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Radiology, Diagnostic Imaging and Instrumentation

Influence of Tooth Loss

Modalities for Preoperative Staging

Highlights

Spinal Surgery in Patients

Unusual Case of Large Conglomerate

Discovering Thoughts, Inventing Future

VOLUME 24 ISSUE 1 VERSION 1.0

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Influence of Tooth Loss and Malocclusions on Condylar Position - Analysis by Cone Beam Computed Tomography

By Lara Lecy Nogueira Barbosa de Sousa, Paulo Goberlânio De Barros Silva, Rafael Linard Avelar, Claudio Roberto Tavares Pereira Filho, Maysa Luna de Souza, Fernanda Araújo Sampaio, Jonathan Francisco de Melo Silva, Thaís Cavalcante Cabral, Lucas Muniz Pinto Bandeira, Edson Luiz Cetira Filho & Phillipe Nogueira Barbosa Alencar

Federal University of Ceará

Abstract- This study aimed to assess the position of the condyle in the condylar fossa using cone beam computed tomography in patients with tooth loss and malocclusion. A sample of 47 patients of both genders from the Unichristus Dentistry service was selected and divided into six groups. The division was as follows: 1. Angle Class I patients; 2. Angle Class II patients; 3. Angle Class III patients; 4. edentulous patients in both arches; 5. edentulous upper and partially edentulous lower patients; 6. patients with multiple losses. All the patients underwent closed-mouth cone-beam computed tomography, with exposure values of 85kVp, 6.3ma, and 20s of exposure. The images were analyzed in sagittal and axial sections on both sides. Data was expressed as mean and standard deviation, and the Kolmogorov-Smirnov normality test was used to compare the right and left sides or ANOVA/ Bonferroni for independent or repeated measures.

Keywords: *mandibular condyle. temporomandibular joint. cone beam computed tomography.*

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Influence of Tooth Loss and Malocclusions on Condylar Position - Analysis by Cone Beam Computed Tomography

Lara Lecy Nogueira Barbosa de Sousa [α], Paulo Goberlânio De Barros Silva [σ], Rafael Linard Avelar [ρ], Claudio Roberto Tavares Pereira Filho [ω], Maysa Luna de Souza [¥], Fernanda Araújo Sampaio [§], Jonathan Francisco de Melo Silva [χ], Thaís Cavalcante Cabral [ν], Lucas Muniz Pinto Bandeira [θ], Edson Luiz Cetira Filho [ζ] & Phillipe Nogueira Barbosa Alencar [£]

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Keywords: mandibular condyle. temporomandibular joint. cone beam computed tomography.

I. Introduction

The temporomandibular joint (TMJ) is one of the most complex joints in the human body. It comprises bone and soft tissue structures located between the mandible and the temporal bone (1).

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The balanced functioning of the TMJ is of great importance in maintaining the harmony of the masticatory system. The asymmetrical position and morphological changes of the temporomandibular joint structures can be influenced by various factors, such as missing teeth, abrasion, premature contacts, parafunction, unilateral crossbite, and dental-skeletal asymmetries (2).

The condyle is the primary growth center of the mandible and responds to functional stimuli and mechanical stresses exerted on the TMJ region from childhood to adulthood, continuously undergoing bone remodeling processes that affect its volume and shape (3). Factors such as gender, age, facial growth pattern, occlusal force, and pathological and functional changes can affect the morphology of the TMJ and, as a result, there is a reconfiguration of the joint surfaces (4).

In the literature, it has been hypothesized that the condyle and fossa may differ in shape and their interrelations between people with various malocclusions and dentofacial morphologies. Several conventional tomography studies have been conducted to find the relationship between skeletal malocclusions - Class II and Class III - and some characteristics of the temporomandibular joint (TMJ), but the results have not been homogeneous. It is also unclear what the position of the condyle is within the fossa in the other types of malocclusions, whether there is a difference between them, and, if so, whether they are a cause or a result of the occlusion, given that the structures of the TMJ do not grow homogeneously (5).

The interpretation of the condyle-fossa relationship in images is challenging. Two-dimensional (2D) radiographs have limitations inherent to the technique, primarily when used to assess the joint (6). This is because the TMJ is a small joint with complex morphology, surrounded by bony structures that produce overlapping images (7). Cone beam computed tomography is the modality of choice for evaluating the bone morphology of the TMJ, as it produces three-dimensional (3D) images with high resolution and without magnification or distortion, enabling precise and accurate measurements of the structures. (8). In

addition, compared to conventional CT scans, it has a shorter scanning time and radiation dosages that are up to 15 times lower (3).

This study aims to evaluate the position of the condyle in the condylar fossa using cone beam computed tomography in different clinical dental situations.

II. Materials and Methods

This is an observational, in vivo, cross-sectional study. This study was approved by the Human Research Ethics Committee of the Christus University Center (UNICHRISTUS) under protocol number 89152618.7. 0000.5049.

a) Study Design

Patients seen at the Christus University Center dental service were included in this study. Pregnant women, minors, those with apparent facial asymmetry, edentulous patients with implants for prosthetic fixation, and those with any syndrome involving the craniofacial bones were excluded from the sample. A total of 47 patients made up a convenience sample, aged between 18 and 70, divided into six groups:

Group A: Angle Class I patients;
Group B: Angle Class II patients;
Group C: Angle Class III patients;
Group D: Edentulous bimaxillary patients;
Group E: Edentulous upper and partially edentulous lower patients (Kennedy Class I)
Group F: Patients with multiple losses.

All the individuals participating in the study were informed of the possible risks involved, signed the Free and Informed Consent Form (ANNEX II), and kept a copy of it.

After selection, the patients underwent an intraoral clinical examination with a wooden toothpick and were divided into the study groups according to their dental classification. Any TMD symptoms were not a criterion for excluding patients from the sample. Finally, they underwent CBCT scans of the bilateral TMJ region with the mouth closed in a relaxed position.

b) Cone Beam Computed Tomography (Cbct)

The position of the patient's head was standardized so that the Frankfurt plane was parallel to the ground, and the median sagittal plane was perpendicular to the ground. The device used for all the CT scans was the Eagle 3D (Dabi Atlante S/A Indústrias Médico Odontológicas, Ribeirão Preto, SP, Brazil) belonging to the Unichristus Imaging Clinic. All patient safety measures, such as wearing a lead apron and using the lowest radiation dose, were complied with. The exposure values established were 85kVp, 6.3ma, 20s exposure. The images were transformed into DICOM (Digital Imaging and Communications in Medicine), reconstructed three-dimensionally, and interpreted in the Blue Sky Plan 4 program (Blue Sky Bio, Libertyville, IL, USA), where analysis and measurements were carried out on the sagittal and axial sections.

The condylar position of all the patients in the sample was analyzed by a single evaluator who was a radiologist and experienced with tomographic images. This same evaluator selected all the patients in the sample in the study's first phase. A maximum of 10 images a day were interpreted to avoid visual fatigue and interference with the results. The images were viewed and evaluated in a room with reduced lighting to increase accuracy.

The analysis methodology used in this work was previously described by VITRAL et al. (9).

The right and left sides were analyzed separately. The sagittal measurements (MS) evaluated were (FIGURE 1):

1. Depth of the articular fossa: measured from the uppermost point to the horizontal plane with the lowermost point of the external acoustic meatus.
2. Anterior articular space: determined by the shortest distance between the condyle's most anterior point and the articular tubercle's posterior wall.
3. Superior articular space: measured by the shortest distance between the condyle's uppermost point and the articular fossa's uppermost point.
4. Posterior articular space: determined by the shortest distance between the condyle's most posterior point and the articular fossa's posterior wall.

In the axial section, the measurements analyzed (MA) were (FIGURE 2):

1. Largest anterosuperior diameter of the condylar process of the mandible.
2. Largest mediolateral diameter of the condylar process of the mandible.
3. Angle between the long axial axis of the mandibular condyle and the median sagittal plane.
4. Distance between the geometric center of the condylar process and the median sagittal plane: measured by a line running from the geometric center of the condyle perpendicular to the median sagittal plane.

c) Statistical Analysis

Data were expressed as means and standard deviations, subjected to the Kolmogorov-Smirnov normality test, and compared using the paired t-test to compare right and left sides or ANOVA/Bonferroni for independent measures (analysis between groups) or repeated measures (analysis between positions).

The SPSS software version 20 was used to obtain the results of the statistical tests, and the significance level adopted was 5% probability ($p<0.05$).

III. Results

The convenience sample was established with ten patients from Group A, 03 patients from Group B, ten from Group C, 08 from Group D, 06 from Group E, and ten from Group F.

In the analysis between groups (Table 1) concerning sagittal measurement 1 (MS1), groups D and E showed a significant discrepancy between the right ($p=0.028$) and left ($p=0.047$) sides.

In sagittal measurement 2 (MS2), group D showed a significantly higher measurement than all the other groups ($p=0.016$) on the left side, which was not the case on the right side ($p=0.095$), where there was no difference between the groups.

In sagittal measurements 3 and 4 (MS3 and MS4), there was no statistically significant difference when comparing the right and left sides of the patients nor between the groups ($p>0.05$).

Concerning axial measurements, in axial measurement 1 (MA1), on the right side, group C had the highest measurements compared to the other groups ($p=0.043$), while on the left side, the same did not occur ($p=0.133$).

In axial measurements 2 and 4 (MA2 and MA4), when comparing the right and left sides of the patients, there was no statistically significant difference ($p>0.05$).

In axial measurement 3 (MA3), the left side was significantly superior to the other groups ($p=0.038$), which did not occur on the right side ($p=0.465$), and patients in group F also showed a significant discrepancy between the right and left sides, with a value of $p=0.043$.

Table 2 shows that in group A, MS2 was lower than MS3 and higher than MS4, with MS2 and MS4 being equal. In other words, the condyle is slightly extruded and centralized in the fossa. With p-values on the right side ($p=0.001$) and on the left side ($p<0.001$).

In the case of patients in group B, there was no statistical difference between the positions of the mandible on the right and left sides and the average of the two, i.e., in group B, the condyle is centralized, but in a more intrusive position when compared to the patients in group A.

Group C showed the same behavior as group A, with the condyle in a slightly extruded position and centered in the fossa, and the p-values were ($p<0.001$) on the right side and ($p=0.004$) on the left side.

Patients in group D, on the right side, had MS2 equal to MS3 and both higher than MS4, with $p=0.001$. These data show the condyle in a more posteriorized and extruded position. On the left side, the behavior of the patients was the same as group A, with the condyle in a slightly extruded position and centered in the fossa ($p=0.002$).

In groups E and F, the behavior was also the same as in group A, with the condyle slightly extruded and centered in the fossa. The p-values were ($p=0.001$) on the right side and ($p=0.002$) on the left side in group E, ($p=0.001$) on the right side, and ($p=0.001$) on the left side in group F.

IV. Discussion

Cone-beam computed tomography provides three-dimensional information from a series of thin slices of the structure being assessed, without overlapping images, with a higher quality of differentiation of bone tissues when compared to conventional radiography and allows for image manipulation and adjustment even after scanning. (6). For these reasons, the imaging technique was chosen for this study.

The sagittal section is more appropriate for assessing the condyle-fossa relationship, as it allows the depth of the articular fossa to be analyzed and condylar concentricity based on a comparison of the articular spaces. In this study, the depth of the mandibular fossa showed a significant difference between the right and left sides in the groups of totally and partially edentulous patients, with values of $p=0.028$ and $p=0.047$, respectively. The results also showed a significant difference in the anterior joint space on the left ($p=0.016$) in all the groups analyzed. Concerning the superior and posterior joint spaces, there was no significant difference between the right and left sides in the groups. This finding partially corroborates that of Rodrigues et al. (7), who found no statistically significant difference in the anterior and superior joint spaces, while the posterior joint space did. Thus, only the analysis of the superior joint space was in agreement between the two studies.

In the study by Vitral et al. (9), which analyzed Class I patients, the posterior joint space showed a significant difference when comparing the right and left sides of the patients. Rodrigues et al. (7) used the same methodology and found a significant difference in assessing posterior joint spaces on both sides in Class I patients. In the present study, no relevant differences were found about the joint spaces on both sides in the Class I group of patients. This result may infer greater symmetry in these patients.

Concerning Class II patients, the same authors (10) found a statistically significant difference in the posterior articular space but not in the superior and anterior spaces. They justified the asymmetry in the posterior articular space by the different dimensions of the mandibular fossae. Despite the different results, this same justification can explain the significant difference in the anterior joint space on the left found in this study.

Vitral et al. (11), who also used the same methodology in their study, found a more anterior condylar position bilaterally in patients with Class II division 1 malocclusion, with the left condyle in a more anterior position than the right, and attributed this finding

to an asymmetry due to unilateral chewing. Rodrigues et al. (10) results concerning Class II division 1 patients were also non-concentric on both sides, with condyles positioned more anteriorly in the mandibular fossa.

As for Angle Class III patients, the results of the study by Rodrigues et al. (10) showed no significant difference between the two sides in the anterior, superior, and posterior joint spaces. Katsavrias and Halazonetis (12), in their study comparing Class II and Class III malocclusion, concluded that the condyle had an intermediate anteroposterior position in the mandibular fossa in Class III patients.

Comparing the joint spaces on the two sides in the sagittal section does not provide enough information to conclude that one condyle is positioned anteriorly or posteriorly. For this, an association must be made with images in the axial section. If no asymmetrical position is found in this section, it can be said that the differences in joint spaces are associated with the dimension or asymmetrical positioning of the mandibular fossa (10).

The axial section is more suitable for assessing symmetry between the condyles in the anteroposterior and mediolateral aspects, as it shows the two condyles in the same image and allows for actual measurement of their dimensions and angulations (7). Evaluating Class II division 1 patients, these authors found no statistically significant differences between the right and left sides concerning the anteroposterior and mediolateral dimensions of the condyle evaluated in this study. In a study evaluating Class I patients, Rodrigues et al. (7) also found no statistically significant differences between the right and left sides of the condylar processes. Vitral and Telles (13) found similar results when assessing Class II patients using a similar methodology. However, in the present study, the right side of all the groups showed a statistically significant difference, with the Class III patients showing the highest measurements.

The functional stimuli and mechanical stress exerted on the TMJ differ in individuals according to skeletal discrepancies. Paknahad and Shahidi (8) found an association between condylar position and craniofacial morphology and stated that this association may be related to functional loads in patients with various malocclusions, leading to a change in condylar position.

In a normal dentition, harmony between the function and position of the dental elements and the condyles exists. When posterior teeth are removed, the load balance between the dentition and the TMJ can be disturbed. This is because the loss of teeth results in the displacement of adjacent and opposing teeth, causing premature contact in centric and eccentric movements, compromising occlusion and condylar position, and leading to structural alterations of the TMJ surfaces and temporomandibular dysfunction. (14).

In the study by Ammanna et al. (14), patients who had lost posterior support showed a predominance of posteriorized condylar position. This reduction in posterior articular space can cause compression in the bilaminar zone, which is responsible for the blood supply and nutrition of TMJ structures and leads to disc displacement. Thus, the posterior condylar position is more unstable than the concentric and anterior positions since the latter two keep the disc more stable against the articular eminence. The authors assessed that the posterior articular space on both sides of Kennedy Class I and II patients showed a reduction, both in the resting position and at maximum habitual intercuspation, compared to Kennedy Class III and IV patients.

In this study, the measurements between the right and left sides differed statistically significantly in the groups of edentulous patients when MS1 was assessed. This may be due to the chronological loss of dental elements in an unknown order, as this data was not collected during the data collection phase.

When analyzing the anterior articular space in this study, Class III patients showed statistically significant values on the left side compared to all the other groups. In their study, Katsavrias and Halazonetis (15) stated that the condyle and mandibular fossa differ in shape according to the patient's malocclusion. Thus, the data found in this study can be explained by the different dimensions of the mandibular fossae.

Evaluating the angulation of the condyle concerning the median sagittal plane, Rodrigues et al. (7) found no significant difference between the right and left sides in Class I, Class II division 1, and Class III patients. The present study showed significant results on both sides in the patients with multiple losses group and on the left side of all groups. For the group of patients with multiple losses, it can be inferred that the angulation of the condylar process was altered due to muscular and physiological adaptations in chewing and phonation resulting from the lack of dental elements.

V. Conclusion

Patients in the Angle Class I, Angle Class III, upper total edentulous, lower partial edentulous, and multiple loss groups on both sides of the mandible had the condyle centralized in the fossa and slightly extruded. The same happened with the condyle on the left side in the group of edentulous patients, while on the right side, the position observed was with the condyle posteriorized and extruded.

A clinical interpretation of the data collected shows that edentulism tends to posteriorize the condyle, which can be explained by the probable rotation of the mandible in the face of tooth loss.

Angle Class II patients had a centralized and slightly intruded condyle. However, this group had the

limitation of a small sample size, so the results are not as reliable.

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Conflict of Interest
There is no conflict of interest.

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Table 1: Statistical analysis of group measurements

	Groups						p-Value†
	A Class I	B Class II	C Class III	D Fully	E Partially	F Multi Losses	
Sagittal MS 1							
Right	13,92±3,23	10,98±7,40	14,69±2,27	15,14±2,96	15,25±1,60	14,29±2,50	0,420
Left	13,47±2,51	11,72±6,92	13,04±2,40	12,74±2,03	13,17±3,06	14,01±3,98	0,907
p-Value*	0,492	0,186	0,089	*0,028*	*0,047*	0,688	
Sagittal MS 2							
Right	2,29±0,58	3,25±2,22	2,19±0,64	3,57±1,75	2,70±0,67	2,59±0,76	0,095
Left	2,22±0,85	2,34±0,76	1,88±0,58	3,51±1,54[c]	2,50±0,70	2,36±0,64	*0,016*
p-Value*	0,802	0,394	0,084	0,942	0,296	0,322	
Sagittal MS 3							
Right	3,53±1,15	2,58±0,96	3,63±1,05	4,06±0,73	4,15±0,77	4,00±1,08	0,238
Left	3,39±0,85	2,23±0,65	3,44±1,21	4,17±1,35	3,67±0,70	3,93±0,77	0,101
p-Value*	0,565	0,192	0,366	0,773	0,067	0,709	
Sagittal MS 4							
Right	1,99±0,76	2,12±0,37	2,32±0,91	1,67±0,73	1,83±0,90	2,32±1,23	0,620
Left	2,22±0,96	1,92±0,42	2,46±1,15	1,87±0,49	1,74±0,77	2,53±1,37	0,547
p-Value*	0,223	0,211	0,606	0,311	0,700	0,210	
Axial MA 1							
Right	6,71±0,85	5,51±1,23	7,60±0,93[b]	6,84±1,43	7,07±0,83	7,28±0,67	*0,043*
Left	6,84±0,90	5,79±0,38	7,90±1,60	6,81±1,34	7,39±1,19	7,29±1,12	0,133
p-Value*	0,750	0,730	0,465	0,949	0,094	0,970	
Axial MA 2							
Right	17,03±1,95	14,03±0,12	17,93±3,37	18,47±2,40	17,78±1,87	17,53±1,51	0,127
Left	17,34±1,86	15,22±2,82	18,52±2,97	18,14±2,82	16,79±2,32	17,71±2,06	0,383
p-Value*	0,345	0,528	0,119	0,754	0,183	0,695	
Axial MA 3							
Right	66,92±4,99	56,46±17,66	65,59±11,16	61,88±10,01	62,41±3,91	64,71±4,63	0,465
Left	64,43±4,51	51,13±15,60	67,07±8,34[b]	62,50±11,34	66,95±7,84	69,12±4,69[b]	*0,038*
p-Value*	0,083	0,513	0,447	0,733	0,140	*0,043*	
Axial MA 4							
Right	49,23±3,02	51,06±1,59	49,57±3,40	51,57±3,02	51,56±2,39	52,79±3,27	0,117
Left	48,75±1,96	51,19±1,91	50,74±3,67	51,90±4,83	51,12±3,54	52,44±3,18	0,265
p-Value*	0,591	0,845	0,066	0,755	0,591	0,628	

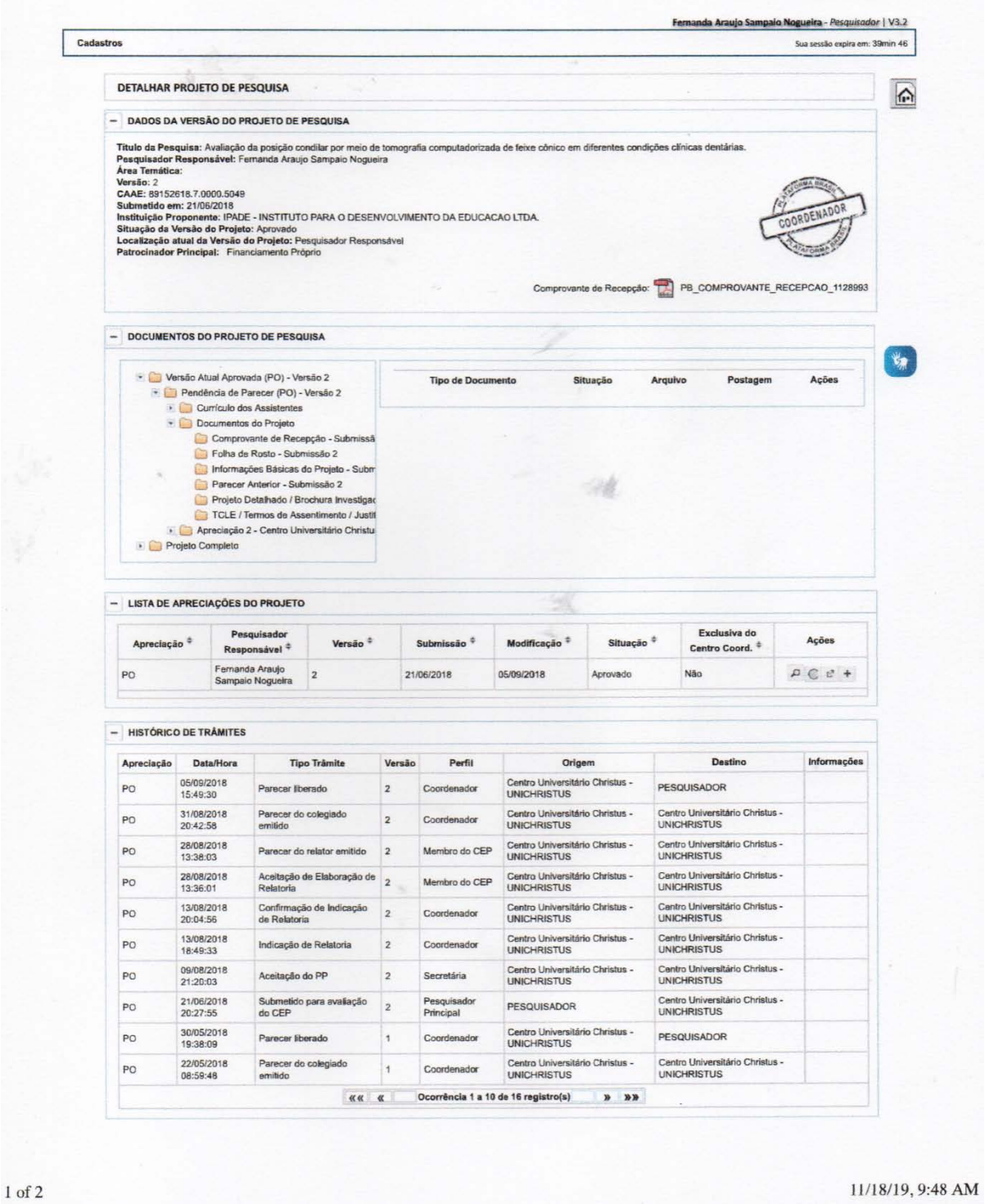
**Paired t-test;† ANOVA/Bonferroni test;[a] p<0.05 versus A;[b] p<0.05 versus B;[c] p<0.05 versus C;[d] p<0.05 versus D;[e] p<0.05 versus E;[f] p<0.05 versus F. Mean ± SD.*

Table 2: Analysis of condyle positioning

Group	p-Value*	Post-test
A		
Right side	p=0,001	$MS2^a < MS3^b > MS4^a$
Left side	p<0,001	$MS2^a < MS3^b > MS4^a$
Average	p<0,001	$MS2^a < MS3^b > MS4^a$
B		
Right side	p=0,848	$MS2^a = MS3^a = MS4^a$
Left side	p=0,900	$MS2^a = MS3^a = MS4^a$
Average	p=0,870	$MS2^a = MS3^a = MS4^a$
C		
Right side	p<0,001	$MS2^a < MS3^b > MS4^a$
Left side	p=0,004	$MS2^a < MS3^b > MS4^a$
Average	p<0,001	$MS2^a < MS3^b > MS4^a$
D		
Right side	p=0,001	$MS2^a = MS3^a > MS4^b$
Left side	p=0,003	$MS2^a < MS3^b > MS4^a$
Average	p=0,001	$MS2^a < MS3^b > MS4^a$
E		
Right side	p=0,001	$MS2^a < MS3^b > MS4^a$
Left side	p=0,002	$MS2^a < MS3^b > MS4^a$
Average	p<0,001	$MS2^a < MS3^b > MS4^a$
F		
Right side	p=0,001	$MS2^a < MS3^b > MS4^a$
Left side	p=0,001	$MS2^a < MS3^b > MS4^a$
Average	p<0,001	$MS2^a < MS3^b > MS4^a$

**p<0.05, ANOVA test for repeated measures followed by the Bonferroni post-test. Different letters = significant difference between groups.*

ANNEX I: Research Ethics Committee Approval



Fernanda Araujo Sampaio Nogueira - *Pesquisador* | V3.2

Cadastros — Sua sessão expira em: 39min 46

DETALHAR PROJETO DE PESQUISA

DADOS DA VERSÃO DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação da posição condilar por meio de tomografia computadorizada de feixe cônico em diferentes condições clínicas dentárias.
Pesquisador Responsável: Fernanda Araujo Sampaio Nogueira
Área Temática:
Versão: 2
CAAE: 89152618.7.0000.5049
Submetido em: 21/06/2018
Instituição Proponente: IPADE - INSTITUTO PARA O DESENVOLVIMENTO DA EDUCACAO LTDA.
Situação da Versão do Projeto: Aprovado
Localização atual da Versão do Projeto: Pesquisador Responsável
Patrocinador Principal: Financiamento Próprio

COORDENADOR

Comprovante de Recepção: PB_COMPROVANTE_RECEPCAO_1128993

DOCUMENTOS DO PROJETO DE PESQUISA

- Versão Atual Aprovada (PO) - Versão 2
  - Pendência de Parecer (PO) - Versão 2
    - Currículo dos Assistentes
    - Documentos do Projeto
      - Comprovante de Recepção - Submissã
      - Folha de Rosto - Submissão 2
      - Informações Básicas do Projeto - Subm
      - Parecer Anterior - Submissão 2
      - Projeto Detalhado / Brochura Investigac
      - TCLE / Termos de Assentimento / Justif
    - Apreciação 2 - Centro Universitário Christu
  - Projeto Completo

Tipo de Documento	Situação	Arquivo	Postagem	Ações

LISTA DE APRECIAÇÕES DO PROJETO

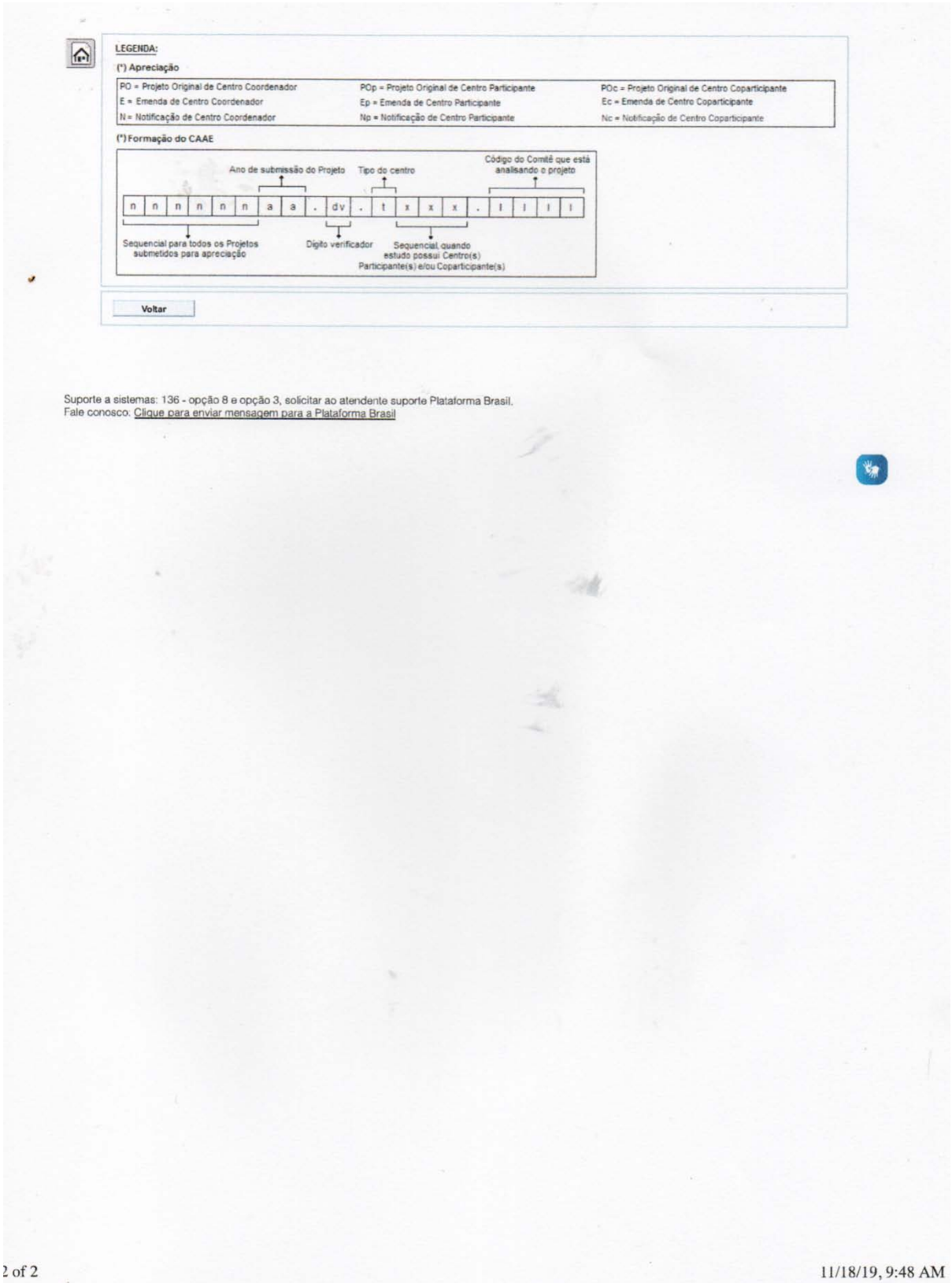
Apreciação	Pesquisador Responsável	Versão	Submissão	Modificação	Situação	Exclusiva do Centro Coord.	Ações
PO	Fernanda Araujo Sampaio Nogueira	2	21/06/2018	05/09/2018	Aprovado	Não	

HISTÓRICO DE TRÂMITES

Apreciação	Data/Hora	Tipo Trâmite	Versão	Perfil	Origem	Destino	Informações
PO	05/09/2018 15:49:30	Parecer liberado	2	Coordenador	Centro Universitário Christus - UNICHRISTUS	PESQUISADOR	
PO	31/08/2018 20:42:58	Parecer do colegiado emitido	2	Coordenador	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	
PO	28/08/2018 13:38:03	Parecer do relator emitido	2	Membro do CEP	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	
PO	28/08/2018 13:36:01	Aceitação de Elaboração de Relatoria	2	Membro do CEP	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	
PO	13/08/2018 20:04:56	Confirmação de Indicação de Relatoria	2	Coordenador	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	
PO	13/08/2018 18:49:33	Indicação de Relatoria	2	Coordenador	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	
PO	09/08/2018 21:20:03	Aceitação do PP	2	Secretária	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	
PO	21/06/2018 20:27:55	Submetido para avaliação do CEP	2	Pesquisador Principal	PESQUISADOR	Centro Universitário Christus - UNICHRISTUS	
PO	30/05/2018 19:38:09	Parecer liberado	1	Coordenador	Centro Universitário Christus - UNICHRISTUS	PESQUISADOR	
PO	22/05/2018 08:59:48	Parecer do colegiado emitido	1	Coordenador	Centro Universitário Christus - UNICHRISTUS	Centro Universitário Christus - UNICHRISTUS	

« « « Ocorrência 1 a 10 de 16 registro(s) » »»

1 of 2 — 11/18/19, 9:48 AM



LEGENDA:

(*) Apreciação

PO = Projeto Original de Centro Coordenador	POp = Projeto Original de Centro Participante	POc = Projeto Original de Centro Coparticipante
E = Emenda de Centro Coordenador	Ep = Emenda de Centro Participante	Ec = Emenda de Centro Coparticipante
N = Notificação de Centro Coordenador	Np = Notificação de Centro Participante	Nc = Notificação de Centro Coparticipante

(*) Formação do CAAE

Voltar

Suporte a sistemas: 136 - opção 8 e opção 3, solicitar ao atendente suporte Plataforma Brasil.
Fale conosco. Clique para enviar mensagem para a Plataforma Brasil

2 of 2 11/18/19, 9:48 AM

ANNEX II: Informed Consent Form

You are being invited to take part in the study: *Evaluation of condylar position using cone beam computed tomography in different clinical dental conditions,* authored by Lara Lecy Nogueira Barbosa de Sousa and supervised by Prof. Dr. Fernanda Araújo Sampaio. In this study, you will be asked to undergo a clinical dental examination to assess your dental condition. You will also be asked to undergo a Cone Beam Computed Tomography scan at the Christus University Center - UNICHRISTUS to analyze the condylar position. You will not incur any costs for the examinations or procedures carried out. The only risk you are exposed to in this research is radiation during the CT scan. However, this risk is considerably reduced with patient protection measures, such as the use of a lead apron, which will be guaranteed by the researcher in charge. The assessments will not cause you any physical, moral, or material harm. The information provided will be kept confidential, respecting your privacy. The results will be analyzed and published in scientific media without your identification.

You must be aware that participation in this study is entirely voluntary and that you can refuse to participate or leave the study at any time without penalty. Refusal to participate or withdrawal from the study will not influence your care at this institution. The researcher is responsible for reimbursing any expenses incurred by the participants in the study and for any damages arising from this study.

You will receive an equally valid copy of this form with the principal investigator's telephone number and address. You can ask questions about the project and your participation now or at any time. If you have any further questions about the study, please call Lara Lecy Nogueira Barbosa de Sousa at (85) 999398581, R. João Adolfo Gurgel, 133 - Cocó (CEP 60190-060 - Fortaleza - CE) or send your questions by email: laralecynbs@gmail.com. If you have any complaints and/or questions about your participation in this research, you can contact the Research Ethics Committee of the Christus University Center (UNICHRISTUS), located at R. João Adolfo Gurgel, 133 - Cocó (CEP 60190-060 - Fortaleza - CE), telephone: (85) 3265-8100.

By this instrument, which complies with legal requirements, you, Mr. _____, bearer of identity card _____, after carefully reading the information contained in this *FREE AND INFORMED CONSENT FORM,* duly explained by the professionals in its smallest details, aware of the services and procedures to which you will be subjected, leaving no doubts about what has been read and explained, *DECLARE and FIRM your FREE AND INFORMED CONSENT by* agreeing to participate in the proposed research. It is made clear that the research participant may at any time withdraw his/her *FREE AND INFORMED CONSENT* and stop participating in this research, and is aware that all the information provided will be kept confidential under professional secrecy (Art. 9 of the Code of Dental Ethics).

Finally, as the researcher responsible for the research, I DECLARE compliance with the provisions of CNS Resolution No. 466 of 2012, contained in items IV.3 and IV.4, item IV.5.a, and in full with the CNS Resolution No. 466 of December 2012.

As we agree with this agreement, we sign it in two equally valid copies (one for the research participant and one for the researcher), which will be initialed on all its pages and signed at the end, following the provisions of CNS Resolution No. 466 of 2012, items IV.3.f and IV.5.d.

Fortaleza-CE, _____, _____, _____.

_____ _____

Research Participant Lara Lecy Nogueira Barbosa de Sousa

ANNEX III: Initial assessment form

Date: _____

N. Research Subject: _____

Name: _____

Age _____ Gender: ( ) Male ( ) Female

Phone number: _____

I) Odontogram

X - Missing teeth

II) Angle Classification

Class I

Class II Subdivision 1

Class II Subdivision 2

Class III

OVERJET: _____ mm

OVERBITE: _____ mm

III) Research Group

Group 1: Edentulous patients in both upper and lower arches.
Group 2: Unilateral partially edentulous patients.
Group 3: Bilateral partial edentulous patients.
Group 4: Angle Class I patients.
Group 5: Angle Class II, subdivision one patients.
Group 6: Angle Class II, subdivision two patients.
Group 7: Angle Class III patients.

IV) Tomography Evaluation

1. SAGITTAL PLANE

RIGHT

1: _____
2: _____
3: _____
4: _____

LEFT

1: _____
2: _____
3: _____
4: _____

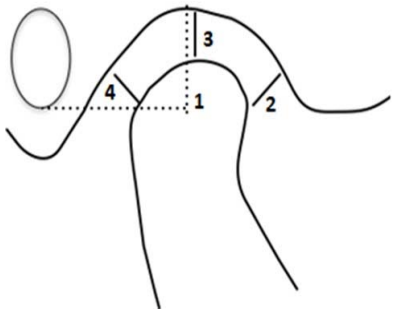


Figure 1: Illustration of the measurements in the sagittal section

2. AXIAL PLANE

RIGHT

1: _____
2: _____
3: _____
4: _____

LEFT

1: _____
2: _____
3: _____
4: _____

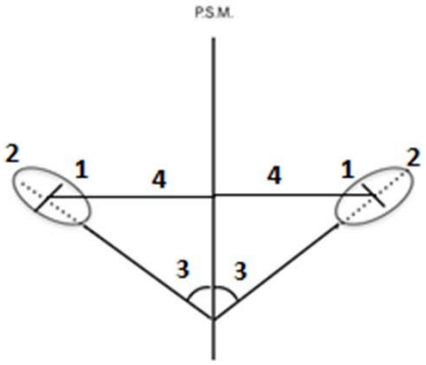


Figure 2: Illustration of axial cut measurements

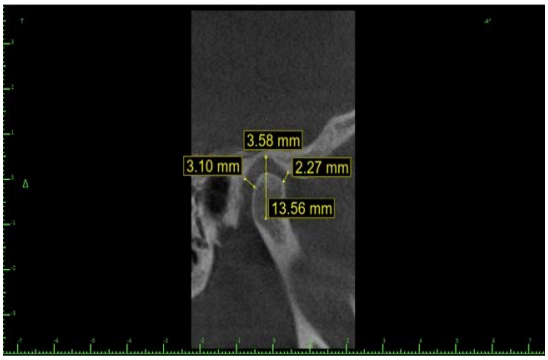


Figure 3: Sagittal section measurements

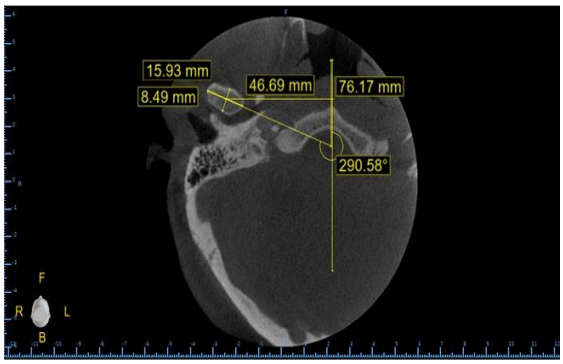


Figure 4: Axial cut measurements

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Imaging Modalities for Preoperative Staging of Rectal Cancer in Developing Countries: A Comparative Study of F-FDG PET/CT and MRI

By Nishita Gandhi, Soundarya Barani Nanjegowda, Shahpoor A. Shirzada & Harsh Bansal

New Vision University

Abstract- Rectal cancer represents a significant healthcare challenge globally, demanding accurate pre-operative staging to guide therapeutic interventions and prognostic estimations. This study aims to compare the efficacy and use of F-FDG PET/CT and MRI in preoperative staging of rectal cancer in developing countries such as india. Using a cross-sectional study design, a total of 70 patients diagnosed with rectal cancer were prospectively enrolled and equally divided Into group A and group B. For group A f- fdg PET/CT and for group B MRI was conducted. The primary outcome measures were accuracy, sensitivity, and specificity of each imaging modality in detecting local tumor extent (T stage), lymph node involvement (N stage), and distant metastasis (M stage). Histopathological biopsy was taken for each patient and considered as reference standard.

Keywords: *Rectal cancer, pre-operative staging, MRI, F-FDG PET/CT.*

GJMR-D Classification: *LCC: RC280.R3*

Strictly as per the compliance and regulations of:

Imaging Modalities for Preoperative Staging of Rectal Cancer in Developing Countries: A Comparative Study of F-FDG PET/CT and MRI

Nishita Gandhi [α], Soundarya Barani Nanjegowda [σ], Shahpoor A. Shirzada [ρ] & Harsh Bansal [ω]

Abstract- Rectal cancer represents a significant healthcare challenge globally, demanding accurate pre-operative staging to guide therapeutic interventions and prognostic estimations. This study aims to compare the efficacy and use of F-FDG PET/CT and MRI in preoperative staging of rectal cancer in developing countries such as india. Using a cross-sectional study design, a total of 70 patients diagnosed with rectal cancer were prospectively enrolled and equally divided Into group A and group B. For group A f- fdg PET/CT and for group B MRI was conducted. The primary outcome measures were accuracy, sensitivity, and specificity of each imaging modality in detecting local tumor extent (T stage), lymph node involvement (N stage), and distant metastasis (M stage). Histopathological biopsy was taken for each patient and considered as reference standard. Data were analyzed using descriptive statistics and diagnostic accuracy measures. Results showed that both F-FDG PET/CT (71.4%) and MRI (75..5%) had high accuracy in T staging, with comparable sensitivity (F - FDG PET/CT -59.6%, MRI - 72.0%) and specificity (F -FDG- 94.8% , MRI -82.2%). MRI showed higher sensitivity (78.6%) in detecting lymph node involvement than F-FDG PET/CT (72.2%) .F-FDG PET/xCT demonstrated higher sensitivity in detecting distant metastasis compared to MRI. Conclusion: F-FDG PET/CT and MRI are comparable for preoperative staging of rectal cancer, with their own limitations and benifits. MRI provides detailed information about the local tissue involvement, and presence of lymph node metastases whereas F-FDG PET/CT is more helpful in detecting distant metastases. But as MRI is more readily available and is more cost effective than F-FDG PET/CT in developing countries such as india, it should be used as the imaging modality of choice for pre - operative staging of rectal cancer.

Keywords: Rectal cancer, pre-operative staging, MRI, F-FDG PET/CT.

I. Introduction

Rectal cancer remains a formidable healthcare challenge worldwide[1], characterized by its potential for local invasion, lymphatic spread, and distant metastasis. Accurate pre-operative staging[2] is imperative for guiding treatment decisions, including the selection of appropriate neoadjuvant therapies[3], surgical approaches, and postoperative management strategies. Pre-operative staging not only informs clinicians about the extent of disease but also serves as a crucial prognostic indicator, guiding therapeutic interventions and facilitating patient counseling.

Traditionally, staging modalities[4] for rectal cancer have included digital rectal examination, endorectal ultrasound (ERUS), and computed tomography (CT) imaging. However, these modalities have limitations in accurately assessing tumor extent, particularly in defining the relationship between the primary tumor and adjacent structures, as well as in detecting small lymph node metastases and distant metastatic disease. In recent years, advancements in imaging technology have led to the emergence of two pivotal modalities for pre-operative staging of rectal cancer: Fluorine-18 fluorodeoxyglucose positron emission tomography/computed tomography (F-FDG PET/CT)[5] and magnetic resonance imaging (MRI)[6].

F-FDG PET/CT combines metabolic information[7] from PET with anatomical details from CT, offering comprehensive insights into tumor metabolism, proliferation, and metastatic spread. The uptake of FDG, a glucose analog, reflects increased metabolic activity within malignant tissues, enabling the detection of distant metastases, particularly in the liver, lungs, and bones. Moreover, F-FDG PET/CT has shown promising results in assessing treatment response and predicting outcomes in rectal cancer patients undergoing neoadjuvant therapy.

In contrast, MRI[8] offers superior soft tissue contrast and multiplanar imaging capabilities, making it an invaluable tool for delineating tumor extent, assessing local invasion, and characterizing pelvic anatomy. High-resolution MRI sequences, such as T2-weighted imaging, diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging, provide detailed anatomical information and enable accurate assessment of tumor stage, mesorectal fascia involvement, and nodal status. Additionally, MRI is less susceptible to artifacts from bowel gas and metallic implants compared to CT imaging, enhancing its utility in rectal cancer staging.

While both[9] F-FDG PET/CT and MRI offer unique advantages in pre-operative staging of rectal cancer, comparative studies evaluating their diagnostic performance in a real-world clinical setting are limited.

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Author σ: Kempe gowda Institute of Medical Sciences
Author ρ: New Vision University School of Medicine
Author ω: Pacific Medical College and Hospital.
e-mail: harshbansal1101@gmail.com

Existing evidence suggests that these modalities may have complementary roles, with F-FDG PET/CT excelling in detecting distant metastases and MRI providing detailed information on local tumor characteristics and nodal involvement. However, discrepancies in sensitivity, specificity, and overall diagnostic accuracy between the two modalities necessitate further investigation to elucidate their respective roles and optimize staging strategies in rectal cancer patients.

Against this backdrop, this cross-sectional study aims to comprehensively compare the diagnostic performance of F-FDG PET/CT and MRI in pre-operative staging of rectal cancer. By evaluating patients diagnosed with rectal cancer who underwent both imaging modalities, we seek to provide valuable insights into their relative efficacy and use, informing clinical practice and guiding future research endeavors.

II. Methodology

In this cross-sectional study, a total of seventy (70) known cases of rectal cancer were included whose baseline parameters are as shown in table 1. These patients were equally divided into group A and group B each containing thirty-five (35) patients. Group A underwent F-FDG PET/CT imaging and group B underwent MRI imaging.

Inclusion Criteria:

1. Patients of age 18 or older with histologically[10] confirmed rectal cancer.
2. Patients who underwent both F-FDG PET/CT and MRI for preoperative staging within specific time frame and has the availability of complete imaging studies and medical records for analysis.
3. Willingness to provide informed consent for participation in the study.

Exclusion Criteria:

1. Patients with contraindications to MRI or F-FDG PET/CT, including severe claustrophobia, metal implants, or allergy to contrast agents.
2. Prior pelvic radiation therapy, which could potentially impact imaging interpretation and staging accuracy.
3. Incomplete imaging studies or patient non-compliance, such as inadequate bowel preparation or motion artifacts or unable to give informed consent.
4. Patients with a history of other malignancies, to minimize confounding factors related to previous treatments or concurrent cancers.
5. Pregnancy or breastfeeding women, as both F-FDG PET/CT and MRI involve radiation exposure or contrast administration.

Table 1: Baseline Parameters

Parameter	Total (n=70)	F-FDG PET/CT Group (n=35)	MRI Group (n=35)
Age (years), Mean (±SD)	60.5 (±8.3)	61.2 (±7.9)	59.8 (±8.7)
Sex (Male/Female), n (%)			
- Male	42 (60%)	20 (57.1%)	22 (62.9%)
- Female	28 (40%)	15 (42.9%)	13 (37.1%)
Tumor Location, n (%)			
- Rectosigmoid	20 (28.6%)	10 (28.6%)	10 (28.6%)
- Rectum	50 (71.4%)	25 (71.4%)	25 (71.4%)
Tumor Size (cm), Mean (±SD)	4.7 (±1.2)	4.5 (±1.1)	4.9 (±1.3)
Histological Subtype, n (%)			
- Adenocarcinoma	65 (92.9%)	32 (91.4%)	33 (94.3%)
- Mucinous carcinoma	5 (7.1%)	3 (8.6%)	2 (5.7%)
Clinical T Stage (cT), n (%)			

- T1	8 (11.4%)	4 (11.4%)	4 (11.4%)
- T2	15 (21.4%)	7 (20%)	8 (22.9%)
- T3	40 (57.1%)	20 (57.1%)	20 (57.1%)
- T4	7 (10%)	4 (11.4%)	3 (8.6%)
Clinical N Stage (cN), n (%)			
- N0	38 (54.3%)	18 (51.4%)	20 (57.1%)
- N1	20 (28.6%)	10 (28.6%)	10 (28.6%)
- N2	12 (17.1%)	7 (20%)	5 (14.3%)

The PET/CT examinations were conducted using synthesized 18F-FDG, with image acquisition 60 minutes post-injection. CT images were acquired with a multi-detector-row CT component covering the head to mid-thigh region. Reconstruction of PET images were performed using the 3D-OSEM method, with both conventional PET and PSF-PET reconstructions. The MRI examinations were carried out using either a 1.5-T or 3-T scanner, with imaging parameters varying based on the scanner used.

For imaging analysis, PET/CT scans were evaluated by consensus of two nuclear medicine physicians, with a focus on SUVmax and L/B ratio for lymph nodes. Meanwhile, MRI images were reviewed by two diagnostic radiologists, primarily focusing on lymph node evaluation and tumor invasion, particularly using high-resolution T2-weighted images and diffusion-weighted imaging (DWI). The staging findings from both imaging modalities were compared with histopat hological analysis of the primary tumor and harvested lymph nodes.

Statistical analysis included sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy values for T and N staging, with comparisons made between conventional PET/CT, PSF-PET/CT, and MRI.

III. Results

Preliminary analysis of seventy (70) patients in our study revealed that F-FDG PET/CT detected local tumor[11] extent (table 2) and mesorectal fascia involvement with a sensitivity of [59.6], specificity of [94.8], PPV of [96.0], NPV of [52.7], and accuracy of [71.4]. MRI demonstrated a sensitivity of [72.0], specificity of [82.2], PPV of [90.8], NPV of [58.5], and accuracy of [75.5] for the assessment of local tumor extent. For assessing lymph node[12] involvement (table 3 and figure 1) , MRI exhibited a sensitivity of [78.6], specificity of [98.2], PPV of [62.5], NPV of [93.7], and accuracy of [89.6], compared to [72.2] sensitivity, [97.6] specificity, [76.9] PPV, [97.5 NPV, and [94.6] accuracy for F-FDG PET/CT. With regards to metastasis both F-FDG PET/CT detected all distant metastasis [9/70 patients; 3 cases for lung, 3 case for liver, 1 case for para-aortic LNs, and 2 case for lung, liver, and bone metas- tasis], whereas pelvic MRI was not able to diagnose distant metastases because of its scanning range limitations.

Table 2: Diagnostic performance of F - FDG PET/CT vs MRI for local tissue staging

	F-FDG PET/CT	MRI
Sensitivity %	59.6 (0.49 to 0.79)	72.0 (0.64 to 0.90)
Specificity %	94.8 (0.76 to 0.98)	82.2 (0.64 to .92)
Accuracy %	71.4 (0.65 to 0.84)	75.5 (0.69 to 0.87)
Ppv %	96.0 (0.75 to 0.99)	90.8 (0.76 to 0.99)
Npv %	52.7 (0.43 to 0.82)	58.5 (0.62 to 0.89)
Postive LR	9.6 (2.43 to 72.60)	5.7 (2.36 to 12.62)
Negative LR	0.65 (0.54 to 0.76)	0.58 (0.42 to 0.84)

Table 3: Diagnostic performance of F - FDG PET/CT vs MRI for lymph node

	F-FDG PET/CT	MRI
Sensitivity	72.2	78.6
Specificity	97.6	98.2
Accuracy	94.6	89.6
Ppv	76.9	62.5
Npv	97.5	93.7
Positive LR	19.6	10.9
Negative LR	0.46	0.68

IV. Discussion

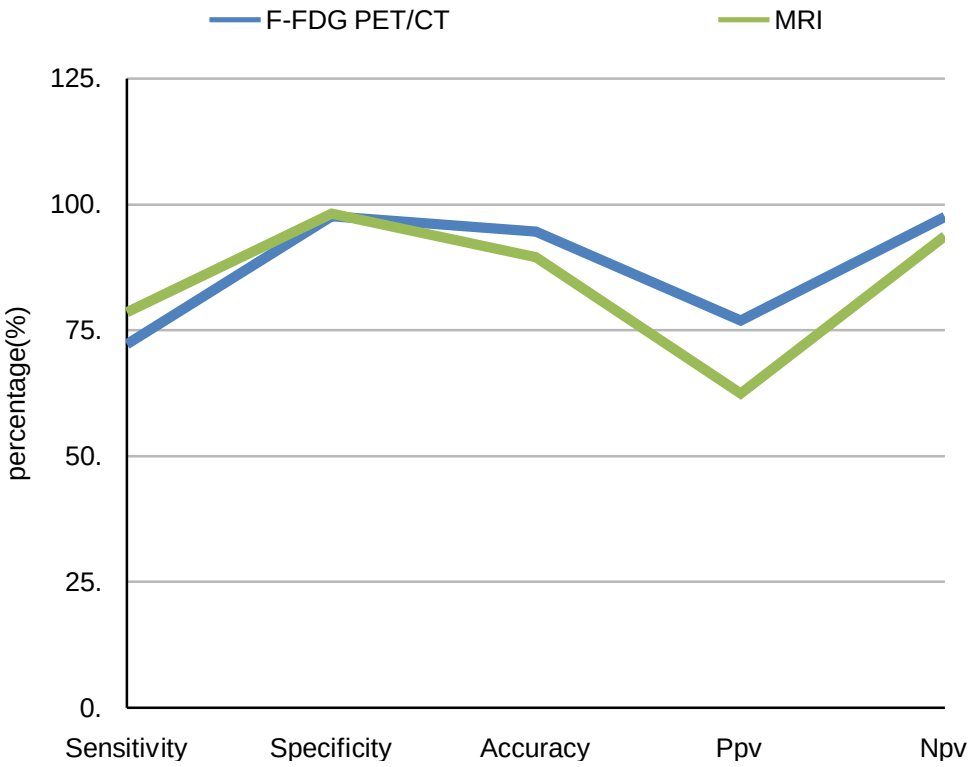

Figure 1

The comparative evaluation of F-FDG PET/CT and MRI for preoperative staging of rectal cancer provides critical insights into the complementary nature of these imaging modalities. This study underscores the importance of utilizing both techniques to achieve a comprehensive understanding of disease extent, which is paramount for optimal patient management.

a) F-FDG PET/CT in Detecting Distant Metastases

F-FDG PET/CT has emerged as a powerful tool for detecting distant metastases due to its ability to highlight regions of increased glucose metabolism, which is a characteristic of many malignant cells. This capability is particularly advantageous in identifying metastases in organs such as the liver, lungs, and bones. The metabolic imaging provided by F-FDG PET/CT offers significant prognostic information that is crucial for patient stratification and treatment planning. Patients with detected distant metastases often require different therapeutic approaches compared to those with localized disease, making accurate detection vital for guiding treatment decisions.

However, the high sensitivity of F-FDG PET/CT can sometimes be a double-edged sword. The modality is prone to false positives, where benign processes

such as inflammation or infection can exhibit increased glucose uptake, mimicking metastatic disease. This can lead to over-staging and potentially unnecessary treatments. Additionally, F-FDG PET/CT has limitations in detecting lesions that are either too small or have low metabolic activity, which can result in under-staging and missed metastatic sites. These limitations highlight the need for careful interpretation of F-FDG PET/CT results, considering the full clinical context and corroborating with other diagnostic findings.

b) MRI for Local Staging and Surgical Planning:

MRI is considered the gold standard for local staging of rectal cancer due to its superior soft tissue contrast and resolution. The high spatial resolution of MRI allows for detailed visualization of the primary tumor and its relationship with surrounding structures. Key aspects of local staging, such as tumor depth of invasion, involvement of the mesorectal fascia, and the presence of suspicious lymph nodes, can be assessed with high accuracy using MRI. This detailed anatomical information is crucial for surgical planning, particularly in determining the feasibility of achieving clear margins and thus reducing the risk of local recurrence.

The multiplanar imaging capabilities of MRI allow for the acquisition of images in multiple planes without repositioning the patient, which is invaluable for assessing complex anatomical regions. MRI can provide detailed information on the tumor's circumferential resection margin (CRM), which is a critical factor in surgical decision-making. Understanding the involvement of the CRM helps surgeons plan the extent of resection needed to achieve negative margins, which is associated with improved oncological outcomes.

Despite its advantages, MRI interpretation can be challenging and requires specialized expertise. Variability in MRI image quality and the subjective nature of some interpretative aspects can lead to differences in staging accuracy, particularly in less experienced hands. Furthermore, access to high-quality MRI equipment and trained radiologists may be limited in some healthcare settings, posing a barrier to its widespread use.

c) Integrating F-FDG PET/CT and MRI

The complementary strengths of F-FDG PET/CT and MRI highlight the value of an integrated[13] imaging approach. F-FDG PET/CT's ability to detect distant metastases and MRI's superiority in local staging make them an ideal combination for a comprehensive preoperative assessment of rectal cancer. This integrated approach can enhance staging accuracy, leading to more informed treatment decisions.

By leveraging the metabolic imaging capabilities of F-FDG PET/CT, clinicians can identify patients with distant metastatic disease who may benefit from systemic therapies or palliative care instead of curative surgery. Concurrently, the detailed anatomical information provided by MRI can guide precise surgical planning for those with localized disease, ensuring optimal resection and reducing the risk of local recurrence. The integration of these modalities provides a holistic view of the disease, which is essential for tailoring personalized treatment strategies. Additionally, advancements in imaging technology[14], such as the development of hybrid PET/MRI systems, could further enhance diagnostic accuracy by combining the strengths of both modalities in a single imaging session. Emerging imaging tracers and techniques may also improve the detection of both local and distant disease, providing more detailed insights into tumor biology.

Therefore, our comparative evaluation of F-FDG PET/CT and MRI for preoperative staging of rectal cancer underscores the necessity of a multimodal imaging approach. Clinicians must carefully consider the benefits and limitations of each modality, alongside patient-specific factors and institutional resources, to select the most appropriate imaging strategy. An integrated approach that leverages the strengths of both F-FDG PET/CT and MRI is essential for achieving comprehensive disease assessment and guiding personalized treatment strategies, ultimately improving patient care and outcomes in rectal cancer.

V. Conclusion

In this study we demonstrate that F-FDG PET/CT and MRI are comparable for preoperative staging of rectal cancer, with their own limitations and benefits. MRI provides detailed information about the local tissue involvement, mesorectal fascia and nearby structure involvement and presence of lymph node metastases whereas F-FDG PET/CT is more helpful in detecting distant metastases and tumour metabolism. But as MRI is more readily available and is more cost effective than F-FDG PET/CT in developing countries such as India, it should be used as the imaging modality of choice for pre-operative staging of rectal cancer.

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Unusual Case of Large Conglomerate Mass in Abdomen

By Sajanakan Sriselvakumar

Abstract- Testicular seminoma commonly occurs in young men aged between 15 and 45 years old. Those with testicular cancer may present with a lump or swelling in the testicle. If treated and managed early, patients can expect a greater than 90% success rate. However, advanced stages of testicular seminoma can lead to eventual metastasis. We present a 45-year-old male patient with a prior history of testicular seminoma who was admitted to the emergency department with abdominal distension and mild abdominal pain. The CT identified a rather sizable abdominal mass and the biopsy report confirmed metastatic testicular seminoma. This patient is currently on active chemotherapy with bleomycin, cisplatin, and etoposide.

Keywords: *metastatic testicular seminoma; abdominal pain; abdominal distention.*

GJMR-D Classification: *FOR Code: 1112*

Strictly as per the compliance and regulations of:

Unusual Case of Large Conglomerate Mass in Abdomen

Sajanakan Sriselvakumar

Abstract- **Testicular seminoma commonly occurs in young men aged between 15 and 45 years old. Those with testicular cancer may present with a lump or swelling in the testicle. If treated and managed early, patients can expect a greater than 90% success rate. However, advanced stages of testicular seminoma can lead to eventual metastasis. We present a 45-year-old male patient with a prior history of testicular seminoma who was admitted to the emergency department with abdominal distension and mild abdominal pain. The CT identified a rather sizable abdominal mass and the biopsy report confirmed metastatic testicular seminoma. This patient is currently on active chemotherapy with bleomycin, cisplatin, and etoposide.**

Keywords: metastatic testicular seminoma; abdominal pain; abdominal distention.

I. Introduction

Testicular cancer represents 1% of male tumors and 5% of urological cancers (1) and predominantly affects young males between the ages of 15 and 45 years old (2). With early diagnosis and intervention, the prognosis is promising with greater than 90% cure rate and 95% five-year survival rate (1). There is a multitude of factors that can cause testicular cancer including cryptorchidism (2-4-fold increased risk) (3), family history of testicular cancer (6-10% fold increased risk) (4), prior history of testicular cancer (1), sexually transmitted infections (5), testicular trauma (6), and potentially elevated maternal estrogen levels (7). There may be no prominent symptomology for patients with testicular cancer (8). However, some patients may experience painless swelling and other less common symptoms such as back pain, enlargement or tenderness of breast tissue and pain in the lower abdomen (8).

Case Report

A 45-year-old man with prior medical history of testicular cancer and left orchiectomy in 2021 was admitted to the emergency room with mild abdominal pain, distention, and vomiting. Our patient reported missed outpatient attendance following their orchidectomy in 2021. He had no known testicular cancer in his family history. Additionally, there is no medical history of cryptorchidism. On initial presentation, his heart rate was 130, blood pressure was 130/70, respiratory rate of 16, oxygen saturation was 98% and he was afebrile. His tachycardia improved with fluid resuscitation. On physical examination, a large, distended abdomen and generalized abdominal tenderness was noted. His bowel sounds were present, and previous surgical scars healed well.

The abdominal and pelvic CT in *Figure 1* and *Figure 2* revealed a large undifferentiated mass localized throughout the abdomen and pelvis (transverse dimensions: 25.4 x 22.8 cm). The CT scan in *Figure 1* also demonstrated left kidney displacement and encasement of the abdominal aorta, visceral branches, and inferior vena cava. There is also encasement of the small and large bowel loops in the upper abdomen and this mass extends into the central pelvis. The liver in *Figure 2* also highlights one of the many multiple solid lesions spread throughout both hepatic lobes and is mainly right-sided. The largest solid lesions in segment 6 and 4A are respectively measuring up to 3.2 cm and 2.9 cm. Our patient proceeded to have further staging scans which did not reveal any metastatic depositions to the chest, head, and neck.

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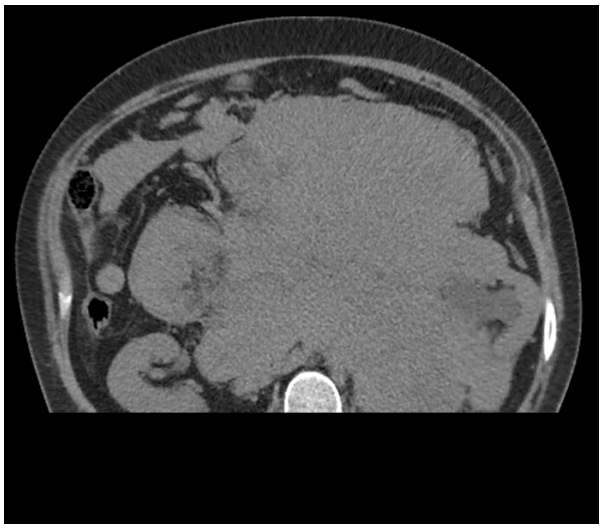

Figure 1: Axial slice of the abdomen noting large conglomerate mass located centrally with significant displacement of the left kidney and the small bowels. This mass measures up to 25.4 x 22.8cm in transverse directions

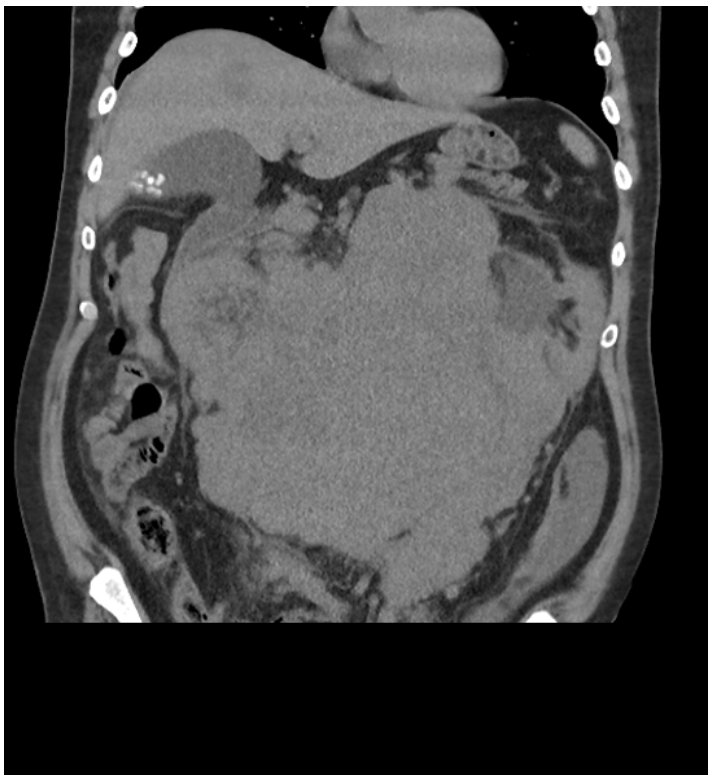

Figure 2: Coronal slice of the abdomen noting same mass with significant displacement of the bowels. A hypodense lesion can be visualised on the liver

Histopathology presented sheets of polygonal cells with substantial clear cytoplasm and vesicular nuclei, with dispersed lymphocyte-rich septa. Immunohistochemistry revealed that the tumor cells are positive for PLAP, OCT3/4 and CD117 and negative for SOX10. Hence, this histologic evaluation was deemed to be consistent with the diagnosis of metastatic seminoma for our patient.

The current oncologic diagnosis of this patient is stage IIIc seminoma. The oncologic history is pure seminoma PT1bNx with left orchiectomy in 2021. The tumor markers for this admission are alpha-fetoprotein (AFP) at 4.4, Lactate dehydrogenase (LDH) at 1230, and beta-human chorionic gonadotropin (β-hCG) at 38. He was admitted under the oncology team and started chemotherapy. He has been scheduled for 4 cycles of chemotherapy and is currently on bleomycin, etoposide, and platinum (BEP) therapy.

II. Discussion

This is a unique case of a patient presenting with abdominal distension. Abdominal distension is a common presentation to the emergency department and has a wide range of differentials (9). It is important to obtain a thorough medical history and physical examination of the patients before requesting an investigation. This patient had a left orchiectomy in 2021 and was noted to miss most of his follow-up appointments. It is important to consider imaging of these subset of patients with oncological history and has been more routinely performed in the emergency department in recent years.

Seminomas are germ cell tumors that account for up to 50% of all testicular tumors (10). These tumors metastasize within the lymphatic system with the retroperitoneal lymph nodes being the most common sites (10). The risk factors for seminomas are cryptorchidism (3), family history of testicular cancer (4), prior history of testicular cancer (1) and testicular trauma (6). This patient has a prior history of testicular cancer. His AFP was within normal levels, which is consistent with seminoma. His LDH was 1230 which is 2.5-fold above the upper normal limit for LDH.

One third of seminoma patients present with metastatic disease (10). There are different chemotherapy medications and regimens currently in use to manage this condition. This patient is currently on treatment with BEP. BEP was studied in a randomized control trial in 1980 against cisplatin, vinblastine, and bleomycin (PVB) (11). This study had a total of 244 patients, with 121 patients treated with BEP compared to 123 in PVB. 74% of patients with PVB became disease-free compared to 83% with BEP therapy. Neuromuscular toxicity was significantly less in BEP than that of PVB, favoring BEP therapy.

The results from the Internationalgerm-cell cancer collaborative group (IGCCG) compared the current data to that of original data from the 1980s for metastatic seminoma (10). The progression free survival rate (PFS) has improved from 82 to 89% with a 95% confidence interval between 87 to 90% with BEP therapy in favor of the current data. The 5-year overall survival rate in the modern series is 95% to that of 86% in the 1980s with confidence interval between 94 to 96% in patients with a good prognosis. For intermediate prognosis, the overall survival has improved from 72% to 88% with 95% confidence interval between 80-93%.

LDH has been recommended for assessment of the prognostic factor for seminoma cancer. Patients with good prognosis with LDH 2.5-fold above the normal limit had a 3-year progression free survival rate of 80% and overall survival of 92%. Patients with lower LDH level are noted to have a progression free survival rate of 92% and overall survival of 97% (10). This patient will be classed poor prognosis given the abdominal metastasis with LDH levels 2.5-fold above the normal upper limit. His current estimated 2-year survival rate is 36% with 95% confidence interval between 12-60%.

Most testicular cancers exist as a mass localized to the testicle and thereby presents as a painless testicular mass which can progress to a significant size. With early diagnosis and effective management, patients can expect to lead a good quality of life following treatment. However, this patient reported poor attendance in follow up consultations after their testicular cancer diagnosis and orchidectomy in 2021. This resulted in a significant palpable metastatic mass present in their abdominal region as the initial manifestation from testicular seminoma confirmed via CT scan and histological assessment. This patient is currently on bleomycin, etoposide, and platinum (BEP) therapy and is scheduled for four cycles of chemotherapy.

III. Conclusion

Testicular seminoma is a common malignancy amongst young men between the ages of 15 and 45 years old (2). Most patients will not experience obvious symptoms. However, there may be a subset of patients experiencing less common symptomatology such as abdominal and back pain. Perhaps young men experiencing regular, painful bouts of abdominal pain should also be considered for testicular cancer especially if the patient has a history of testicular malignancy.

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Conflict of Interest

The authors declare no conflict of interest in preparing this article.

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Neuronavigation Assistance. Decreased Radiation Exposure During Spinal Surgery in Patients with Severe Combined Trauma

By R.V. Yarmoshuk & M.I. Spitsyn

Summary- The results of studies of intraoperative x-ray radiation with the participation of two groups are presented: the main database using a neuronavigation group and a control group where standard 2D fluoroscopy was used. The radiation load on the operating surgery and operating supporting staff was estimated. Stryker iNtellect ENT Second Generation Navigation for the Injured of RFD Ziehm Vision Core and Optical Converters for the Injured of the Control Group. Variants of visualization using an electron-optical transducer are especially important for minimally invasive procedure where instrumentation is performed percutaneously without direct anatomical control in contrast to open procedures or work with misrepresented anatomical structures in case of injuries. Biplanar fluoroscopy was one of the first methods of intraoperative imaging in real time as well as one of the most advanced technologies in orthopedic and spinal surgery. However, radiation exposure from intraoperative fluoroscopy remains a serious problem for patients, surgeons and supporting staff.

Keywords: intraoperative radiation, neuronavigation, biplanar X-ray electron-optical transducer, individual dosimeter, detector, transpedicular fixation, fluoroscopy, ionizing radiation.

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Neuronavigation Assistance. Decreased Radiation Exposure During Spinal Surgery in Patients with Severe Combined Trauma

R.V. Yarmoshuk [α] & M.I. Spitsyn [σ]

Summary- The results of studies of intraoperative x-ray radiation with the participation of two groups are presented: the main database using a neuronavigation group and a control group where standard 2D fluoroscopy was used. The radiation load on the operating surgery and operating supporting staff was estimated. Stryker iNtellect ENT Second Generation Navigation for the Injured of RFD Ziehm Vision Core and Optical Converters for the Injured of the Control Group. Variants of visualization using an electron-optical transducer are especially important for minimally invasive procedure where instrumentation is performed percutaneously without direct anatomical control in contrast to open procedures or work with misrepresented anatomical structures in case of injuries. Biplanar fluoroscopy was one of the first methods of intraoperative imaging in real time as well as one of the most advanced technologies in orthopedic and spinal surgery. However, radiation exposure from intraoperative fluoroscopy remains a serious problem for patients, surgeons and supporting staff. The negative effects of ionizing radiation lead to cell damage through the induction of deoxyribonucleic acid (DNA) and the release of reactive oxygen species. In this regard, cell death or genome instability occurs which leads to various radiation-related pathologies. It was found that the use of neuronavigation programs can reduce the number of errors, reduce intraoperative trauma and significantly reduce the intraoperative radiation load on the injured, operating surgical and operating supporting staff. The large-scale introduction of navigation technologies will reduce or eliminate the harmful effects of ionizing radiation on the injured and medical personnel.

Keywords: intraoperative radiation, neuronavigation, biplanar X-ray electron-optical transducer, individual dosimeter, detector, transpedicular fixation, fluoroscopy, ionizing radiation.

I. Introduction

Currently, much attention is being paid to the impact of ionizing radiation on patients and medical personnel. This is due to the fact that in almost all fields of medicine, diagnostic search and surgical imaging techniques are closely related to x-ray radiation.

One of the most important diagnostic methods of mankind appeared due to Professor of Physics at the University of Würzburg Wilhelm Conrad Roentgen (1845-1923), who discovered the "X-rays" on November 8, 1895, for which he was later awarded the Nobel prize. It was the time when the era of medical imaging begins, which allows us to objectively assess the quantitative and qualitative pathological processes occurring in the human body.

One of the urgent problems of minimally invasive surgery is the impact of ionizing radiation on the human body, particularly the effect on the structure of deoxyribonucleic acid (DNA), which leads to irreversible changes. Negative effects of ionizing radiation lead to cell damage through DNA induction and the release of reactive oxygen species. In this regard, cell death or genome instability occurs, which leads to various radiation-related pathologies. Children and people of reproductive age are primarily at high risk [1, 2]. This is due to the high intensity of replication processes which occur with damage to the DNA structure under the influence of ionizing radiation, thereby causing mutations in the daughter chain. The probability of transmitting a damaged DNA chain to offspring is currently not confirmed [3].

The most frequent and actively used type of imaging when fixing the spine with transpedicular metal structures is biplane radioscopy.

In the attempts to reduce the risks associated with ionizing radiation to the body, radiation safety has become an important topic in the medical industry. All practitioners regardless of the field of medicine can apply the radiation safety methods, including shielding and distancing to reduce radiation exposure. In addition, detailed adjustment of the parameters for bringing doses of fluoroscopic racks and new imaging techniques can be used as an effective way to reduce the radiation dose [9].

Neuronavigation systems have become a new visualization technique. The main purpose of these systems was to provide a reliable assistance for surgical interventions, to reduce intraoperative radiation load and surgical aggression [4]. While the number of new advanced radiation safety technologies in spinal surgery is not large, much needs to be done to overcome the difficulties and limitations associated with funding, material supply, and a fairly labor-intensive training process.

The use of fixation structures and other implants is particularly relevant in the field of spinal surgery, where instrumentation is often used for the treatment of degenerative, traumatic and neoplastic diseases.

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Screws used for spinal fusion are the most widely used methods of stabilization in spinal surgery, but inaccurate implantation of such structures can lead to significant intraoperative and postoperative complications [6, 11, 13]. In particular, damage to nearby neurovascular structures can occur leading to severe complications or disability of patients.

To ensure high accuracy of placement of metal structures in spinal surgery intraoperative radiography is used as a navigator when placing implants [12, 16]. This imaging option is particularly important in minimally invasive interventions where instrumentation is performed percutaneously without direct anatomical imaging as opposed to open procedures or surgery of misrepresented anatomy in case of injuries.

2D fluoroscopy is the first and one of the most reliable methods of intraoperative navigation in real time and continues to be one of the leading techniques for controlling screw implantation [5, 8, 10].

However, radiation exposure from intraoperative fluoroscopy is a serious problem for patients, surgeons, and operating room support staff [14 – 15, 17 – 18]. Personal protective equipment and the latest imaging techniques such as neuronavigation have been developed in order to reduce the risk associated with intraoperative radiation. Organizations have also been established in our country and abroad that have developed documents and legal acts regulating work with ionizing radiation designed to protect staff and patients from the harmful effects of radiation. In our country the documents regulating work with x-ray radiation are the sanitary rules and regulations "Hygienic requirements for the device and operation of x-ray devices and x-ray research" SanPiN 2.6.1.1192-03, Federal law No. 3 of 09.01.1996 "About radiation safety of the population", Order of the Minister of Defense (MD) of the Russian Federation (RF) of 07.04.2003 No. 111 "Approval of instructions for the organization in military units and institutions using sources of ionizing radiation".

The criteria of these guidelines are designed to protect those who are exposed to excessive radiation exposure in professional practice as well as to reduce the radiation load on the patient. The main international organization developing these guidelines is the International Commission on Radiological Protection (ICRP).

In both national and foreign regulatory documents, the dosage limits are expressed in joules per kilogram (j/kg) otherwise known as Sievert (SV). The latter is a measure of stochastic exposure of ionizing radiation and an exposure of 1 SV is associated with a 5.5% risk of cancer. According to the ICRP guidelines occupational exposure should be limited to a maximum average of 20 mSv per year for no more than a five-year period, with exposure not exceeding 50 mSv per year. Exposures should be strictly limited to a maximum average of 1 mSv per year over a 5-year period for patients [7]. These values can be used as benchmarks for evaluating the safety and effectiveness of new imaging technologies and anti-radiation protection methods. At the same time, when there is a question of saving the life of the injured the standards and doses of ionizing radiation affecting the injured are erased or expanded.

II. Purpose of Research

To prove experimentally that neuronavigation technologies in comparison with standard methods of fluoroscopy can significantly reduce the intraoperative radiation load on the injured, surgeons and auxiliary medical personnel of the operating room.

III. Materials and Methods

The results of 21 patients with combined vertebral-cerebrospinal injury (VCI) who made up the main hard data were analyzed prospectively as well as the results of treatment of 45 patients with severe combined injury (SCI) of spine and spinal cord who made up the control group.

The average age of the injured of the main hard data was 39 years, including 18 men and 3 women. The average value of the severity of combined trauma on the scale of military field surgery-injuries (MFS-I) = 5.8 points.

The injured of this group were operated on for spinal injuries in the clinic of Military Field Surgery (MFS) of the Military Medical Academy named after S. M. Kirov (MMA) in the period from 2017 to 2019. The injured were included in the main hard data according to the following criteria: all of them had combined injuries to the spine and spinal cord, indications for performing posterior spondylodesis based on data obtained by computed tomography (CT) and/or magnetic resonance imaging (MRI), performed when they were hospitalized in the clinic's reception and diagnostic Department (RDD). The use of CT-based intraoperative neuronavigation for spinal surgery has been studied to reduce the use of radioscopy and improve the accuracy of screw implantation.

The average age of the injured of the control group was 33 years, including 35 men and 10 women. The average value of the severity of combined injuries on a scale MFS-Iwas 8.8 points. The injured were operated on at the MFS of MMA clinic between 2011 and 2016.

The injured of both groups had similar spinal injuries (compression-comminuted fractures, fractures-dislocations, spondylolistheses) accompanied by instability and neurological deficit. The spinal operations were performed using standard fluoroscopy.

In the control group, the screws were implanted using classical fluoroscopy using a Vision RFD device manufactured by Ziehm (Germany). Individual

dosimeters (ID) were used to assess radiation exposure from intraoperative fluoroscopy. In the course of the study the radiation dose received by the injured, operating surgeons and other medical personnel of the operating room (anesthesiologists, anesthesiologist and operating nurses, aidmen) was evaluated.

Note that radiation exposure during spinal surgery is a serious risk factor for operating surgeons, staff and patients adversely affecting the body. However, the actual biological effect is determined by cumulative exposure over long periods of time. The cumulative effect of x-rays can be a serious risk to the health of surgeons and medical staff. The radiation dose that affects the body will be affected by the factors such as the distance from the source to the object, screening and the time of the x-ray. The main tasks facing medicine to reduce the impact of ionizing radiation on surgeons and medical personnel are to find ways to reduce radiation load.

To evaluate the received doses of ionizing radiation of surgeons during surgery, the ID was placed on the surgeon:

1) in the orbits and under the surgical magnifying glass, in maximum proximity to the eye (fixed on the bracket), figure 1;

Figure 1: Individual dosimeter fixed in the orbit area

2) In the area of the neck that is not covered by the neck collar (the neck of surgical underwear is fixed) to assess the impact on the thyroid and upper breast (Fig. 2);

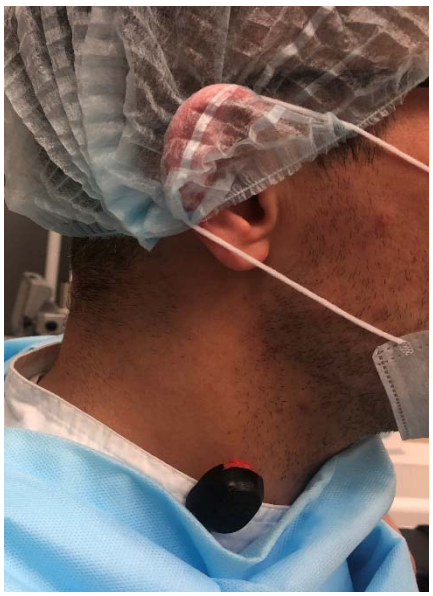

Figure 2: Individual dosimeter fixed in the neck area

3) On the right back surface of the operating surgeon's right hand, in the area of the wrist joint under the surgical glove (Fig. 3);

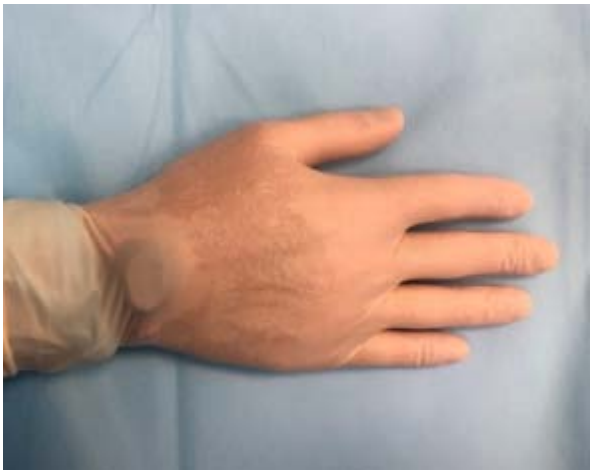

Figure 3: Individual dosimeter fixed in the area of the wrist joint

4) On the surface of the chest and in the groin area under the standard protective apron of the surgeon (Fig.4).

Figure 4: Standard x-ray protection apron

All personal protective equipment is regulated by the interstate standard from 01.01.2015 "Protection Against X-ray Radiation in Medical Diagnostics. Part 3. Protective Clothing", individual dosimeters on the injured were located in the scanning zone (cervical, thoracic, lumbar spine). Tracking the doses of ionizing radiation on the injured for each zone was performed using two IDs to clarify the average value. In the operating room two sensors were placed which were located from the x-ray source at a distance of 1 and 2 m. In addition, we used individual thermoluminescent dosimeters (thermoluminescent solid-state detector TSD-4 TU 50.477-85) of the company "DTU-1". After the surgery the dosimeters were removed from the work area and protected from further radiation.

All the IDs used in our study were identical and the results from all the sensors were recorded on the same device by the same specialist who was responsible for the measurement results. The dosimeters were processed and the measurements were tabulated.

The x-ray source of the electron-optical Converter (EOC) was located in 2 projections (straight and side) in relation to the operating field and on the side opposite to the surgeon (Fig. 5). The injured was not screened in the operating room.

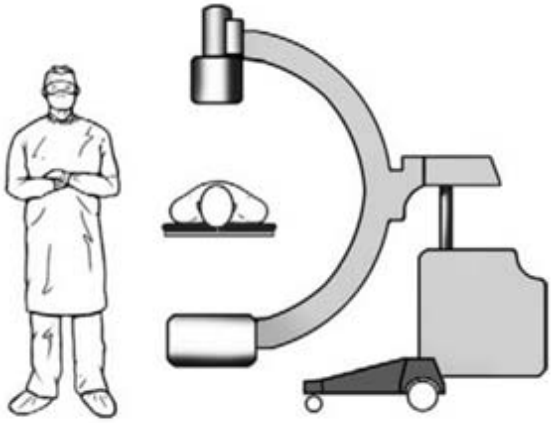

Figure 5: The position of the EOC x-ray source in relation to the patient's back

For the injured of the main hard data the 2nd-generation "iNtellect Navigation" of Stryker (USA) was used to install the transpedicular structure (Fig. 6).

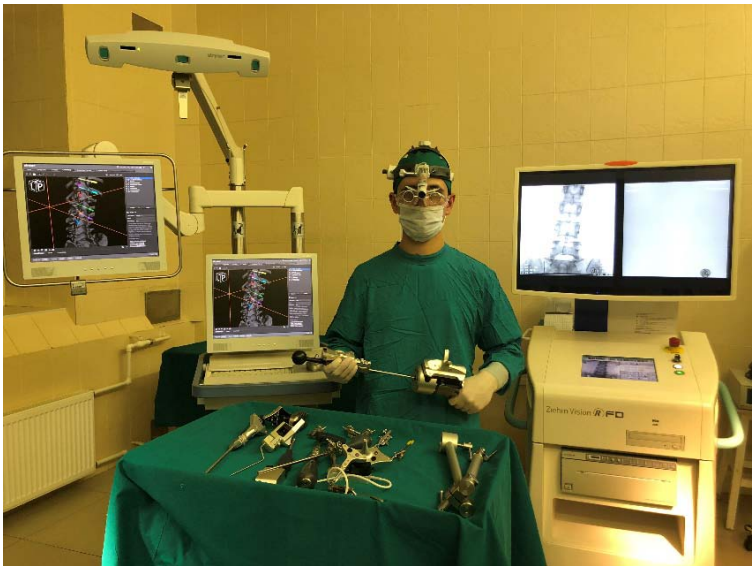

Figure 6: Neuro-navigation rack "iNtellect Navigation" of company "Stryker" (USA) with a set of basic tools

All the injured were operated on using 3D modeling of data obtained during preoperative CT scanning.

Single "forced radiation doses" for diagnostic and therapeutic purposes the so-called average effective doses per examination using medical sources of ionizing radiation were as follows:

- Radiography overview (chest) - 0.150-0.400 mSv;
- Radiography of the limb-0.02 mSv;
- Computed tomography on standard devices – 20 mSv, if the study was performed in the "Whole body" mode and is a native scan-40 mSv. In cases where contrast is introduced during the study – 50 mSv for one study in the "Whole body" mode (the figures may vary depending on body weight, injuries, etc.).

At the same time, the maximum allowable annual rate for personnel working with x - ray radiation is 20 mSv (the periods of receiving this dose should not exceed 5 years); the maximum annual rate for a healthy person is 1 mSv; natural annual radiation for a person is 3 mSv per year; the first signs of radiation sickness are 250 - 300 mSv.

IV. Results and Discussion

It was found that the dose of x-ray radiation during the installation of transpedicular fixation using x-rays on the cervical, thoracic and lumbar spine with a total number for the entire structure was: for the injured in the lumbar spine and pelvic region – 1.22 mSv-1st detector; 1.05 mSv-2nd detector, average value-1.14 mSv (0.11 P), for the thoracic spine and chest cavity organs – 1st detector-2.17 mSv, 2nd detector – 2.0 mSv, average value-2.09 mSv (0.2 P), and the cervical spine – 1st detector – 0.264 mSv, 2nd detector – 0.212 mSv, average value-0.238 mSv (0.023 P).

For the operating surgeon the x – ray radiation dose when fixed on the right hand was-1st Indicator

detector – 1.87 mSv, 2nd detector-0.75 mSv, average value – 1.31 mSv (0.26 p), on the protected thyroid gland– 1st detector – 0.12 mSv, 2nd detector-0.095 mSv, average value – 0.11 mSv, on the head and eye area-1st detector – 0.09 mSv, 2nd detector – 0.07 mSv, average value – 0.08 mSv (0.009 p). In turn, personal protective equipment against x-ray radiation (individual aprons) demonstrated a reliable protection since the radiation dose on dosimeters when working with them was – 0 mSv.

X-ray irradiation doses when installing transpedicular fixations at different levels of the spine on a single screw were as follows: in the cervical spine – 0.034 mSv, in the thoracic spine – 0.075 mSv and in the lumbosacral spine-0.063 mSv.

Indicators of ID located in the operating room at a distance of 1 and 2 m from the x-ray source were 0.3 and 0 mSv (Fig. 7). This location of the ID was necessary to assess the spread of x-rays in the operating room.

Figure 7: Scheme of x-ray radiation spreading in the operating room

This drawing shows the top view of the EOC in the position above the patient. Dosimeters were placed within a radius of 1 and 2 m from the center of the EOC x-ray source. In this case the radiation exposure varies not only with the distance (the lowest radiation dose beyond 2 m), but also with the angle of the x-ray source position in the EOC. Thus, the spreading of rays in a vertical plane is practically absent, but when the source is changed to a horizontal position the rays spread over a distance of 1 m. All radiation dose data obtained in our study are shown in table 2.

Table 2: Table of radiation doses received during the study, mSv

Indicator	Spine Department				
Methods of visualization	cervical spine		thoracic spine		lumbar spine
Radiography (per screw)	0,034		0,075		0,063
Total radiation dose (by parts for the entire operation)	0,238		2,09		1,14
The area of exposure of the surgeon					
Methods	eye socket	Neck	Right arm	Chest	Pelvis
Radiography	0,08	0,11	1,31	0	0
Navigation	0	0	0	0	0
Operating room					
Distance from the x-ray source (during the entire operation), m	1		2		
Radiation dose	0,3		0		

Thus, the average dose of ionizing radiation received by the injured of both groups in the course of treatment and performing forced x-ray diagnostics was from 40.3 to 74.6 mSv (exceeded the annual radiation

exposure for a healthy person by 40 times). Thanks to the use of neuronavigation technologies for spinal operations intraoperative radiation was reduced by 14 times since they performed only 2 control images to clarify the positioning of screws in the vertebral bodies which was 0.15 mSv. Medical personnel in the operating room were not exposed to ionizing radiation at all. Patients of the control group depending on the damaged spine were intraoperatively subjected to additional x-ray irradiation at a dose of 1.15 to 2.1 mSv which is associated with the use of EOC for navigation.

Exposing patients to excessive radiation the doctor of each specialty should understand that it is possible in the long term this radiation may affect the development of neoplastic processes in patients and medical personnel.

Specialists performing surgical interventions using x-ray navigation must use personal protective equipment (aprons and collars) approved by regulatory documents. But despite the measures taken for screening, the surgeon's body remains unprotected places that are exposed to x-ray radiation. For example, the total dose that a surgeon receives for the distal area of the upper limb on average for one operation on the spine or extremities is 1.31 mSv, and for the eye area (depending on the position of the surgeon from the EOP) – 0.08 mSv. Having performed about 15 similar operations, the surgeon already significantly exceeds the professional average annual radiation dose established by regulatory documents. At the same time performing surgical interventions using neuronavigation the surgeon receives a minimal x-ray radiation which in some cases is reduced to zero.

In general, in our opinion in terms of the effectiveness, intraoperative radiation safety and ease of use navigation technologies as a means of intraoperative visualization are the most preferable in comparison with standard methods of radioscopy. At the same time the entire medical staff of the operating room can continuously assist in the process of surgery without being exposed to radiation. The operating room increases the working space associated with bulky equipment and wires. One of the important aspects of its application of navigation technologies for intraoperative visualization is the absence of harmful ionizing effects on the operating surgeon.

V. Conclusions

1. Neuronavigation technologies can significantly reduce the radiation load on the injured, reduce the ionizing effect on surgeons and operating room support staff to almost zero.
2. When using neuronavigation the surgeon has more opportunities to move around the operating table since there are no bulky devices in the form of an ionizing radiation source and an EOC receiving panel that restrict these actions.
3. Due to the absence of constant ionizing radiation in the operating room, all its medical personnel (anesthesiologists, nurses,aidmen) can perform their professional duties during surgery without fear of radiation exposure.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

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Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for writing a good quality Medical Research Paper

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of medical research then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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