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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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MITOFUSIN 1 AS A MARKER FOR EMBRYO QUALITY AND DEVELOPMENT IN RELEVANCE TO ICSI OUTCOME IN INFERTILE FEMALES

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Abstract.

Background: Mitofusin-1 is one of the membrane profusion proteins that is present in the mitochondria wall. It has a role in mitochondrial fusion. Deletion of mitochondrial fusion proteins in oocytes leads to dynamic defects in mitochondria. Growth of implanted and after implantation embryo is an ATP-demanding step that involves a range of ATP-consuming events that require a small amount of ATP.

Aim: The study aims to evaluate the mitofusin-1 in the serum and follicular fluid as a marker for the evaluation of embryo quality, in addition to the pregnancy rate in infertile females undergoing ICSI cycles.

Patients and Methods: The cross-section study included 50 infertile couples who were prospectively recruited according to specific criteria at the" High Institute for Infertility Diagnosis and Assisted Reproductive Technologies" at AL-Nahrain University for one year. all participants have undergone oocyte pickup, ICSI, and embryo transfer. Mitofusin-1 levels were measured in serum on day 2 of the cycle and in follicular fluid on the day of ova pick-up.

Results: Showed important positive relations between follicular fluids mitofusin-1 with a total number of embryos (r= 0.428 & p= 0.002), GI embryos (r= 0.335 & p= 0.017) and GII embryos (r= 0.295 & p= 0.038). Out of 50 females, 14 (28.0 %) females became pregnant according to the results there were significantly higher follicular fluids mitofusin-1 levels in pregnant females (3.88 ± 1.41 vs. 2.73 ± 1.24 & p=0.007) compared to non-pregnant group. Also, the follicular fluids mitofusin-1 cut-off value was ≥ 2.89 ng/ml with sensitivity= 71.4%, specificity = 66.7%, positive predictive value 47.8%, negative predictive value 88.9%.

Conclusion: elevated MEN1 levels in the follicular fluid may affect positively IVF / ICSI outcomes (embryo quality, and pregnancy rate).

Key words. ICSI, infertility, mitofusin-1, pregnancy.

Introduction.

One of the major issues faced by couples during their marriage is infertility. It has been noticed by 'The World Health Organization as a major public disease that affects many people. Globally, 48 million and 186 million had infertility [1].

Mitochondria has a major role in normal cellular functions such as energy generation, calcium homeostasis, signal transduction, programmatic cell death, oocyte growth, and early embryonic development [2,3]. As research efforts focused on the reproductive sciences, Mfn1 and Mfn2 are also involved in oogenesis, follicle maturity, and embryo development [4].

The gene mitofusin-1 is located on chromosome 3, the protein encoded by this gene is a mediator of mitochondrial fusion. This protein interacts with each other to enable mitochondrial dynamics [5].

During the development of follicle and embryo, the expression of mitofusin-1 is precisely controlled in different steps; an extra or lack of mitofusin-1 leads to abnormal mitochondrial function and ATP metabolism, also preventing oocyte divisions and embryo growth [6].

Patients and Methods.

Fifty infertile women were seeking fertility treatment at the "High Institute for Infertility Diagnosis and Assisted Reproductive Technologies" at Al-Nahrain University. Ages were 22 to 42 years old. All participants received written informed consent after an explanation of the study procedure. On day 1 or 2 cycles, all females had their basal serum hormonal level, and the serum sample was taken and kept in a deep freezer (-20) to be used for measurement of mitofusin 1 level. Follicular fluid samples were taken on the day of oocyte retrieval and kept in a deep freezer (-20) to be used for the measurement of mitofusin-1 level later on. On day 3 embryo grading and embryo transfer were performed. Mitofusin-1 levels were measured in follicular fluid and serum by mitofusin-1 ELISA kit (Mybiosource /USA). Blood levels of b-hCG were measured on the 14th day after embryo transfer. Biochemical pregnancy was considered when the serum b-hCG level was > 5 mIU/ mL. Under an inverted microscope at day 1 post-fertilization, checking was done for the presence of two pronuclei (PN) then incubation of the dish containing the zygotes until day 3. On day 3 post-transfer, the evaluation of each embryo was performed individually under a microscope [7].

Grade 1: Top-quality embryos: embryos that contain 4–5 cells at 44 h and 7 cells or more at 68 h, elastomers that have equal size and 10 or less than 10 % fragmentation at 68 h and no multinucleation at any time point.

Grade 2: Normally developed embryos: embryos with 6 or more than 6 cells at 68 h and 20 or less than 20% fragmentation at 68 h.

Grade 3: defined as embryos with or more than 4 cells at 68 h, no cleavage arrest (i.e. cleavage must have occurred within the last 24 h) and more than 20% fragmentation at 68 hours.

Results.

Correlations between follicular fluids and serum mitofusin-1 levels with embryos ICSI outcomes: Correlation between follicular fluids and serum mitofusin-1 with embryos ICSI outcomes were demonstrated in table 1 and the results also showed significant positive correlations between follicular fluids mitofusin-1 with total embryos (r=0.428 & p=0.002) (Figure 1), GI embryos (r=0.335 & p=0.017) (Figure 1) and GII embryos (r=0.295 & p=0.038) (Figure 1); there was also insignificant positive correlation with GIII embryos; however there were also no significant correlations between serum mitofusin-1 with all embryos ICSI outcomes.

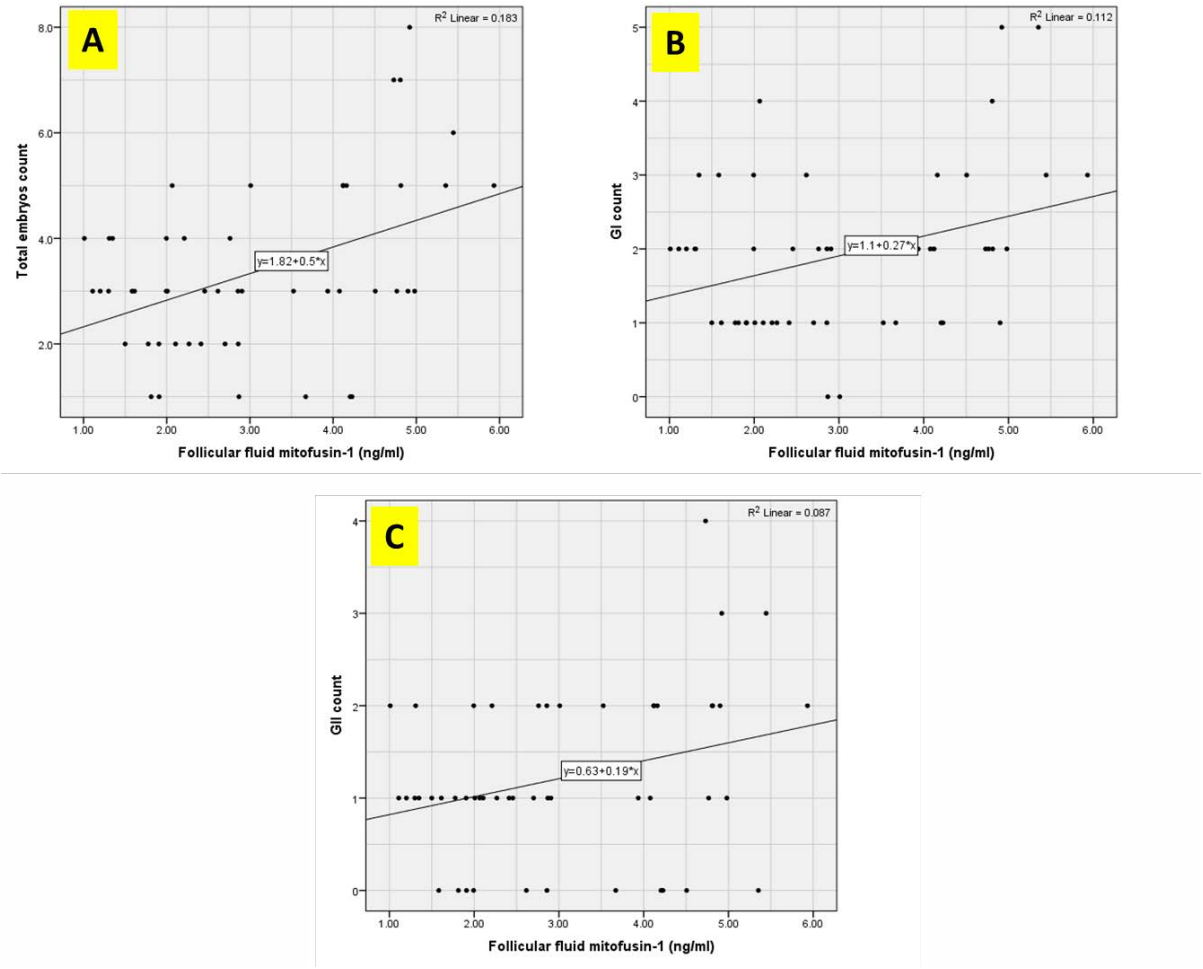

Figure 1. *Correlation between follicular fluids mitofusin-1 and total embryo count (A), GI count (B), GII count (C).*

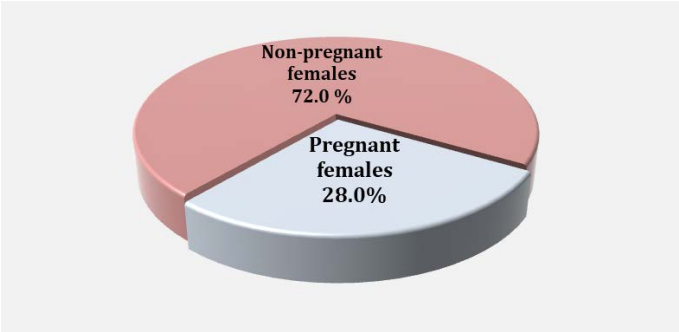

Figure 2. *Pregnancy rates of patients in the present study.*

Comparison of follicular fluids and serum mitofusin-1 levels between pregnant and non-pregnant females: Out of 50 females, 14 (28.0 %) females became pregnant (Figure 2). The comparison of follicular fluids and serum mitofusin-1between pregnant and non-pregnant females were presented in Table 2, according to the results there were significantly higher follicular fluids mitofusin-1 levels in pregnant females (3.88 ± 1.41 vs. 2.73 ± 1.24 & p=0.007), there was also insignificantly higher serum mitofusin-1 in pregnant females (11.95 ± 1.16 vs. 11.73 ± 1.46 & p=0.917).

Discussion.

Mitochondrial profusion proteins are essential players in the intricate process of embryonal development. These proteins are responsible for maintaining the dynamic balance of mitochondrial fusion and fission, thereby ensuring the health and functionality of these vital cellular organelles. During embryogenesis, when a single cell evolves into a complex organism, there is a tremendous need for energy production, cellular growth, and differentiation. Mitochondria, known as the powerhouses of the cell, are crucial in meeting these demands. Mitochondrial profusion proteins, such as mitofusins (MFN1 and MFN2) and optic atrophy 1 (OPA1), facilitate the fusion of mitochondria, allowing for the exchange of contents, mixing of mitochondrial genomes, and restoration of damaged mitochondria. This fusion process enables the formation of an interconnected mitochondrial network that efficiently distributes energy and metabolites throughout the developing embryo. Furthermore, mitochondrial fusion plays a pivotal role in embryonic stem cell maintenance and differentiation. It has been observed that defects in mitochondrial profusion proteins can lead to impaired embryonic development, as evidenced by studies on knockout animal models. These findings highlight the critical role of mitochondrial profusion proteins in ensuring the proper development and functioning of embryonic cells. Understanding the underlying molecular mechanisms of mitochondrial dynamics during embryogenesis can provide valuable insights into the aetiology of developmental disorders and potentially guide the development of therapeutic interventions in the future [8,9].

Table 1. *Correlations between follicular fluids and serum mitofusin-1 with embryos' ICSI outcomes.*

Mitofusin-1 correlation with	Statistics	F.F.Mitofusin-1	Serum mitofusin-1
Total embryos	R	0.428	0.094
	p value	0.002 S	0.545 NS
GI embryos	R	0.335	0.074
	p value	0.017 S	0.631 NS
GII embryos	R	0.295	0.113
	p value	0.038 S	0.464 NS
GIII embryos	R	0.105	-0.246
	p value	0.469 NS	0.108 NS

G: Grade; r: Pearson's correlation coefficient.
S: Significant ($p \leq 0.05$); NS: Not significant ($p > 0.05$) .

Table 2. *Comparison of follicular fluids and serum mitofusin-1 levels between pregnant and non-pregnant females.*

Parameters	Pregnant females N.=14	Non-pregnant females N.=36	p value
F.F. Mitofusin-1 (ng/ml)	3.88 ± 1.41	2.73 ± 1.24	0.007 ₸ S
Serum mitofusin-1 (ng/ml)	11.95 ± 1.16	11.73 ± 1.46	0.917 ₸ NS

N S: Not significant ($p > 0.05$); ₸: Independent sample t-test

A decrease in the level of Mfn1, also known as Mitofusin-1, can have significant implications for the mitochondrial dynamic of somatic cells in embryos. This phenomenon has been highlighted in scientific research, where it has been observed that defects in mitochondrial function and embryonic genome initiation occur when Mfn1 levels are reduced [10]. The Mitofusin-1 gene plays a crucial role in controlling mitochondrial function and embryonic genome initiation, thereby influencing embryo development [11-13].

Mitochondria are essential organelles in mammals that function as dynamic entities. Their shape and structure are maintained through a delicate equilibrium between fusion and fission processes. Fusion involves the merging of two or more mitochondria, leading to the formation of a larger, interconnected network. Fission, on the other hand, is the process by which mitochondria divide into smaller units. These two processes work in tandem to regulate the size, number, and distribution of mitochondria within a cell [8,11].

Mfn1, as a key regulator of mitochondrial fusion, plays a vital role in maintaining the balance between fusion and fission. When Mfn1 levels decrease, the fusion process is impaired, leading to fragmented and dysfunctional mitochondria. This disruption in mitochondrial dynamics can have detrimental effects on the overall function of somatic cells in embryos [7,8].

The importance of proper mitochondrial dynamics in embryonic development cannot be overstated. Mitochondria are not only responsible for providing energy to the cell but also play a crucial role in various cellular processes, including apoptosis, calcium signalling, and reactive oxygen species (ROS) production. Dysfunctional mitochondria can compromise these essential functions, leading to developmental abnormalities and cell death [10,11].

Furthermore, Mfn1 has been shown to be involved in embryonic genome initiation, which is the activation of the embryonic genome during early development. This process is crucial for proper embryo development and cellular differentiation. Mfn1-mediated mitochondrial function is necessary for the initiation and regulation of gene expression during embryogenesis [8].

Pregnancy is a complex process involving the growth of the fetus and the formation of tissues and organs. Numerous studies have highlighted the significance of mitochondria in maintaining pregnancy and facilitating neonatal progress through the regulation of ATP production, metabolism, and hormone production. Mitochondria, often referred to as the "powerhouses" of cells, play a crucial role in energy production by generating ATP through oxidative phosphorylation. In the context of pregnancy, the demand for ATP increases significantly to support various processes, including embryonic growth and development. The relocation of mitochondria within the cytoplasm of the ovum is essential for meeting the ATP demands of critical processes such as meiotic progression and chromosome segregation [14,15]. Mitochondria are strategically positioned near the sites of high energy consumption to ensure an adequate supply of ATP. Any abnormalities in mitochondrial function can have detrimental effects on the developmental processes during pregnancy. Studies have shown that mitochondrial abnormalities in oocytes can lead to disrupted meiotic spikes, embryonic growth arrest, and sterility in mammals. Meiotic spikes are essential for the proper segregation of chromosomes, which is crucial for the formation of a healthy embryo. When mitochondrial function is compromised, these meiotic spikes may be disrupted, leading to chromosomal abnormalities and developmental issues. Such abnormalities can result in failed implantation, spontaneous abortions, or the birth of offspring with genetic disorders [16]. It is evident that mitochondrial function plays a vital role in embryonic development and the overall success of pregnancy outcomes. Maintaining a healthy mitochondrial dynamic is crucial for ensuring proper ATP production, metabolic regulation, and hormone synthesis during pregnancy. This emphasizes the importance of maintaining a healthy lifestyle, including regular exercise, a balanced diet, and avoidance of factors that can negatively impact mitochondrial function, such as smoking or exposure to environmental toxins [17,18].

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