

بسم الله الرحمن الرحيم

: قال تعالى

**قل لو كان البحر مداداً لكلمات ربي ( لنفد البحر قبل أن تنفد كلمات ربي و  
(لو جئنا بمثله مدداً**

سورة الكهف – الآية 109

## **Dedication**

To...

My family

\*\*\*

My teachers

\*\*\*

My friends

\*\*\*

My colleagues

**ASIM**

## **Acknowledgements**

I extremely grateful to many people who supported me during the preparation of this study.

Firstly, I would like to express my deep gratitude to my supervisor Dr Abdelmoneim Adam Mohamed for his supports and advice.

Also great thanks to the staff of Medical Physics department (Rick) for their helps to complete the study.

Finally I would like to thank every one who has participated in the completion of this study.

## Contents

<b>Subject</b>	<b>Page No</b>
<b>Dedication</b>	<b>ii</b>
<b>Acknowledgement</b>	<b>iii</b>
<b>Contents</b>	<b>iv</b>
<b>Abbreviations</b>	<b>viii</b>
<b>List of tables</b>	<b>ix</b>
<b>List of figures</b>	<b>x</b>
<b>Abstract in Arabic</b>	<b>xii</b>
<b>Abstract in English</b>	<b>xiii</b>
<b>Chapter 1: introduction</b>	
<b>1.1 Radiation history</b>	<b>1</b>
<b>1.2 Lithotripsy</b>	<b>2</b>
<b>1.2.1 history of lithotripsy</b>	<b>2</b>
<b>1.2.2 Shockwaves generation</b>	<b>3</b>
<b>methods</b>	
<b>1.2.3 : Procedure of lithotripsy</b>	<b>4</b>
<b>1.3 Radiation</b>	<b>6</b>
<b>1.3.1 Radiation risk</b>	<b>6</b>
<b>1.3.2 1.3.2 The importance of research</b>	<b>6</b>
<b>1.4 Objectives</b>	<b>7</b>
<b>1.5 Thesis outline</b>	<b>8</b>
<b>Chapter 2: Literature review</b>	
<b>2.1: Previous study</b>	<b>9</b>
<b>2.2. 2:2 Machinery</b>	<b>12</b>
<b>2.2.1 Fluoroscopy</b>	<b>12</b>
<b>2.2.2 History of fluoroscopy</b>	<b>12</b>
<b>2.2.3 Fluoroscopy Radiation</b>	<b>14</b>
<b>Risks</b>	
<b>2.2.3 Fluoroscopy Equipment</b>	<b>14</b>
<b>2.2.3.1X-ray Image Intensifiers</b>	<b>15</b>
<b>2.2.3.2 Flat-panel detectors</b>	<b>16</b>
<b>2.2.3.3 Imaging concerns</b>	<b>16</b>
<b>2.4 Anatomy and physiology of renal system</b>	<b>17</b>
<b>2.4 .1 Anatomy</b>	<b>17</b>

<b>2.4.2 Physiology of Kidney</b>	<b>24</b>
<b>2.4.2.1 Functions of the Kidneys</b>	<b>24</b>
<b>2.5 SHOCK WAVE SYSTEM</b>	<b>25</b>
<b>2.5.1 Shock waves principle</b>	<b>25</b>
<b>2.5.2 Lithotripsy machine</b>	<b>26</b>
<b>2.5.2.1 Shockwave generator</b>	<b>26</b>
<b>2.5.2.2 Focusing system</b>	<b>26</b>
<b>2.5.2.3 A coupling mechanism</b>	<b>27</b>
<b>2.5.2.4 An imaging/localization unit</b>	<b>27</b>
<b>2.5.3 History of manufacture</b>	<b>28</b>
<b>Chapter 3 :material and method</b>	
<b>3.1 The population and study site</b>	<b>29</b>
<b>3.2Lithotripter machines</b>	<b>29</b>
<b>3.2.1.1 Siemens (lithostar multilines)</b>	<b>29</b>
<b>X-ray fluoroscopy machine</b>	<b>29</b>
<b>3.2..1.2</b>	
<b>3.2.2 Dorneir compact Delta lithotripter</b>	<b>31</b>
<b>3.2.2.1 X-ray fluoroscopy machine</b>	<b>31</b>
<b>3.3 Detectors Used</b>	<b>32</b>
<b>3.3.1 Ionization chamber</b>	<b>32</b>
<b>3.3.1.1 Electrometer</b>	<b>32</b>
<b>3.2.1.2TLD material</b>	<b>33</b>
<b>3.2.1.3 TLD annealing oven</b>	<b>33</b>
<b>3.3.5 TLD reading system</b>	<b>34</b>
<b>3.3.6 TLDs Calibration</b>	<b>36</b>
<b>3.3.7 Entrance surface dose</b>	<b>39</b>
<b>3.3.8 Enveloping of the TLDs</b>	<b>39</b>
<b>3.3.9 Using of TLDs in doses measurements</b>	<b>40</b>
<b>3.4 Method of dose calculations</b>	<b>41</b>
<b>3.4.1 Organ dose calculations</b>	<b>41</b>
<b>3.4.2 Estimation of absorbed</b>	<b>41</b>

<b>organ doses and effective doses</b>	
<b>3.5 Cancer risk estimation</b>	<b>42</b>
<b>Chapter 4: Results</b>	
<b>4.1 Entrance surface dose</b>	<b>44</b>
<b>4.2. Patients' characteristics Vs measured doses</b>	<b>45</b>
<b>4:2:1 N.Center result</b>	<b>45</b>
<b>4:2:2 KADC result</b>	<b>47</b>
<b>4.3 Organs doses calculations</b>	<b>49</b>
<b>4.4 carcinogenic risk of the procedure</b>	<b>52</b>
<b>Chapter 5 Discussions, Conclusion and Recommendation</b>	
<b>5.1 Discussions</b>	<b>53</b>
<b>5:1:1 TLDS used</b>	<b>53</b>
<b>5:1:2 Patient body characteristics data</b>	<b>53</b>
<b>5:1:3 Patient body characteristics vs measured doses</b>	<b>54</b>
<b>5.2 Conclusion</b>	<b>56</b>
<b>5.3 Recommendation:</b>	<b>57</b>
<b>5.4 Futures works</b>	<b>58</b>
<b>References</b>	<b>59</b>
<b>APPENDIX</b>	<b>61</b>
<b>Appendix 1 : TLDs signals and the highlighted eliminated TLDs</b>	<b>61</b>
<b>Appendix 2: Showed ESD in N.C.</b>	<b>62</b>
<b>Appendix 3: Showed measured ESD in KADC</b>	<b>63</b>
<b>Appendix 4: Information sheet</b>	<b>64</b>

## **Abbreviations**

ESWL: Extra Coporeal Shock Wave Lithotripsy.

IRCP: International Radiation commission on protection.

N.C: Naileen Centre.

KADC: Khartoum Advanced Diagnostic Centre.

BMI: body mass index.

DAP: dose area product.

NRPB: national radiological protection board.

Sd: stander deviation.

T12: Thorathic vertebrae no 12.

L2: lumbar vertebrae.

## List of tables

<b>Table No</b>	<b>Content</b>	<b>Page No</b>
Table 4.1	Showes Patient body characteristics	44
Table 4.2	Exposure factors and parameters for fluoroscopy	44
Table 4. 3	Patient radiation dose in Eswl ( <i>mGy</i> )and Effective dose mSv	46
Table 4:4	Organ doses for patients who were submitted to ESWL in N.C	50
Table 4:5	Organ doses for patients who were submitted to ESWL in KADC	51
Table 5:1	The current study results compared to the recent one	55



## List of Figure

Figure No	Content	Page No
Fig 2:1	Shows kidneys site of the body and the longitudinal cut of the kidney.	19
Fig 2.2	shows longitudinal section of the kidney with a detailed instructions	19
Fig 2.3	Structure of the Nephron	22
Fig 3.1	present the lithostar multilines lithotripter	30
Fig 3.2	Image for the TV monitor.	30
Fig 3.3	Dornier compact Delta lithotripter.	31
Fig 3.4	The x-ray tube, electrometer, ionization chamber and the meter which was used to determine the distance	32
Fig 3.5	TLDs in conductive a tray	33
Fig 3.6	The annealing oven	34
Fig 3.7	The TLDs cupells.	35
Fig 3.8	TLD reader & the holders	36
Fig 3.9	Perspex tray	37
Fig 3.10	Exposing the TLDs	39
Fig 3.11	The packing of the TLDs	40
Fig 3.12	The way of placing the envelope in the entrance of the fluoroscopy beam on the patient	41
Fig 4.1	The correlation between weight and ESD	45
Fig 4.2	The correlation BMI and ESD	45
Fig 4.3	The correlation between kV and the measured ESD	46

Fig 4.4	The relationship between mAs and the measured ESD	47
Fig 4.5	The correlation between patients' characteristics and ESD	47
Fig 4.6	The correlation between BMI and ESD	48
Fig 4.7	The correlation between kV and ESD	48
Fig 4.8	The correlation between mAs and ESD	49
Fig 4.9	organ doses for patients who were submitted to ESWL in N.C	50
Fig 4.10	organ doses for patients who were submitted to ESWL in KADC	51
Fig 4.11	Shows the proportion of organ carcinogenesis for N.C	52
Fig 4.12	Shows the proportion of organ carcinogenesis for KDAC	52

## ملخص البحث

يعتبر تفتيت الحصاوى بواسطة الموجات التصادمية هو الاكثر انتشارا فى العالم لتفتيت حصاوى الكلى والحالب والمثانة و المرارة من الخارج. هذه الخطوة فى العادة يتبعها استخدام اجهزة الاشعة المرئية لضبط التمرکز وذلك لاجل اعطاء الجرعة المثلى للمريض وفقا لتوصيات

المنظمات العالمية. تهدف هذه الدراسة لقياس دخول الجرعة السطحية واحتمال حدوث سرطان نتيجة لاشعاعات جهاز الاشعة المرئية اثناء عملية التفتيت. اجريت هذه الدراسة فى مركز النيلين التشخيصى (على المجموعة الاولى 50 مريضا) ومركز الخرطوم التشخيصى المتطور (على المجموعة الثانية 25 مريضا). اعتمد تصنيف المرضى على نوع مأكيزة التفتيت. تم قياس دخول الجرعة السطحية بواسطة جهاز قياس الجرعات الحرارى. متوسط الجرعة الداخلة و الفاعلة هما 34-37, مللى غراى بالنسبة للمجموعة الاولى والمجموعة الثانية على التوالي والجرعات التى تم قياسها للاعضاء 16, 02, 01, مللى سيفرت بالنسبة للكلى، الامعاء، والمبايض. من الملاحظ ان المجموعة الاولى تعرضت لجرع اكبر من المجموعة الثانية والسبب ان جهاز الاشعة المرئية للمجموعة الاولى ليست لديه القدرة على تغيير توجيه المأكيزة من دون تعريض المريض للاشعة، والسبب هو زيادة الجرعة الداخلة. اوضحت النتائج ان احتمال الاصابة بالسرطان نتيجة للتعرض لكميات م قاسية صغيرة جدا (1 فى كل مليون مريض) لكن التاثر البايولوجى الرئيسى يكون نتيجة لتراكم الاشعة. ايضا اكدت الدراسة ان هناك علاقة بين الوزن وعوامل الاشعاع والجرعات الممتصة. وفى الختام توصى الدراسة بتدريب التقنيين وانفاذ برنامج جودة متاملة لتقليل الجرعة للمريض.

## Abstract

Extracorporeal shock wave lithotripsy is considering the extensive world external treatment process for renal, uretric , bladder and gallbladder stones. This procedure is usually followed up by using x-ray fluoroscopy devices as localizer, the reason is that to optimize the absorbed dose of patients according to the recommendations of international organizations; the aim of this study is to measure the entrance surface dose and the probability of carcinogenesis regarding to x-ray fluoroscopy irradiating during ESWL. The study was applied in Al-Naileen diagnostic center (Group 1, 50 patient) and in Al-Khartoum advance diagnostic center (Group 2, 25 patients), the classification of patients was depending on the type of the lithotripter. The entrance surface dose measurements were done by using thermoluminescence dosimeter (TLDs) GR200A LiF. The mean entrance surface dose and mean effective dose were (0.38 mGy) and (0.34 mGy) for group1 and 2 respectively, the measured organ dose were (0.16 mGy), (0.02) and (0.01) for kidneys, intestines and ovaries. As it was observed Group1 was irradiated to higher dose than Group 2 that's because of the x-ray fluoroscopy equipment in Group 1 has no ability to change the orientation of the machine without exposing the patient to radiation, thus the duration of irradiating is extended and as a result then increasing the entrance surface dose. The results show that the probability of carcinogenesis due to irradiating to the measured amounts of radiation exposures is a tiny value (1 for million patient) but the main biological effect is occur due to the cumulative impact of radiation. In addition the study insures that there is a correlation between the weights, irradiating factors and absorbed doses. As a result guiding charts, training courses for technologist and a strong quality assurance program were recommended to optimize the ESD for patients.