunocompetent mouse model of endometriosis. Fertil Steril, 1430-1437 (2012)
DOI: 10.1016/j.fertnstert.2012.03.004
PMid:22464761 PMCid:PMC3367060

60. Hitomi Nakamura, Tadashi Kimura, Kazuhide Ogita, Takafumi Nakamura, Masahiko Takemura, Koichiro Shimoya, Sinsuke Koyama, Tomoko Tsujie, Masayasu Koyama, Yuji Murata: NF-kappa Beta activation at implantation window of the mouse uterus. Am J Reprod Immunol, 16-21 (2004)
DOI: 10.1046/j.8755-8920.2003.00116.x
PMid:14725562

61. Dingmin Yan, Xishi Liu, Sun-Wei Guo: The establishment of a mouse model of deep endometriosis. Hum Reprod 34, (2), 235-247 (2019)
DOI: 10.1093/humrep/dey361
PMid:30561644

62. Sang Jun Han, Jiyeun E Lee, Yeon Jean Cho, Mi Jin Park, Bert W O'Malley: Genomic Function of Estrogen Receptor β in Endometriosis. Endocrinology, 495-2516 (2019)

63. K.L. Sharpe-Timms, 2 M. Piva, E.A. Ricke, K. Surewicz, Y.L. Zhang, and R.L. Zimmer: Endometriotic Lesions Synthesize and Secrete a Haptoglobin-Like Protein 1. Biol Reprod, 988-994 (1998)

DOI: 10.1095/biolreprod58.4.988
PMid:9546730

64. Michael W.Vernon. Emery A.Wilson: Studies on the surgical induction of endometriosis in the rat. Fertil Steril, 684-694 (1985)

65. Yuan Lu, Jichan Nie, Xishi Liu, Yu Zheng, Sun-Wei Guo: Trichostatin A, a histone deacetylase inhibitor, reduces lesion growth and hyperalgesia in experimentally induced endometriosis in mice. Hum Reprod, 1014-1025 (2010)
DOI: 10.1093/humrep/dep472
PMid:20118114

66. Emrah Yavuz, Mesut Oktem, Ibrahim Esinler, Hulusi B.Zeyneloglu: Genistein causes regression of endometriotic implants in the rat model. Fertil Steril, 1129-1134 (2007)
DOI: 10.1016/j.fertnstert.2007.01.010
PMid:17559846

67. Natalia Dmitrieva, Hiroshi Nagabukuro, David Resuehr, Guohua Zhang, Stacy McAllister, Kristina McGinty, Ken Mackie, Karen Berkley: Endocannabinoid involvement in endometriosis. Pain, 703-710 (2010)
DOI: 10.1016/j.pain.2010.08.037
PMid:20833475 PMCid:PMC2972363

68. Jason A.Efstathiou, David A.SampsonB.A, Zalman Levine, Richard M.Rohan, David Zurakowski, Judah Folkman, Robert J.D'Amato, Maria A.Rupnick: Nonsteroidal antiinflammatory drugs differentially suppress endometriosis in a murine model. Fertil Steril, 171-1 (2005)
DOI: 10.1016/j.fertnstert.2004.06.058
PMid:15652904

69. Christian M.Becker, David A.SampsonB.A, Sarah M.Short, Kashi Javaherian, Judah Folkman, Robert J.D'Amato: Short synthetic endostatin peptides inhibit endothelial migration in vitro and endometriosis in a mouse model. Fertil Steril, 71-77 (2006)
DOI: 10.1016/j.fertnstert.2005.07.1290
PMid:16412733

70. J. Rudzitis-Auth, Menger, M.W. Laschke: Resveratrol is a potent inhibitor of vascularization and cell proliferation in experimental endometriosis. Hum Reprod, 1339-1347 (2013)
DOI: 10.1093/humrep/det031
PMid:23427233

71. Edurne Novella-Maestre, Sonia Herraiz, José María Vila-Vives, Carmen Carda, Amparo Ruiz-Sauri, Antonio Pellicer: Effect of antiangiogenic treatment on peritoneal endometriosis-associated nerve fibers. Fertil Steril, 1209-1217 (2012)
DOI: 10.1016/j.fertnstert.2012.07.1103
PMid:22921078

72. Mariani M, Vigan P, Gentilini D, Camisa B, Caporizzo E, Di Lucia P, Monno A, Candiani M, Somigliana E, Panina-Bordignon P: The selective vitamin D receptor agonist, elocalcitol, reduces endometriosis development in a mouse model by inhibiting peritoneal inflammation. Hum Reprod, 2010-2019 (2012)
DOI: 10.1093/humrep/des150
PMid:22588001

73. Hakan Cakmak, Murat Basar, Yasemin Seval-Celik, Kevin G. Osteen, Antoni J. Duleba, Hugh S. Taylor, Charles J. Lockwood, Aydin Arici: Statins inhibit monocyte chemotactic protein 1

expression in endometriosis. Reprod Sci, 572-579 (2012)
DOI: 10.1177/1933719111430998
PMid:22267540 PMCid:PMC3439122

74. Mahaut Leconte, Carole Nicco, Charlotte Ngô, Christiane Chéreau, Sandrine Chouzenoux, Wioleta Marut, Jean Guibourdenche, Sylviane Arkwright, Bernard Weill, Charles Chapron, Bertrand Dousset, Frédéric Batteux: The mTOR/AKT inhibitor temsirolimus prevents deep infiltrating endometriosis in mice. Am J Pathol 179, (2), 880-889 (2011)
DOI: 10.1016/j.ajpath.2011.04.020
PMid:21718677 PMCid:PMC3157265

75. Carla Olivares, Analía Ricci, Mariela Bilotas, Rosa InésBarañao, Gabriela Meresman: The inhibitory effect of celecoxib and rosiglitazone on experimental endometriosis. Fertil Steril, 428-433 (2011)
DOI: 10.1016/j.fertnstert.2011.05.063
PMid:21683949

76. Maria Perelló, Iñaki González-Foruria, Paola Castillo, Mario Martínez-Florensa, Francisco Lozano, Juan Balasch, Francisco Carmona: Oral Administration of Pentoxifylline Reduces Endometriosis-Like Lesions in a Nude Mouse Model. Reprod Sci, 911-918 (2017)
DOI: 10.1177/1933719116673198
PMid:27738175

77. Ningning Wang, Shanshan Hong, Jinfeng Tan, Peiqi Ke, Lili Liang, Hui Fei, Bin Liu, Liqun Liu, Yongdong Liu, Bingjun Yu: A red fluorescent nude mouse model of human endometriosis: Advantages of a non-invasive imaging method. Eur J Obstet Gynecol Reprod Biol 176, (1), 25-30 (2014)
DOI: 10.1016/j.ejogrb.2014.02.012
PMid:24630298

78. Aya Tal, Reshef Tal, Nicola Pluchino, Hugh S Taylor: Endometrial cells contribute to preexisting endometriosis lesions in a mouse model of retrograde menstruation. Biol Reprod, 1453-1460 (2019)
DOI: 10.1093/biolre/ioz039
PMid:30869747 PMCid:PMC6561859

79. Gaurang S. Daftary, Ye Zheng, Zaid M. Tabbaa, John K. Schoolmeester, Ravi P. Gada, Adrienne L. Grzenda, Angela J. Mathison, Gary L. Keeney, Gwen A. Lomberk, Raul Urrutia: A Novel Role of the Sp/KLF Transcription Factor KLF11 in Arresting Progression of Endometriosis. PLoS One 8, (3), 1-10 (2013)
DOI: 10.1371/journal.pone.0060165
PMid:23555910 PMCid:PMC3610699

Abbreviations: LPS: lipopolysaccharide; SR: SR-16234; IAPs: inhibitor of apoptosis proteins; PBS: phosphate buffered saline; E2: estradiol valerate; i.p: intraperitoneal; NF: nuclear factor; SERM: selective estrogen receptor modulator; IVIS: *In vivo* Imaging System, Ptgs-2: Prostaglandin-endoperoxide synthase-2, PECAM: Platelet Endothelial cell adhesion molecule, VEGF: Vascular Endothelial Growth Factor, RT-PCR: Reverse Transcription Polymerase Chain Reaction, CCL2 : Chemokine (C-C motif) ligand 2, IL6: interleukin 6, mRNA: messenger Ribo Nucleic Acid, Ki67: Protein that in human in encoded by the Mk167 gene, BV6: an IAP antagonist, GFP: Green Fluorescent Protein, ELuc: Enhanced green-emitting Luciferase, GnRH: Gonadotrophin Releasing Hormone, ER-Beta: Estrogen Receptor-Beta, ER-alpha: Estrogen Receptor-alpha, ERBOE: ERβ over-expressed

Key Words: Endometriosis, Murine Endometriosis-Like Lesion, Experimental Model, Cystic Lesion, Review

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