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RADIOGRAPHY OF THE HIP JOINTS IN INFANTS: RADIATION EXPOSURE, IMPACT ON THE REPRODUCTIVE SYSTEM, AND PROTECTIVE MEASURES

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Abstract. Developmental dysplasia of the hip (DDH) occurs in 2–4% of newborns and requires early diagnosis to prevent complications. Radiography remains the primary imaging method for evaluating the hip joint in infants. Even low-dose ionizing radiation raises concerns regarding potential effects on the reproductive organs [1] The aim of this study was to assess the impact of hip radiographic examinations on the reproductive organs of children under one year of age and to analyze the use of protective aprons in city clinics of Shymkent, Kazakhstan.

Data collection and analysis were performed using the Akgun PACS Viewer software, which allowed systematic evaluation of radiographic images and compliance with radiation protection measures. Dosimetric assessment was conducted based on exposure parameters recorded by the system to calculate the absorbed dose to the gonads. Statistical analysis was applied to determine the frequency of protective apron use and to evaluate the potential risk of radiation exposure to reproductive organs [2]

The study analyzed 223 radiographic images of 87 infants from 5 major city clinics. Results showed that approximately 70% of infants underwent up to three hip radiographs in the first year of life, while protective aprons were used in only 60% of cases. Dosimetric analysis indicated that without protection, the testes and ovaries received doses exceeding recommended limits, whereas correct use of lead aprons and shields reduced the absorbed dose by approximately tenfold.

The relevance of this study is supported by the need to enforce the Ministry of Health of the Republic of Kazakhstan Order No. KR DSM-275/2020 (December 15, 2020) on sanitary and epidemiological requirements for radiation safety, which mandates the use of protective aprons for children during hip radiography.

The findings emphasize the necessity of strict adherence to radiation safety protocols and support the regulatory requirement for mandatory use of protective aprons and shields during infant hip radiography [3, 14]

Keywords: developmental dysplasia of the hip, pediatric radiography, radiation protection, dosimetric assessment, protective apron, reproductive organs.

Нәрестелердің жамбас буындарын рентгенографиялау: сәулелену дозасы, оның репродуктивтік жүйеге ықтимал әсерлері және радиациялық қорғаныс шаралары

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Аңдатпа. Жамбас буынының дисплазиясы (ЖБД) жаңа туған нәрестелердің 2–4 %-ында кездеседі және асқынулардың алдын алу үшін ерте диагностикалауды талап етеді. Рентгенография нәрестелердегі жамбас буындарын бейнелеудің негізгі әдісі болып табылады. Тіпті төмен дозалы иондаушы сәулеленудің өзі репродуктивтік ағзаларға ықтимал әсеріне байланысты алаңдаушылық туындатады. Зерттеудің мақсаты – бір жасқа дейінгі балаларда жамбас буындарының рентгенологиялық зерттеулерінің репродуктивтік ағзаларға ықтимал әсерін бағалау және Қазақстан Республикасының Шымкент қаласындағы қалалық емханаларда қорғаныс фартукын қолдану тәжірибесін талдау.

Деректерді жинау және талдау Akgun PACS Viewer бағдарламасы арқылы жүргізілді, бұл рентгенологиялық кескіндерді жүйелі түрде бағалауға және радиациялық қорғаныс талаптарының сақталуын анықтауға мүмкіндік берді. Дозиметриялық бағалау жүйеде тіркелген экспозиция параметрлері негізінде жүргізіліп, гонадалардың жұтылған дозасын есептеуге бағытталды. Статистикалық өңдеу қорғаныс фартукын қолдану жиілігін анықтауға және репродуктивтік ағзалардың сәулелену қаупін бағалауға мүмкіндік берді.

Зерттеуде 5 ірі қалалық клиникадан 87 нәрестенің 223 рентгендік суреті талданды. Нәтижелер көрсеткендей, балалардың шамамен 70% алғашқы жылы 3 рентгендік зерттеуден өтті, ал қорғаныс фартуктары тек 60% жағдайда қолданылды. Дозиметриялық талдау қорғаныссыз жағдайда аталық және аналық бездердің ұсынылған нормадан жоғары доза алатынын, ал қорғасын фартуктері мен қорғаныс пластиналарын дұрыс пайдалану жұтылған дозаны шамамен он есеге төмендететінін анықтады.

Зерттеудің өзектілігі Қазақстан Республикасы Денсаулық сақтау министрінің 2020 жылғы 15 желтоқсандағы № ҚР ДСМ-275/2020 «Радиациялық қауіпсіздікті қамтамасыз етуге қойылатын санитариялық-эпидемиологиялық талаптар» бұйрығына сәйкес жамбас буынын рентгенографиялау кезінде балаларға қорғаныс фартукын міндетті түрде қолдануды нормативтік түрде бекітудің қажеттілігімен айқындалады.

Қорытындылар радиациялық қауіпсіздік талаптарын қатаң сақтаудың маңыздылығын және Қазақстан Республикасы Денсаулық сақтау министрлігінің нормативтік-құқықтық актілерінде жамбас буындарының рентгенографиясы кезінде қорғаныс фартуктері мен қорғаныс пластиналарын қолдануды міндетті талап ретінде бекітудің орынды екенін көрсетеді.

Түйін сөздер: жамбас буынының дисплазиясы, балалар рентгенографиясы, радиациялық қорғаныс, дозиметриялық бағалау, қорғаныс фартукы, репродуктивтік ағзалар.

Рентгенография тазобедренных суставов у младенцев: радиационная нагрузка, влияние на репродуктивную систему и меры защиты

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Аннотация. Дисплазия тазобедренных суставов (ДТС) встречается у 2–4 % новорождённых и требует ранней диагностики для предотвращения осложнений. Рентгенография остаётся основным методом визуализации тазобедренного сустава у детей грудного возраста. Даже низкодозовое ионизирующее излучение вызывает опасения относительно потенциального воздействия на репродуктивные органы. Цель исследования — оценить влияние рентгенологических исследований тазобедренных суставов на

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репродуктивные органы детей до одного года и проанализировать практику применения защитных фартуков в Городских поликлиниках города Шымкента (Казахстан).

Сбор и анализ данных осуществлялись с использованием программы *Akgun PACS Viewer*, что позволило систематически оценить рентгенологические изображения и соблюдение мер радиационной защиты. Дозиметрическая оценка проводилась на основе параметров экспозиции, зарегистрированных системой, для расчёта поглощённой дозы гонад. Статистическая обработка позволила определить частоту применения защитных фартуков и оценить потенциальный риск облучения репродуктивных органов.

В ходе исследования проанализировано 223 рентгенографических снимка 87 младенцев из 5 крупных городских поликлиник**.** Результаты показали, что до трёх рентгеновских исследований в первый год жизни проходили примерно 70% детей, при этом защитные фартуки использовались лишь в 60% случаев. Дозиметрический анализ выявил, что без защиты яички и яичники получают дозы, превышающие рекомендуемые нормы, а правильное применение свинцовых фартуков и пластин снижает поглощённую дозу примерно в десять раз.

Актуальность исследования определяется необходимостью нормативного закрепления в приказе Министерства здравоохранения Республики Казахстан от 15 декабря 2020 года № КР ДСМ-275/2020 "Санитарно-эпидемиологические требования к обеспечению радиационной безопасности" об обязательном применении защитных фартуков у детей при проведении рентгенографии тазобедренного сустава.

Выводы подчёркивают необходимость строгого соблюдения радиационной безопасности и целесообразно закрепить обязательное применение защитных фартуков и пластин при рентгенографии тазобедренных суставов в нормативных документах Министерства здравоохранения Республики Казахстан.

Ключевые слова: дисплазия тазобедренных суставов, рентгенография у детей, радиационная защита, дозиметрическая оценка, защитный фартук, репродуктивные органы

Introduction

The reproductive system of a child begins developing at the embryonic stage, and germline cells - spermatogonia in boys and oogonia in girls - are highly radiosensitive. Ionizing radiation can affect the ovarian follicular apparatus, where immature oocytes are located [12,16] Without adequate radiation protection, exposure to high doses of ionizing radiation may cause damage or destruction of oocytes, potentially reducing ovarian reserve and negatively impacting future reproductive function. Similar effects are observed in testicular tissue, as spermatogonia, the precursors of spermatozoa that actively proliferate in early life, also exhibit high radiosensitivity [4,5,13]

In infants with developmental dysplasia of the hip (DDH), the number of radiographic examinations typically reaches up to three procedures during the first year of life, emphasizing the necessity of strict adherence to radiation safety principles. Insufficient protection under conditions of increased radiation exposure may result in the following adverse effects:

- Damage to spermatogonia
- Reduction in the number of developing spermatozoa
- Delayed development of testicular tissue
- Decreased ovarian reserve [6,15]

The aim of this study is to evaluate the impact of X-ray radiation from hip radiography in infants on reproductive organs and to determine the extent to which protective aprons are utilized in the city clinics of Shymkent, Kazakhstan, for this age group.

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Materials and Methods

Study Population: Infants under one year of age who underwent radiographic examination of the hip joints in city clinics.

Study Focus: The impact of X-ray radiation on reproductive organs and the practice of using protective aprons during hip radiography in infants under one year of age.

Methods:

- Literature Review: Scientific publications, regulatory documents, and orders from the Ministry of Health of the Republic of Kazakhstan regarding radiation safety in pediatric radiology were analyzed.

- Systematic Observation: Systematic observation methods were applied to assess the practical implementation of radiation protection measures, including the use of protective aprons during radiographic procedures. Data collection and analysis were performed using the *Akgun PACS Viewer* software, which provides fast and reliable access to medical images stored in a PACS environment and allows radiologists and clinicians to view, compare, and annotate images.

To obtain the results of the study, a selective assessment was conducted across all city clinics in Shymkent from November 1, 2025 to November 15, 2025, which were equipped with radiology departments and the Akgun PACS system. A total of five major clinics that met the criteria for data accessibility and image quality were included in the analysis.

During the observation period, all cases of hip radiography in infants under one year of age were identified in the PACS system. After excluding duplicate entries and incomplete examinations, the final sample consisted of:

- N = 87 infants under 1 year of age
- 223 radiographic images in total

Analysis of Research

The assessment of the number of procedures per patient showed the following:

- 70% of infants (≈61 children) underwent up to three radiographic examinations during their first year of life

- 30% of infants (≈26 children) underwent more than three examinations, primarily due to hip dysplasia or suspected dysplasia

Use of Protective Aprons

Among the 223 radiographic images analyzed:

- 134 images (60%) were performed with the use of protective aprons
- 89 images (40%) were performed without protective shielding

These indicators were obtained through the analysis of radiographic images, where the presence or absence of a protective apron was visually confirmed.

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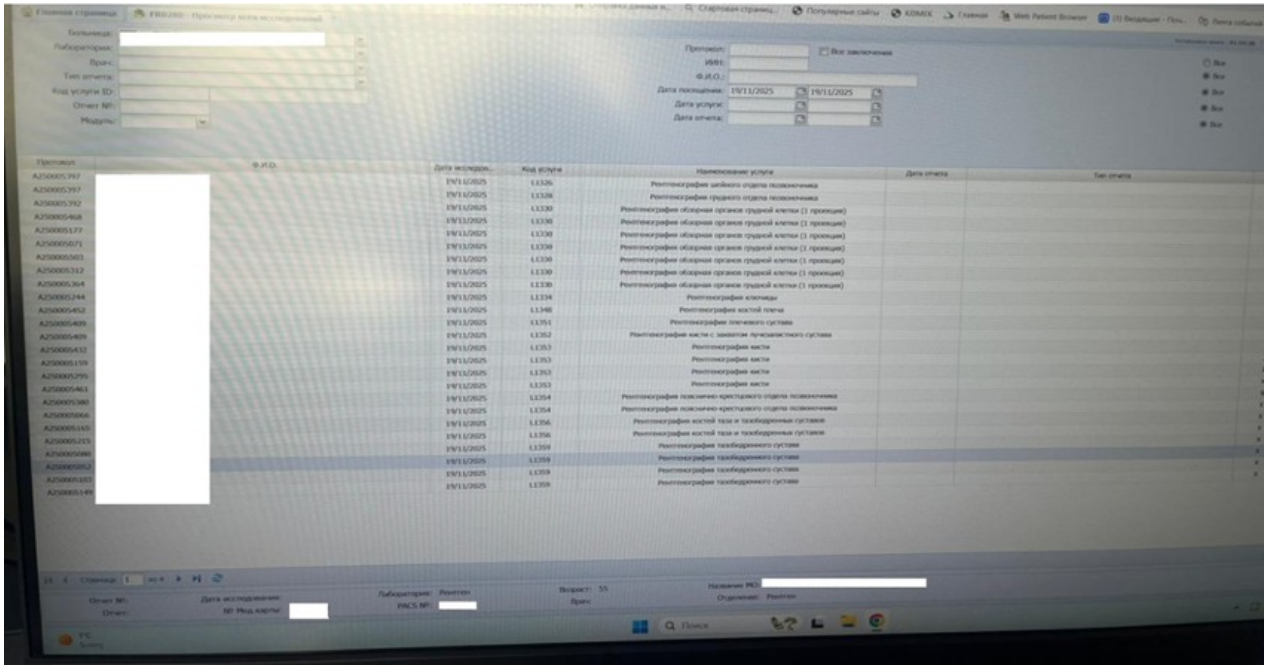

Figure1- . Akgun PACS Viewer – a program for fast and reliable access to medical images stored in a PACS environment

Figure2- The hip joint of a child in the absence of a protective apron

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Figure 3- The hip joint of a child in the absence of a protective apron

Figure 4-The protective apron is used in the image; however, it is improperly secured, which may reduce the effectiveness of the radiation protection

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Figure 5- The protective apron is correctly applied, but it unnecessarily covers adjacent organs, leading to additional radiation exposure

Dosimetric Assessment: To evaluate radiation exposure levels, absorbed doses received by patients during hip radiography were calculated. The assessment was based on exposure parameters recorded in the *Akgun* system, including entrance surface dose (ESD) and technical parameters of the examination.

Ethical Considerations

In this study, radiographic images obtained via the *Akgun* program were used. All materials were employed solely for scientific analysis and were anonymized prior to use. Identifying information about medical institutions was not disclosed; specifically, data indicating which clinics complied with radiation protection protocols were intentionally omitted. This approach ensures confidentiality, minimizes potential risks to healthcare facilities, and fully adheres to the ethical principles of conducting research.

Results

This amount of research (5 clinics, 87 patients, and 223 radiographic images) is sufficient to obtain statistically significant results and to provide an objective assessment of the current situation regarding radiation protection in the city.

Frequency of Radiographic Examinations and Use of Protective Aprons
The study demonstrated that most infants (approximately 70%) underwent up to three radiographic examinations of the hip joints within the first year of life. Protective aprons were used in only 60% of cases, indicating insufficient compliance with radiation protection protocols in the city clinics of Shymkent.

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Dosimetric Assessment and Gonadal Protection

Dosimetric calculations showed that without protective aprons, the testes in male infants and the ovaries in female infants could receive doses exceeding recommended sanitary limits for children under one year of age. The use of lead aprons or protective shields significantly reduces the absorbed dose to the reproductive organs:

- For girls, the shield should fully cover the ovarian region. The lower edge of the shield should be positioned distal to the upper edge of the iliac wings depending on age: 6 cm at 4 months, 7 cm at 8 months, and 8 cm at 1 year.
- For boys, the shield should cover the scrotum and testes.
- Proper gonadal protection with a shield reduces radiation exposure by approximately tenfold [7,8,17]

For restless infants, it is recommended to use a Velcro strap to secure the shield, and the accompanying parent should be provided with a protective apron during the procedure [9,10,11].

Figure 6-. Gonadal protection set with a Velcro strap.

Potential Impact on Reproductive Organs

In the absence of adequate protection, high doses of ionizing radiation may cause damage to spermatogonia and oocytes, reduce ovarian reserve, decrease the number of developing spermatozoa, and slow the development of testicular tissue. Dosimetric analysis underscores the importance of using protective aprons and shields to minimize the risk of radiation exposure to reproductive organs in infants.

Conclusions

The conducted analysis indicates that radiographic examination of the hip joints in infants may exert potential adverse effects on the reproductive organs, particularly in the absence of adequate protection. The use of protective aprons and radiation shields significantly reduces the radiation dose to the ovaries and testes, achieving up to a tenfold decrease in absorbed dose.

Given the high radiosensitivity of reproductive cells in early childhood, it is recommended to formally mandate the use of protective aprons and shields during hip radiography in infants within the regulatory framework of the Ministry of Health of the Republic of Kazakhstan. Standardizing these measures will ensure uniform compliance with radiation safety protocols across all clinics in the country and minimize potential risks to the reproductive health of future generations.

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Limitations of the study and directions for future research

The study was conducted only in selected urban polyclinics in Shymkent using the Akgun program, which is still under development and has not yet been implemented widely. Therefore, the obtained data may not fully reflect the practices of hip joint radiography and the use of protective aprons in other polyclinics within the city or in regions where the program is not used.

In the future, it is planned to continue studying this topic, expand the geographic scope of the research, and conduct a comparative analysis of hip joint radiography practices and the use of protective aprons for children in other countries. This will allow for an assessment of international radiation safety standards and the adaptation of recommendations to improve protection practices in Kazakhstan.

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