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Radiology, Diagnostic Imaging and Instrumentation



Highlights

- Acute Myocardial Infarction
- Identification of Culprit Vessel
- Role of Antenatal Screening
- Perinatal Mortality and Morbidity

Discovering Thoughts, Inventing Future

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Application of Eshelby's Solution to Elastography for Diagnosis of Breast Cancer

By Bonghun Shin, Darindra Gopaul, Samantha Fienberg & Hyock Ju Kwon
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Keywords: *eshelby's solution, elastography, breast cancer, mechanical properties, strain ratio, modulus ratio.*

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APPLICATIONOFESHELBYSSOLUTIONTOELASTOGRAPHYFORDIAGNOSISOFBREASTCANCER

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Application of Eshelby's Solution to Elastography for Diagnosis of Breast Cancer

Bonghun Shin [α], Darindra Gopaul [σ], Samantha Fienberg [ρ] & Hyock Ju Kwon [ω]

Abstract- Eshelby's solution is the analytical method that can derive the elastic field within and around an ellipsoidal inclusion embedded in a matrix. Since breast tumor can be regarded as an elastic inclusion with different elastic properties from those of surrounding matrix when the deformation is small, we applied Eshelby's solution to predict the stress and strain fields in the breast containing a suspicious lesion. The results were used to investigate the effectiveness of strain ratio (SR) from elastography in representing modulus ratio (MR) that may be the meaningful indicator of the malignancy of the lesion. This study showed that SR significantly underestimates MR and is varied with the shape and the modulus of the lesion. Based on the results from Eshelby's solution and finite element analysis (FEA), we proposed a surface regression model as a polynomial function that can predict the MR of the lesion to the matrix. The model has been applied to gelatin-based phantoms and clinical ultrasound images of human breasts containing different types of lesions. The results suggest the potential of the proposed method to improve the diagnostic performance of breast cancer using elastography.

Keywords: eshelby's solution, elastography, breast cancer, mechanical properties, strain ratio, modulus ratio.

I. Introduction

Recently, breast elastography has emerged as a new screening modality for breast cancers.[1-3] Elastography uses palpation principle to detect and classify pathological lesions using elastic properties of tissues.[4] Because pathological lesions are normally stiffer than benign tissues, the strain in the lesion is less than the surrounding tissue under compression.[5] Strains are calculated using the time-gradient of radiofrequency (RF) echo signals[6] or displacement-gradient of B-mode images,[7] obtained before and after a slight compression of the tissue. Resulting strains are displayed as a color-coded image, called elastogram as a map of tissue elasticity.

Elastography can be further classified into strain (or quasi-static) elastography[6] and shear wave (or transient) elastography, [8, 9] according to tissue compression method. In strain elastography, tissue is deformed by applying slight axial compression using a conventional transducer, or alternatively deformation can be produced by respiratory movements. The profile of tissue deformation is converted to a strain map from which elastogram is derived.[6] In shear wave elastography, elastograms are obtained based on the combination of a radiation force induced in a tissue by an ultrasonic beam and an ultrafast imaging sequence capable of catching in real time the propagation of the resulting shear waves.[8, 9] The local shear wave velocity is recovered, enabling the production of a two-dimensional map of shear elasticity.[10]

There have been various efforts to utilize elastography for the diagnosis of breast cancer. It oh et al.[11] proposed a five-point elasticity scoring system on the basis of overall pattern, similar to BIRADS (Breast Imaging Reporting and Data System) criteria[2] for ultrasound (US) and mammogram. It is also known that the size of the tumor determined by elastogram is significantly larger than that in sonogram, only when the tumors are carcinomas.[6] However, most commonly accepted diagnostic measure is strain ratio (SR), [6, 12, 13] which is the ratio of the compressive strain in surrounding tissue to that of a suspicious lesion (also called "observed con- trast"[14] or "strain contrast"[15]). Thomas et al. performed a clinical study to evaluate the performance of SR in differentiating benign and malignant breast lesions.[12] They reported that SR cutoff value of 2.45 allowed significant differentiation ($p < 0.001$) of malignant (5.1 ± 4.2) and benign (1.6 ± 1.0) lesions. Zhi et al. conducted a similar study to compare the diagnostic performance of SR with that of five-point elasticity scoring system.[13] They concluded that SR-based elastography could provide a more reliable diagnostic tool, and the cutoff SR of 3.05 resulted in significant differentiation ($p < 0.00001$) between malignant (8.38 ± 7.65) and benign (1.83 ± 1.22) lesions.

The use of SR as a diagnostic measure is based on the assumption that SR is directly related to modulus ratio (MR: the ratio of the elastic moduli of the inclusion and of the surrounding tissue; also called "true contrast"[14] or "modulus contrast"[15]), which is considered as a true indicator of the malignancy of lesion. However, only a handful of studies are found in the literature that mechanically measured the elastic moduli of breast tissues. Most frequently referred one was conducted by Krouskop et al.[16] which reported that elastic modulus of invasive carcinoma was 5 and 25 times higher than that of normal tissue at the compression levels of 5% and

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20%, respectively. Sarvazyan et al.[17] also reported that fibroadenomas are typically four times stiffer than normal tissue, whereas cancers can be as much as seven times stiffer. More recently, Samani et al.[18] measured the elasticity of breast normal tissues and tumors and reported that breast cancers exhibited 6 to 13 fold increased stiffness compared with normal tissue.

There also have been attempts to infer MR from the measured SR, using either a simplified or continuum mechanical model, via inverse reconstruction schemes. Raghavan and Yagle[19] proposed a direct inversion scheme for recovering shear modulus by deriving a linear system of elasticity equations for the plane–strain condition. The weakness of their approach is that hydrostatic pressure on the boundary must be known to solve the equations. Skovoroda et al.[20] used an analytical method to eliminate the pressure term from the equations. Later on, Skovoroda et al.[5] regarded the inverse problem as an integral rather than a differential form to make the technique less susceptible to measurement noise. Sumi et al.[21, 22] proposed a direct inversion scheme by solving the inverse problem for the plane–stress case, and Le Floc'h et al. [23] extended the concept to the plane–strain case. Barbone and Oberai [24] derived the reconstruction formulae for some special elastic inverse problems, including 2D and 3D, and compressible and incompressible materials. There also have been attempts to view the inverse problem as a parameter optimization problem, where the goal is to find the shear modulus that minimizes the error between measured strain field and those computed by solving the direct problem.[25] For this iterative inversion approach, Hessian-based optimization method, [26-28] gradient-based optimization method, [25,29] and gradient-free optimization method [30-32] were used.

As one of the efforts to relate MR and SR, Kallel et al.[14] used a classical analytic solution of the elasticity equations for an infinite medium subjected to a uniaxial compression to derive a closed form relationship between SR and MR. For incompressible materials ($\nu = 0.5$), they derived the following relationship:

$$MR = 2\,SR - 1. \tag{1}$$

Biligen and Insana[33] also derived an approximate expression for extremely hard inclusion and incompressible materials:

$$MR = 2.5\,SR. \tag{2}$$

Note that the above derivations are limited to 2D with simple inclusion shapes such as sphere or cylinder, although malignant tumors are known to have irregular or ellipsoidal shapes.[34] Therefore, it is essential to derive more general solutions that can relate SR and MR for 3D shapes of inclusions.

Finite element models were also used to estimate the elastic behavior in various types of lesions and surrounding tissues. Kallel et al.[14] investigated the effect of lesion boundary conditions, depth, and modulus contrast on axial strain field by finite element analysis (FEA), assuming planestrain condition and linear elastic materials. Biligen and Insana[33] performed the FEA on an axisymmetric model with a spherical inclusion and concluded that the size of the compressor, location of an inclusion relative to the compressor, and type of compression (uniform stress vs. uniform displacement) alter the strain and stress distributions. Recently, Celi et al.[15] performed the FEA study using simple axisymmetric and more realistic anthropomorphic models. They concluded that simple axisymmetric model has many similarities with the anthropomorphic one and is suitable for elastosonography simulations.

From the point of solid mechanics, breast tumor can be regarded as an elastic inclusion that has different elastic properties from those of the surrounding matrix. Although human tissues show highly nonlinear stress–strain behavior,[35] they can be regarded as linear elastic in the small strain region.[7] In particular, the practice for elastography applies only a small amount of axial compression (typically on the order of 2% strain[36]) to avoid decorrelation errors[4]; therefore, the assumptions of linear elastic inclusion and matrix are reasonable. Based on linear elasticity, Eshelby[37] derived the elastic field inside the elliptic inclusion using the biharmonic potential and Green's tensor. His solution yielded a surprising result that the stress (and strain) within an ellipsoidal inclusion embedded within a matrix subjected to a remote load is homogeneous. In the subsequent paper, 38 he derived that the elastic field outside an ellipsoidal inclusion is given in a form that involves only the harmonic potential of an ellipsoid and can be reduced to a form suitable for numerical calculation of the stress.

We applied Eshelby's solution to the elastic medium containing an ellipsoidal inclusion to determine the elastic fields within and outside the inclusion. Although similar analyses can be pursued by FEA, Eshelby's solution requires much less time and effort than FEA, once the method is established. Also, in general, well-posed analytical approach can yield exact solutions without the issues of meshing effect and/or convergence problem, compared with the approximate solutions from numerical approaches. Compared to inverse methods, Eshelby's solution is much less susceptible to measurement noises and mathematically simpler, and hence requires much less computation. However, current solution is still limited to relatively simple 3D shapes (spheroids).

The results from Eshelby's solution were verified with FEA simulations using axisymmetric models. Based on the results, the relationship between SR and the shape of the inclusion and MR was derived as a simple analytical relationship by using a surface regression

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model, and the relationship was verified using gelatin-based phantoms. The model was further applied to the elastograms of human breasts with different types of lesions, and the results were statistically analyzed to compare the performance of SR and MR in breast cancer screening. This paper concludes that the proposed method adopting MR as an indicator has the potential to better diagnose the malignant tumor than the conventional SR.

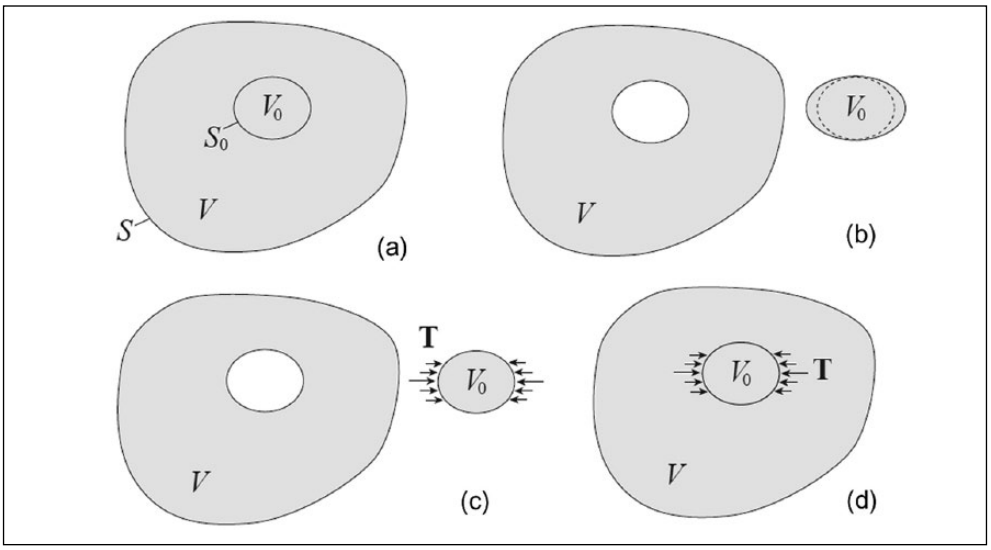


Figure 1: Four steps of a virtual experiment to construct Eshelby's solution: (a) a linear elastic solid with volume *V* and surface *S* (matrix). An inclusion *V0* with surface *S0* is embedded into the matrix; (b) remove the inclusion from the matrix; (c) apply surface traction T to *S0* to make the inclusion return to its original shape; (d) put the inclusion back to the matrix and remove the traction T.

a) Eshelby's Solution

Eshelby[37,38] proposed a general method to derive the local strain and stress fields which can be induced by remote loading applied to an elastic infinite matrix V_0 (phase 0) containing an ellipsoidal inhomogeneous inclusion V_1 (phase 1; Figure 1a). Remote loading implies that stress is uniformly distributed over the matrix without causing local distortions or strain concentrations. He solved this problem elegantly by the superposition principle and the Green's function, through the four steps of a virtual experiment:

- *Step 1:* Remove the inclusion from the matrix (Figure 1b). Then the inclusion is strained due to loss of constraint from the matrix (eigenstrain ε^{**}).
- *Step 2:* Apply the surface traction T to S_0 in order to make the inclusion return to its original shape (Figure 1c). The elastic strain of the inclusion should exactly cancel the eigenstrain.
- *Step 3:* Put the inclusion back to the matrix. The same force *T* is applied to the inclusion surface S_0 (Figure 1d). There is no change in the strain fields in either the inclusion or the matrix from Step 2.
- *Step 4:* Now remove the traction *T*. This makes the problem return the original inclusion problem in Figure 1(a). The change from Step 3 to Step 4 is equivalent to applying a can- celing body force F = −T to the inclusion surface S_0 of the elastic body.

Steps 1 to 4 can be mathematically derived in terms of the Green's function of the elastic body. The strain and stress inside the inclusion can be expressed as:

$$\boldsymbol{\varepsilon} = \boldsymbol{\varepsilon}^0 + \mathbf{S} : \boldsymbol{\varepsilon}^{**}, \tag{3}$$

$$\boldsymbol{\sigma} = \boldsymbol{\sigma}^0 + \mathbf{C}^0 \cdot [\mathbf{S} - \mathbf{I}] : \boldsymbol{\varepsilon}^{**}, \tag{4}$$

where $\boldsymbol{\varepsilon}^0$ is the remote strain, $\boldsymbol{\varepsilon}^{**}$ the eigenstrain, $\boldsymbol{\sigma}^0$ the remote stress, C^0 the stiffness tensor of the matrix, and I the identity tensor.[39] If the entire medium is loaded by the specified remote stress tensor $\boldsymbol{\sigma}^0$, then the corresponding strain $\boldsymbol{\varepsilon}^0$ is derived by Hooke's law:

$$\boldsymbol{\sigma}^0 = \mathbf{C}^0 : \boldsymbol{\varepsilon}^0. \tag{5}$$

Eshelby S tensor is a function solely of the ellipsoid dimensions and the Poisson's ratio of the matrix.[40] Explicit expressions for the components of S for various shapes of ellipsoid have been given by Mura,[40] and in more general form by Ju and Sun.[39,41] In Equations (3) and (4), the eigenstrain $\boldsymbol{\varepsilon}^{**}$ can be derived as:

$$\boldsymbol{\varepsilon}^{**} = (\mathbf{S} + \mathbf{A})^{-1} : (\mathbf{B} : \boldsymbol{\varepsilon}^t - \boldsymbol{\varepsilon}^0), \tag{6}$$

where $\boldsymbol{\varepsilon}^t$ is the prescribed eigenstrain, and the fourth-order mismatch tensors A and B are defined as:

$$\mathbf{A} = \left[\mathbf{C}^1 - \mathbf{C}^0\right]^{-1} \cdot \mathbf{C}^0, \ \mathbf{B} = \left[\mathbf{C}^1 - \mathbf{C}^0\right]^{-1} \cdot \mathbf{C}^1. \tag{7}$$

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For the external field, that is, points outside of the inclusion, stress and strain varies with position as follows:

$$\boldsymbol{\varepsilon}(\mathbf{x}) = \boldsymbol{\varepsilon}^{\mathbf{0}} + \overline{\mathbf{G}}(\mathbf{x}) : \boldsymbol{\varepsilon}^{**}, \quad \mathbf{x} \in V^0, \tag{8}$$

$$\boldsymbol{\sigma}(\mathbf{x}) = \boldsymbol{\sigma}^{\mathbf{0}} + \mathbf{C}^{\mathbf{0}} \cdot \overline{\mathbf{G}}(\mathbf{x}) : \boldsymbol{\varepsilon}^{**}, \quad \mathbf{x} \in V^0, \tag{9}$$

where x is a position vector, G(x) another fourth-order tensor which is a function of the ellipsoid geometry, Poisson's ratio of the matrix and the coordinate position.[38,40] The explicit expressions for all components of G(x) are provided by Ju and Sun.[39,41]

These mathematical solutions were coded into MATLAB functions (see the appendix) to calculate the elastic fields inside the inclusion and in the matrix. Key inputs of the code are elastic modulus *E*, Poisson's ratio ν, remote stress $\boldsymbol{\sigma}^0$, and the size of the inclusion. Prescribed eigenstrain $\boldsymbol{\varepsilon}^t$ is also an input, but merely 0 for the current applications. From those inputs, the code calculates eigenstrain $\boldsymbol{\varepsilon}^{**}$, Eshelby tensor S to finally produce the strain $\boldsymbol{\varepsilon}(x)$ and stress $\boldsymbol{\sigma}(x)$ fields, in the matrix and inclusion, respectively, as key outputs.

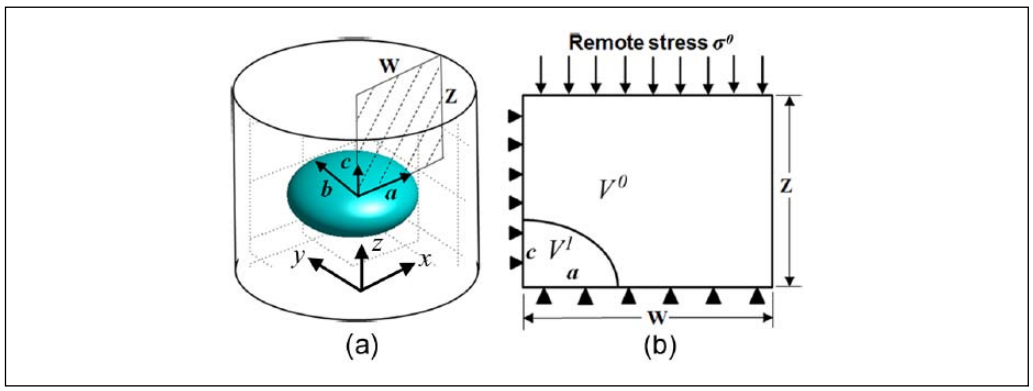


Figure 2: (a) Geometry of an ellipsoidal inclusion embedded in a matrix and (b) an axisymmetric FEA model (dotted area in (a)). Remote stress $\boldsymbol{\sigma}^0$ is applied to the top, and left and bottom edges are constrained in the *x*- and *z*-directions, respectively. In (a), position of coordinate system is arbitrary. FEA = finite element analysis.

II. Materials and Method

a) FEA Simulation

FEA simulations were performed to verify the results from Eshelby's solution using a commercial FEA code (Abaqus 6.10). Assuming inclusions in spheroidal shapes (ellipsoid of revolution), simulations were performed using axisymmetric models as depicted in Figure 2. Note that for axisymmetric models, axisymmetric FEA simulation is identical to 3D FEA.

The size and shape of the spheroidal inclusion is defined by the axes *a, b*, and *c* in *x*-, *y*-, and *z*-directions, respectively, as shown in Figure 2(a). The shape of the matrix is described by a cylindrical volume with height 2*Z* and diameter 2*W*. The matrix and inclusion are each homogeneous with isotropic elastic properties that are described by the elastic modulus E^0 and E^1, and Poisson's ratio ν^0 and ν^1, respectively. The interface between matrix and inclusion is assumed to be perfectly bonded. An 8-node quadratic axisymmetric quadrilateral element with reduced integration (CAX8R in Abaqus 6.10) was used, and the linear elastic deformation was assumed. In the elastography simulation, a static compressive force (remote stress $\boldsymbol{\sigma}^0$ in Figure 2b) was applied to the top surface of the cylinder, while left and bottom edges are constrained in the x- and z-directions, respectively.

b) Displacement-Gradient Elastography (DGE)

Digital image cross-correlation method was applied to B-mode US images to determine the displacement field developed by the compression.[42] To suppress the decorrelation errors in large deformation, dynamic referencing scheme[43,44] was used. Strains were calculated using displace- ment gradients as:

$$\varepsilon_x = \frac{\partial u_x}{\partial x}, \qquad \varepsilon_y = \frac{\partial u_y}{\partial y}, \tag{10}$$

and the roughness of strain field was reduced by applying smoothing algorithm.[45] Graphical representation of the resulting strain map is called DGE elastogram.

c) Gelatin Phantoms

Gelatin-based phantoms were designed to contain an inclusion with higher stiffness than the surrounding matrix, mimicking a carcinoma in a normal breast tissue.[46] Inclusions and matrixes were made with the same constituents to have the similar echogenicity, that is, 1 wt% agarose (J.T. Baker), 2 wt% glutaraldehyde (Sigma-Aldrich), 5 wt% n-propanol (Fisher-Scientific), gela- tin (Fluka; 20 wt% for inclusion and 5 wt% for matrices), and distilled water (the remaining wt%). The procedure to fabricate the phantoms is illustrated in Figure 3.[42]

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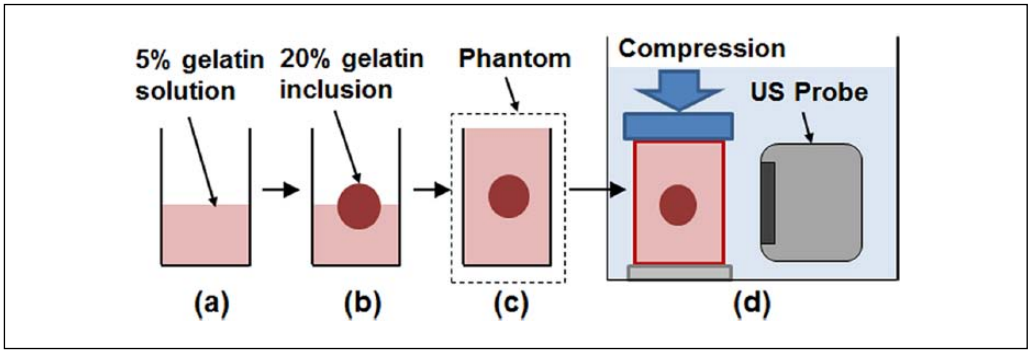


Figure 3: Schematics of phantom fabrication procedure and US imaging setup: (a) 5% gelatin solution was poured into the mold in half; (b) the solid inclusion containing 20% gelatin was placed on the solution; (c) gelatin solution was poured to fill the rest of the mold, and the mold was kept at room temperature for 48 hr for gelation; (d) for US imaging, the phantom was compressed while the US probe acquired US images. US = ultrasound.

Fabricated gelatin phantoms were US imaged using a commercial US scanner (Accuvix XQ, Medison, South Korea), while it was being compressed up to 10% strain at the loading rate of 100 μm/s. During compression, US images were taken with the US probe (L6-12IS, 6-12MHz) placed in the direction perpendicular to the axis of cylindrical inclusion (Figure 3d).

Stress–strain relationships of gelatin inclusion and matrix were determined by conducting separate compression tests on cylindrical samples with aspect ratio of 1 (height and diameter 4 cm each) that were additionally made at each formula. Each sample was loaded up to the engineering strain of 10% at 100 μm/s loading rate using TA material testing machine (Stable Micro Systems, England) with a 50 N load cell.

d) Clinical Applications

Small-scale clinical study was performed on 45 volunteer patients with different BIRADS lesions in their breasts. Patients underwent breast US imaging with Philips IU22 XMTRAIX US system in the Grand River Hospital (Kitchener, Ontario, Canada). US images were taken by a US technologist by applying a slight compression to the breast with a US probe (L17-5). DGE elastograms were produced by applying DGE method to US images. After imaging, all of the lesions were examined histologically with biopsy, but results had been kept until the end of analyses for nonbiased assessment.

III. Results and Discussion

a) Spherical Inclusion

Eshelby's solution was applied to a numerical phantom where a spherical inclusion (E^1 = 50 kPa) was embedded in the matrix (E^0 = 10 kPa) (MR = 5) and remote stress (σ^0 = 1 kPa) was applied in z (axial) direction. Remote strain in the matrix was 0.1 ($\varepsilon^0 = \sigma^0/E^0$). Poisson's ratios of both inclusion and matrix were assumed to be 0.45. Figure 4(a) and (b) show the 3D plots of axial stress (σ_z) and strain (ε_z) fields, and Figure 4(c) and (d) present axial stress and strain distributions in the x–z quarter-plane, respectively. As predicted by Eshelby,[4] stress and strain within the inclusion are uniform at 1.605 kPa and 0.0366, respectively. However, stress and strain varies significantly across the matrix. Highly concentrated stress and strain zones are formed right above the inclusion in the axial (z) direction, whereas significantly low stress and strain are observed right beside the inclusion in the lateral (x) direction. In the matrix far from the inclusion, stress field can be divided into two regions by the borderline inclined at about 45° (Figure 4c). Above the line, the stress is higher (1010~1250 Pa) than the applied stress, while lower (940~995 Pa) below the line. Meanwhile, strain field in the matrix (Figure 4d) can be divided into three regions: upper region with the strain higher than the remote strain (0.13~0.11), upper-right region with lower strain (0.092~0.099), and lateral region with the strain almost the same as the remote strain (0.1~0.103).

The effects of MR on strain fields were investigated by varying the modulus of spherical inclusion. Figure 5(a) and (b) show the strain field of phantoms containing an inclusion with MR = 2 and MR = 10 at 0.1 remote strain, respectively. Strain inside the inclusion decreases with the increase of MR (0.0696 at MR = 2; 0.0204 at MR = 10); however, far-field strain distribution in the matrix is not affected much by the change of MR. Particularly, the shape and the strain levels in the lateral regions are almost identical regardless of the change in inclusion modulus.

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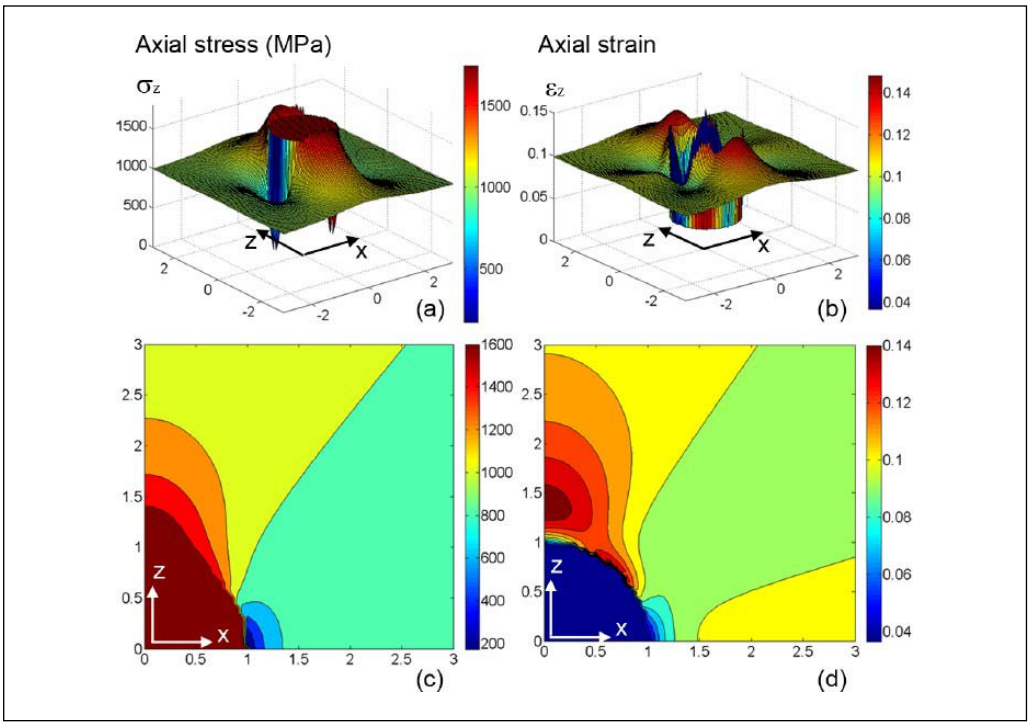


Figure 4: Axial stress and axial strain fields in the numerical phantom containing a spherical inclusion determined by Eshelby solution: (a) 3D axial stress, (b) 3D axial strain, (c) 2D axial stress, (d) 2D axial strain.

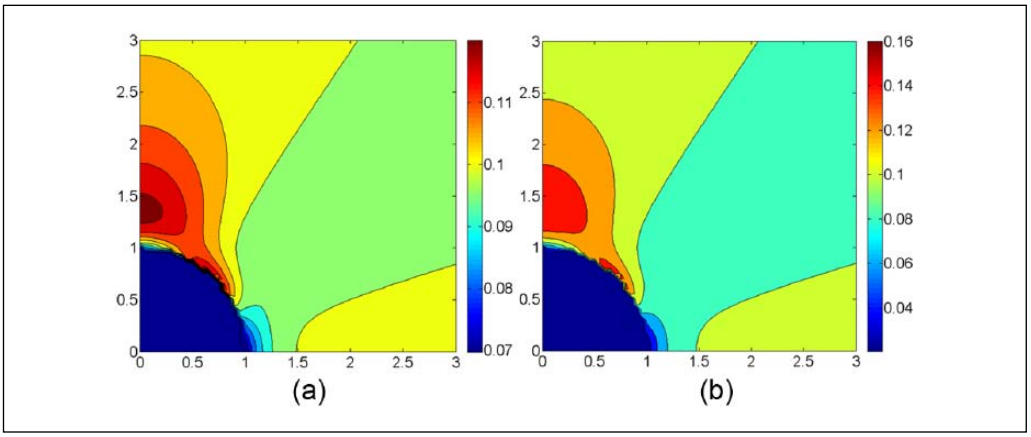


Figure 5: Strain fields in the numerical phantom containing a spherical inclusion embedded in the matrix under 0.1 remote strain: (a) MR = 2 and (b) MR = 10. MR = modulus ratio.

b) FEA Simulation

The results from Eshelby's solution were compared with those from FEA simulations using the same materials properties and boundary conditions. Axial stress and strain fields from FEA (Figure 6a and b) show excellent agreements with those from Eshelby's solution (Figure 4c and d). Results from FEA also confirm that the stress and strain levels inside the inclusion are almost uniform at 1.605 kPa and 0.0363, consistent with Eshelby's solution.

The variations of axial stress and strain from Eshelby's solution and FEA are plotted together along axial (z) and lateral (x) directions in Figure 6(c) and (d), respectively. It is notable that influences of the inclusion on both stress and strain persist much farther along axial direction than along lateral direction. Particularly the strain level converges on remote strain at a distance of about 1.5a (a: inclusion radius) in lateral direction, whereas it is still varying even at a distance of 3a in axial direction (Figure 6d).

In estimating the SR from elastogram, ideally matrix strain should be measured at an infinite distance from the inclusion. However, due to limited field of view of elastogram, measurements at the distance farther than twice the size of inclusion are usually unavailable. Among the three remote regions in the matrix (Figure 4d and b),

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the strain in the lateral region is relatively uniform (less than 3% deviation) and almost equal to remote strain (Figure 6d); thus, this region can be regarded as the best domain to measure the matrix strain. The strain plots in Figure 6(d) also indicate that the measurement should be made farther than a half-radius distance away from the inclusion to avoid the effect of inclusion.

c) MR versus SR—Spherical Inclusion

Results from Eshelby's solution and FEA clearly indicate that the stress inside the inclusion is more than 50% higher than the remote stress (1.605 kPa vs. 1 kPa in Figure 6c); furthermore, the strain is almost 80% higher than that directly obtained from Hooke's law (0.0366 vs. 0.02 in Figure 6d). As a result, SR value estimated from elastogram is much lower than the actual MR value (2.78 vs. 5.0). This type of discrepancy has been identified as the fundamental limitation of elastography[31]; thus, it was further investigated with Eshelby's solution to better understand the transfer characteristic of SR with respect to MR.

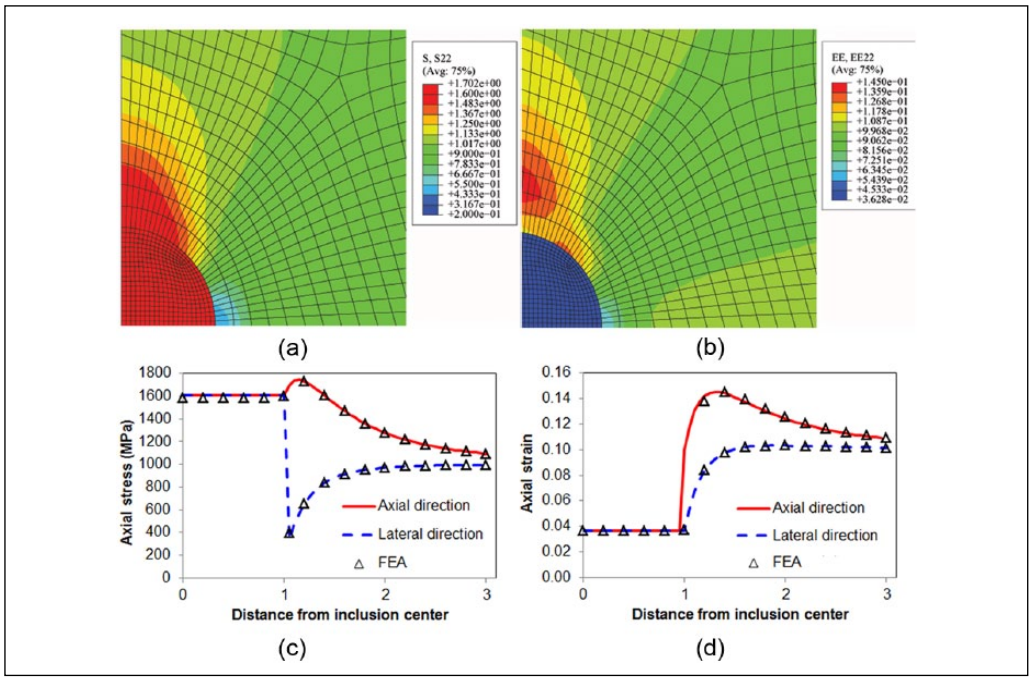


Figure 6: FEA simulation results: axial stress (a) and axial strain (b) distributions in the numerical phantom containing a spherical inclusion. The plots of axial stress (c) and axial strain (d) along axial (y) and lateral (x) directions from the inclusion center (inclusion radius = 1). Inclusion is five times stiffer than the matrix ($E^1/E^0 = 5$). Solid lines and triangles are predicted by Eshelby's solution and FEA, respectively. FEA = finite element analysis.

For the wide range of MR from −20 dB to 20 dB, SR was predicted with Eshelby's solution, as presented in Figure 7(a). It is notable that the SR curve is highly dependent on the MR that is proportional to inclusion modulus when matrix modulus is unchanged. For hard inclusions (MR > 0 dB), the curve follows the ideal curve with a relatively constant gap; however, for soft inclusions (MR < 0 dB), it shows significant deviation from the ideal curve.

Contrast-transfer efficiency (CTE) is sometimes expressed using the ratio of the observed contrast (SR) from the elastogram to the true contrast (MR) of the materials in decibels as[31]:

$$\eta(\mathrm{dB}) = |\mathrm{SR}(\mathrm{dB})| - |\mathrm{MR}(\mathrm{dB})|. \qquad (11)$$

CTE was predicted with Eshelby's solution, as plotted in Figure 7(b). CTE reaches the maximum when MR = 0 dB, that is, the inclusion and the matrix have the same modulus. The efficiency degrades rapidly as the inclusion becomes harder or softer.

In the medical practice using elastography, critical MR range for the diagnosis of the malignancy of the lesion is usually less than 2016; thus, the variation of SR for the MR range from 0.1 to 20 is plotted on a linear scale in Figure 7(c). The relationship between SR and MR is perfectly linear in this range, similar to the first-order relationship proposed by Kallel et al.14 SR (solid line) is less than a half of MR (dotted line) in most of the tested region, except for small MR (<1.28). The relationship is expressed as a first-order linear equation in Figure 7(c). Note that this relationship is valid only for spherical inclusion.

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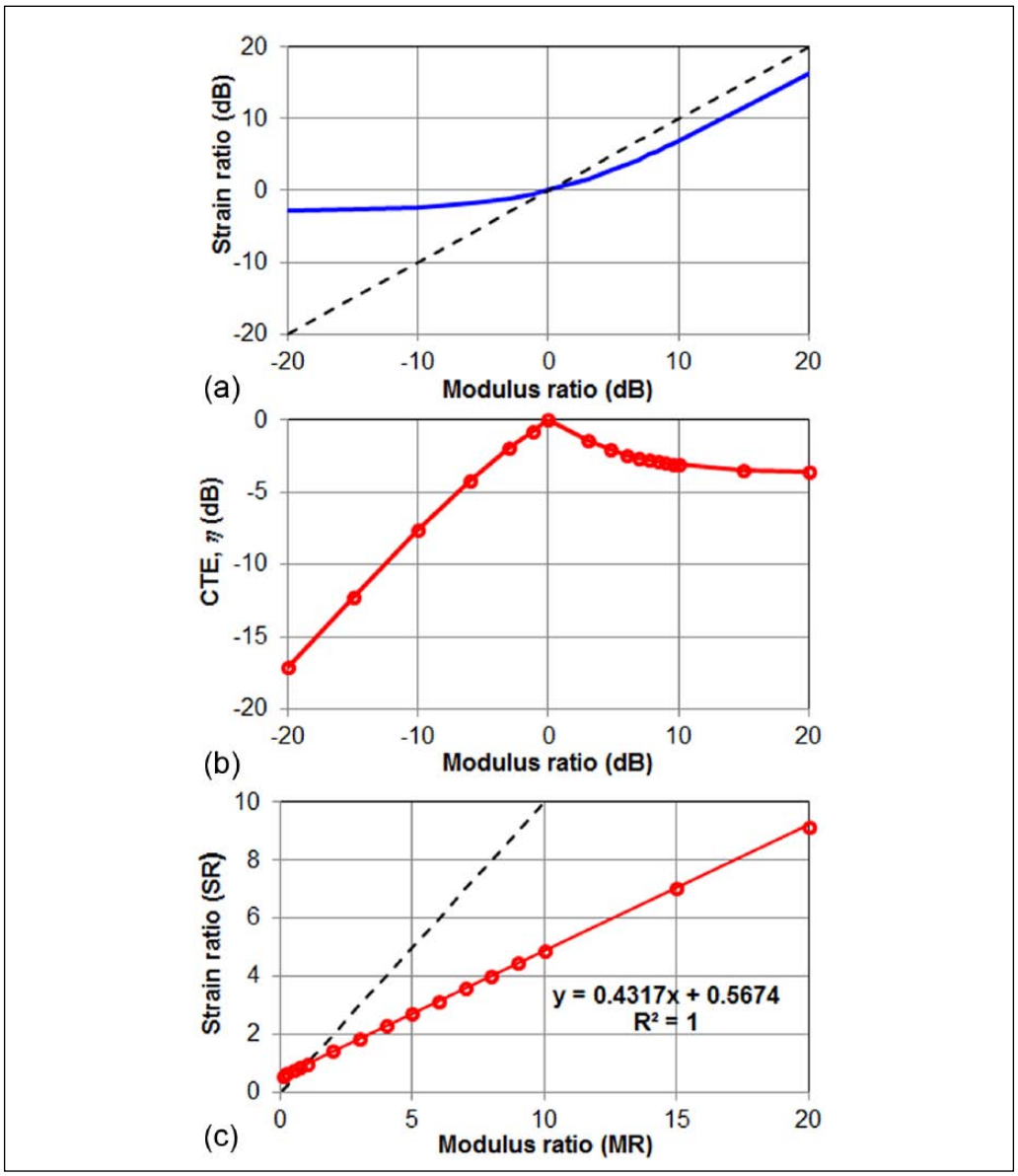


Figure 7: (a) Transfer characteristic curve of elastography predicted by Eshelby's solution (solid line) versus ideal curve (dotted line) on a log scale. (b) Contrast-transfer efficiency curve on a log scale. (c) SR versus MR on a linear scale. Dotted line is an ideal curve. SR = strain ratio; MR = modulus ratio.

d) Ellipsoidal Inclusion

It is known that benign and malignant lesions could differ significantly in shape. An adenoma (benign glandular lesion) has a more regular (close to spherical) shape whereas an adenocarcenoma (malignant glandular tumor) has an irregular or ellipsoidal shape.[17] The effect of ellipticity of an inclusion on SR was investigated by Eshelby's solution using the phantoms containing prolate (a = b = 0.2, c = 1, where a, b, and c are the x, y, and z axis, respectively; Figure 8a) and oblate (a = b = 1, c = 0.2; Figure 8c) spheroids. Although strain fields within the matrix can be divided into three regions and the strain level in each region is close to that around spherical inclusion (Figure 8b and d), the strains within the spheroidal inclusions are significantly different from those in the spherical inclusion. For example, the strain inside the prolate inclusion (0.0683 in Figure 8b) is much higher than that inside the oblate inclusion (0.0396 in Figure 8d). As a result, SR value varies significantly depending on the ellipticity of the inclusion.

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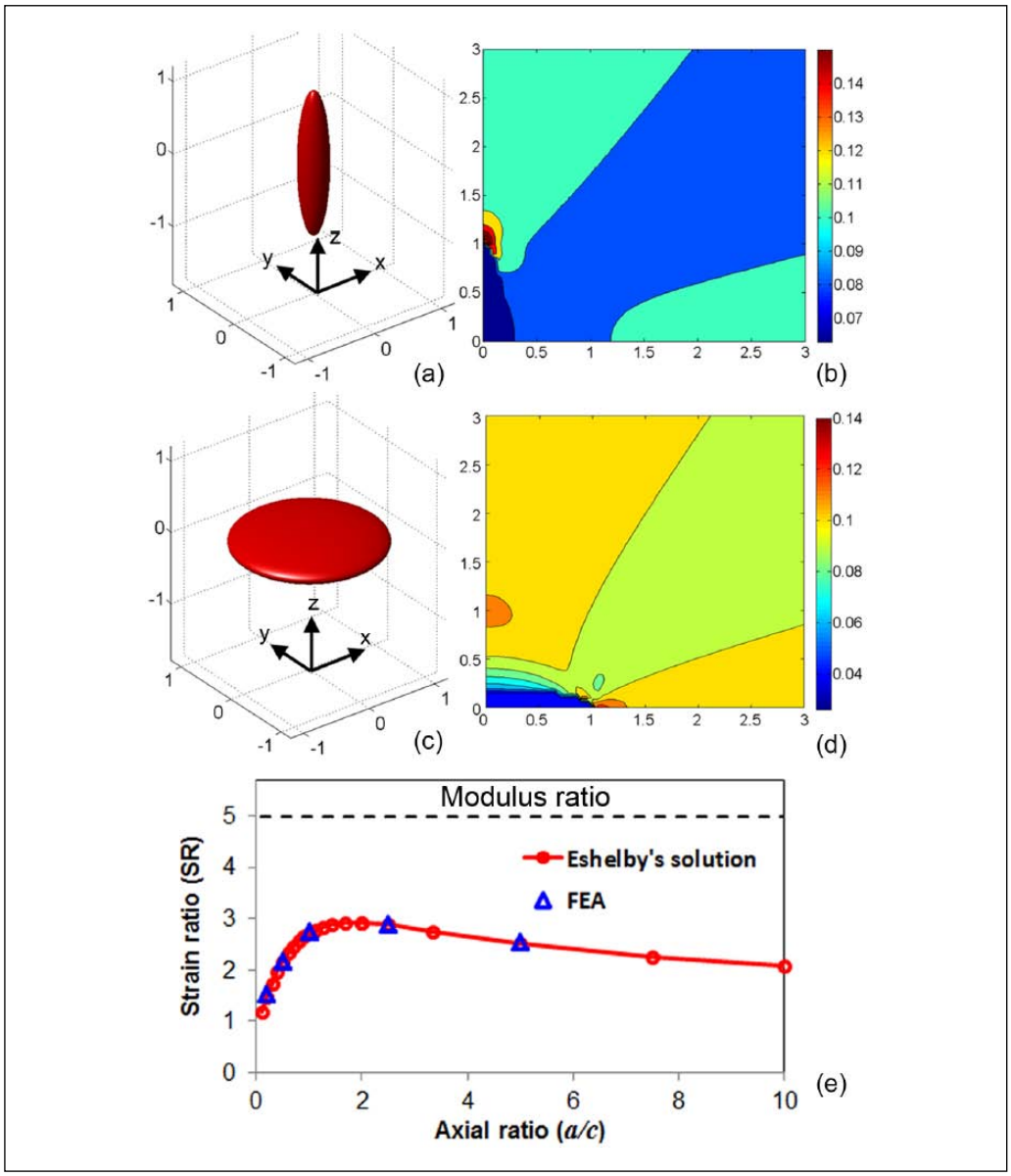


Figure 8: Elastic fields in the phantoms containing spheroidal inclusions: (a) a prolate inclusion (a = b = 0.2, c = 1), (b) the strain field around a prolate phantom, (c) an oblate inclusion (a = b = 1, c = 0.2), and (d) the strain field around an oblate inclusion. (e) Variation of SR (solid line) versus ideal curve (dotted line) against axial ratio (a/c). SR = strain ratio; FEA = finite element analysis.

Table 1: Strain Ratios for Various Axial Ratio and Modulus Ratios.

				a/c			
Modulus Ratio	0.5	1	1.333333	2	4	6.666667	10
1	1	1	1	1	1	1	1
2	1.548	1.392	1.358	1.34	1.386	1.456	1.514
4	2.132	1.74	1.66	1.632	1.768	1.976	2.18
6	2.442	1.896	1.794	1.764	1.956	2.268	2.592
8	2.632	1.984	1.872	1.84	2.072	2.456	2.872
10	2.76	2.04	1.92	1.89	2.15	2.58	3.07

The variation of SR with respect to the axial ratio (a/c) is predicted by Eshelby's solution and plotted (circle) in Figure 8(e). For verification purpose, some data points were also determined by FEA and plotted on the same graph (triangle). Figure 8(e) indicates that SR reaches the maxi- mum (2.92) when a/c is 2, and decreases with the change of a/c in both directions, more rapidly in prolate direction. Note that the maximum SR value of 2.92 is still much lower than the actual MR (5.0, dotted horizontal line).

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e) Surface Regression Model

SRs for various combinations of a/c and MR are summarized in Table 1. Because SR varies non- linearly against a/c, linear regression models such as Equation (1)[14] or Equation (2)[33] cannot be adopted for ellipsoidal inclusions. Instead, we considered a surface regression model with two predictor data (SR and a/c) and one response data (MR). This was achieved by applying a surface-fitting tool in Matlab (R2012b), cftool, to the data in Table 1. Using a polynomial regression model, MR could be formulated as a coupled polynomial equation of the order 4 × 2 as follows:

$$MR = p00 + p10\,x + p01\,y + p20\,x^2 + p11\,xy + p02\,y^2 + p30\,x^3 + p21\,x^2y + p12\,xy^2 + p40\,x^4 + p31\,x^3y + p22\,x^2y^2. \quad (12)$$

where x = a/c, y = SR, and the coefficients are listed in Table 2. Good agreement was obtained between the model and the data in Table 1 ($R^2 = 0.992$). Figure 9(a) shows the fitted surface from the model to the data in 3D and Figure 9(b) illustrates the 2D contour plot of the same surface.

f) Gelatin-Based Phantoms

The polynomial function in Equation (12) was applied to gelatin phantoms containing a spherical inclusion. MR was estimated first by performing the compression tests on 20% (inclusion) and 5% (matrix) gelatin cylindrical samples. Representative engineering stress–strain curves from the compression tests are shown in Figure 10. Loading curves were regarded as linear with R^2 value 0.9971 and 0.9849, for 20% and 5% gelatin content samples, respectively. Loading modulus was determined to be 51 ± 2 kPa and 10 ± 1 kPa for each content, respectively.

Table 2: Coefficients of Polynomial Regression Function in Equation (12).

p^{00}	p^{10}	p^{01}	p^{20}	p^{11}	p^{02}
−2.439	−0.4783	4.827	0.747	−1.887	−0.2935
p^{30}	p^{21}	p^{12}	p^{40}	p^{31}	p^{22}
−0.1538	0.3153	0.166	0.00832	−0.0136	−0.0135

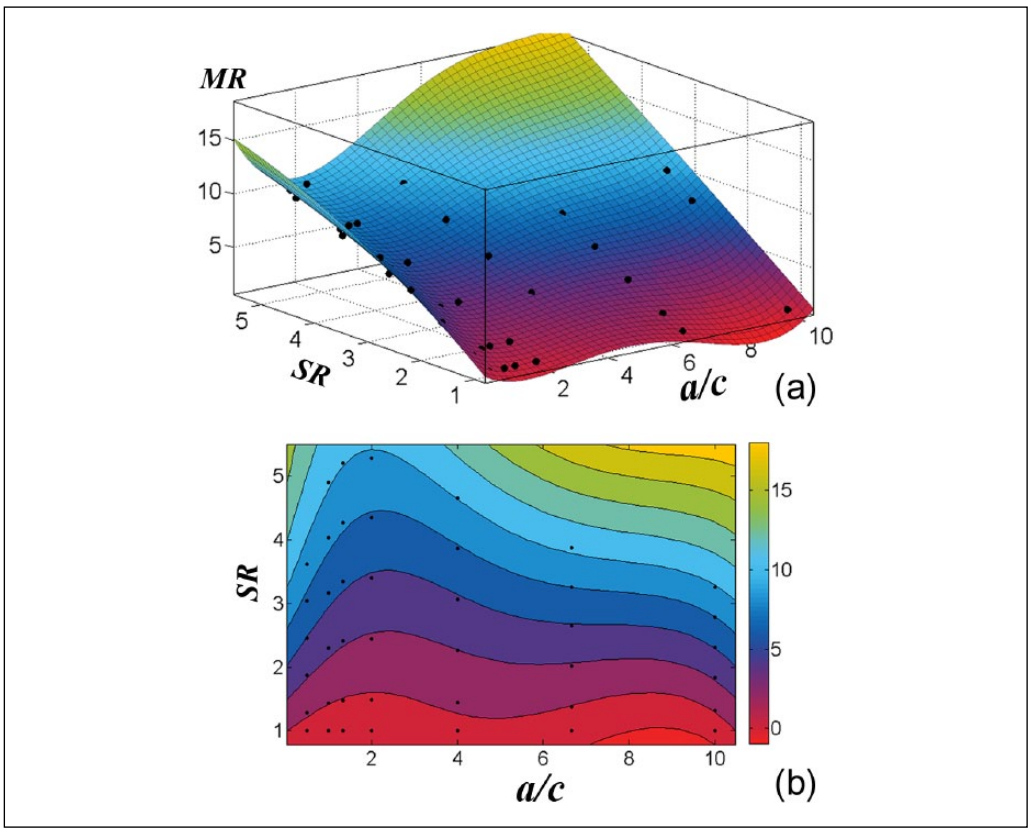


Figure 9: Surface fitting of a 4 × 2 polynomial function to the data in Table 1: (a) 3D surface plot, and (b) 2D contour plot. MR = modulus ratio; SR = strain ratio.

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To estimate the SR, gelatin phantoms were US imaged from the side while compressive loading was applied to the top (arrows in Figure 11a) and the DGE elastograms were generated from the US images. Figure 11(b) is the elastogram of a phantom compressed at 10% strain. Consistent with Eshelby's solution, strain field within the inclusion is almost uniform at 0.036, while the strain significantly varies in the matrix. As discussed in the previous section, the measurement of matrix strain should be made in the lateral region (circled region A) which is distant from the inclusion center by more than 1.5 times of the inclusion radius in the lateral direction. Region B is also a candidate, but the region closer to the probe is generally preferable. Measured strain is 0.1 at A; thus, SR is calculated to be 2.78. By substituting the SR into Equation (12), MR is estimated to be 5.60. These results are close to the predictions from Eshelby's solution (SR = 2.73) and actual MR (5.1).

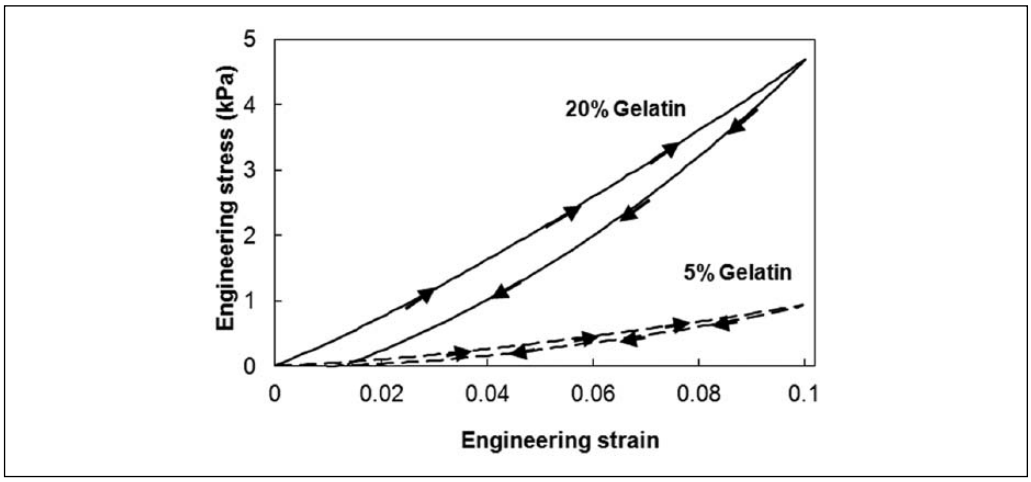


Figure 10: Engineering stress–strain curves for 20% (solid line) and 5% (dotted) gelatin samples from simple compression tests.

Figure 11(c) is the elastogram of a phantom where a part of the inclusion is dissolved into the matrix, mimicking a carcinoma infiltrating into the surrounding tissue. In this image, the strain in the right side of the inclusion cannot be measured due to the infiltrated domain, thus the strain in the left side of inclusion (circled region) is measured as a matrix strain (0.11). The strain level inside the inclusion is 0.035 and the SR is calculated to be 3.05, which are slightly higher than that of spherical inclusion. Assuming the axial ratio of 1.5, MR is estimated to be 5.46 that are consistent with the actual MR value.

Strain field in the matrix can be distorted or localized due to inhomogeneous lesions or local loadings. Figure 11(d) shows highly concentrated compressive deformation above the inclusion, which is caused by the locally concentrated loading on top of the phantom. Although strain field varies significantly along the loading direction, strain along the lateral direction is relatively consistent, and the measured strain value is almost the same as the applied strain (0.1). Inclusion strain is also uniform at 0.035, thus the SR (2.86) is almost the same as the other cases, and the MR is estimated to be 5.8 for circular inclusion.

The above results indicate that elastic fields in the elastograms of gelatin-based phantoms are well predicted by Eshelby's solution. Furthermore, the surface regression model proposed in Equation (12) can successfully predict the actual MRs of gelatin phantoms. Therefore, the pro- posed method has the potential to improve the diagnostic performance of elastography in breast cancer screening practice, as described in the subsequent sections.

g) Clinical Applications

Human breasts are made up of fatty tissue with epithelial and stromal tissues and a number of masses inside, each of which has different echographic properties. Naturally, US and elastogram images commonly contain complex and noisy patterns, which require particular attention for the understanding and the utilization of them. This is particularly true for BIRADS 3 and 4 lesions that are occasionally misdiagnosed even by experienced radiologists. Several case studies are presented here for the lesions in different BIRADS categories.

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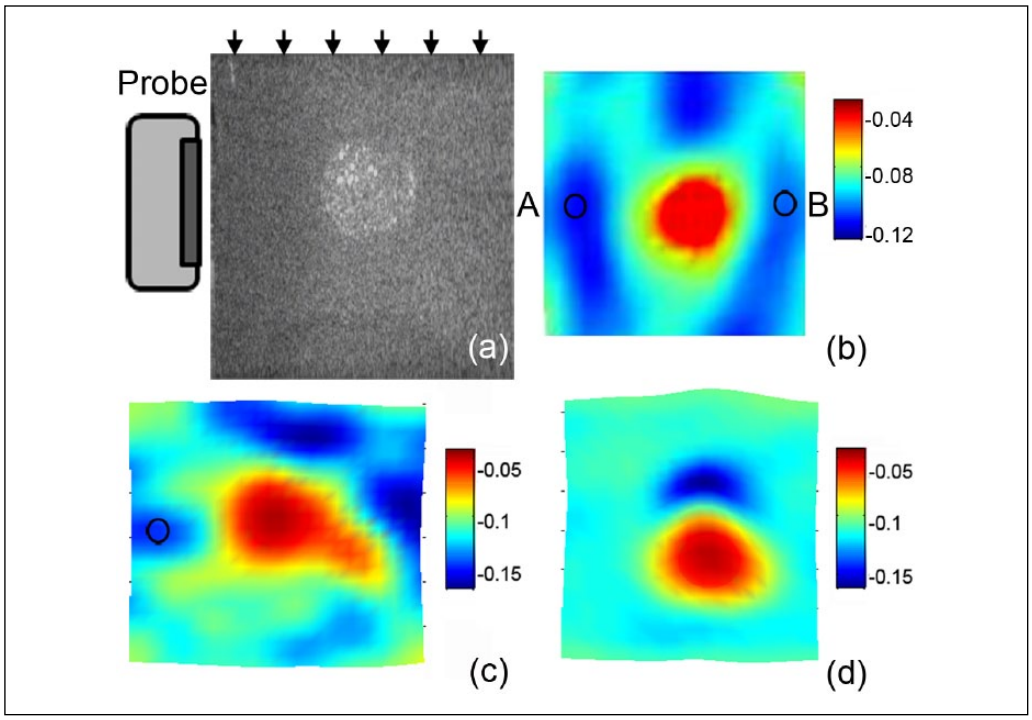


Figure 11: (a) US image of a gelatin phantom containing a stiff inclusion (E^1/E^0 = 5.1). Elastograms of gelatin phantoms with; (b) circular inclusion compressed up to 10% strain; (c) partially dissolved inclusion mimicking infiltrating carcinoma; (d) locally deformed matrix.

Case 1: BIRADS 4 Lesion—Malignant

Figure 12(a) are the US image of a BIRADS 4 lesion where compressive load was applied to the top side of the image, and the elastogram produced from the dotted rectangular region in the US image. The elastogram shows that there is a stiff oblate lesion in the center deformed at about −0.008 strain. Matrix strain is hard to be estimated, as the lateral strains are not consistent along lateral direction, that is, the strain in the right side of the inclusion is much higher (−0.06) than that in the left side (−0.042). However, another stiff lesion can be seen in the right-bottom corner, and the tissue between two stiff lesions might be under higher local deformation. Therefore, the strain in the left side of the inclusion is regarded as the matrix strain, and the SR is estimated to be 5.25. Taking the a/c of 2.5, MR is estimated to 9.79 from Equation (12). As the estimated MR is in the range of cancerous lesions,[16] this lesion is deemed malignant. Biopsy confirmed that it is an invasive mammary carcinoma.

Case 2: BIRADS 4 Lesion—Malignant

Figure 12(b) is the US image and the elastogram of a BIRADS 4 lesion. The shape of the lesion is not identifiable on the US image, but the elastogram clearly shows the existence of a large stiff lesion in the middle of the image. Highly compressed tissue is also observed above the lesion. The inclusion strain is about −0.01, whereas the matrix strain is about −0.05 in the left and −0.03 in the right sides of the lesion, respectively. As the lesion looks connected further to the right-side direction in the US image, the strain in the left side (−0.05) is taken as a matrix strain. By substituting the a/c of 1.6 and SR of 5, MR is estimated to be 9.37. Because this value is higher than the reported MR for cancer (∼7),[17] this lesion is diagnosed as a malignant tumor. Biopsy indicated that this is an invasive ductal carcinoma.

Case 3: BIRADS 4 Lesion—Benign

The lesion in Figure 12(c) is highly noticeable in US image and was classified as a BIRADS 4 lesion by a radiologist, which is usually regarded as malignant. In the elastogram, it shows a diagonally spread shape over a wide area, and is regarded as an oblate ellipsoid with the a/c of 2.2. Inclusion strain is not uniform, ranging from −0.052 to −0.03, whereas tissue strain is at about −0.05. Therefore, the maximum SR is up to 2.5 and the corresponding MR is estimated to be 3.86 from Equation (12). As this value is much lower than the reported range of MR for cancer, it may not be malignant. According to biopsy result, this is a benign fibroadenoma. A small lower strain region can be found in the left bottom corner. Although not histologically examined, this region may be another lesion.

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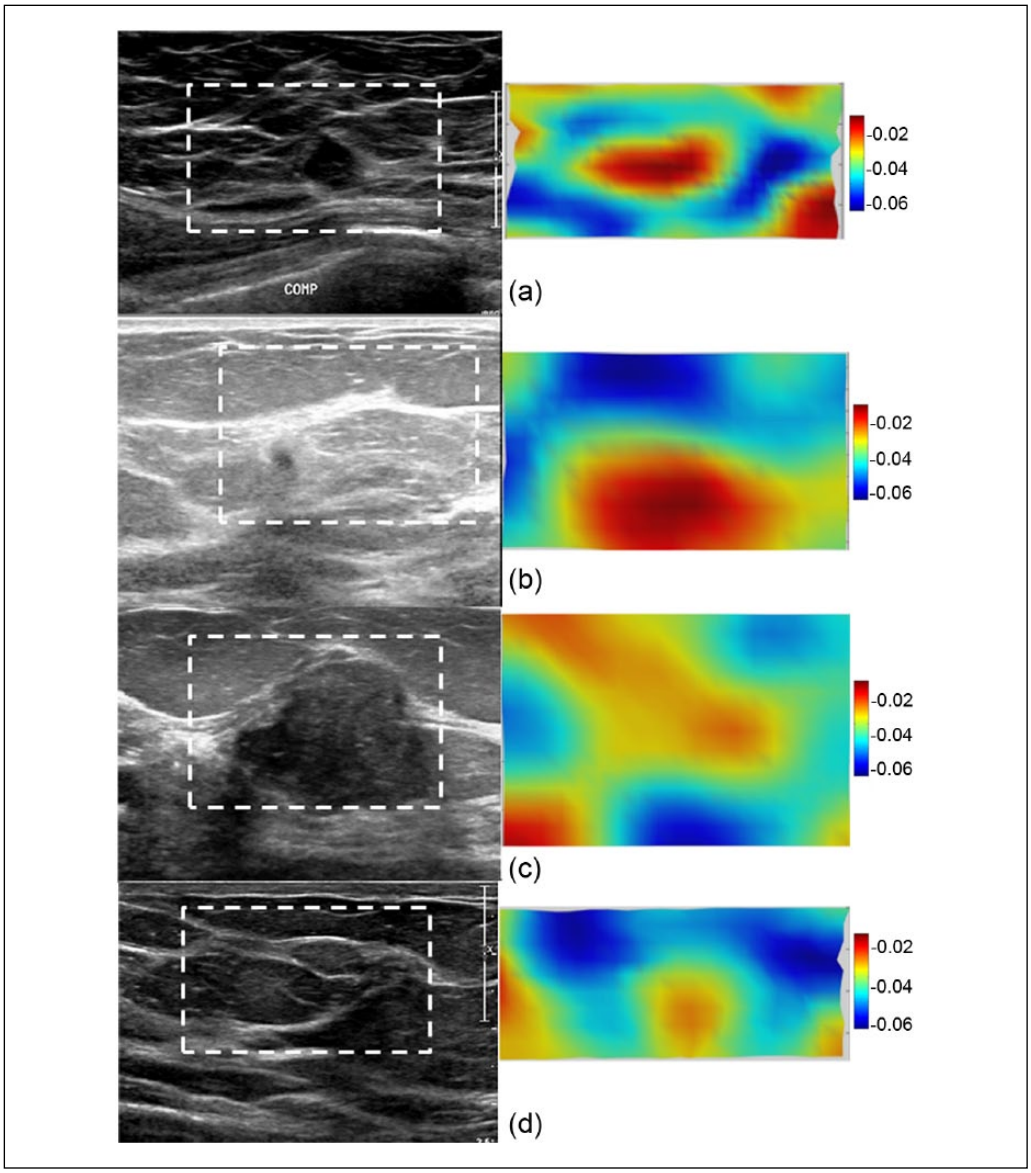


Figure 12: US images and elastograms of human breasts containing: (a) an invasive mammary carcinoma (BIRADS 4); (b) an invasive ductal carcinoma (BIRADS 4); (c) a fibroadenoma (BIRADS 4); (d) a necrotic hemorrhage (BIRADS 5).

Case 4: BIRADS 5 Lesion—Benign

The lesion in Figure 12(d) was clearly visible in the US image and was classified as BIRADS 5 by a radiologist. In the elastogram, inclusion strain is −0.025, while the matrix strain is between −0.05 and −0.055. Assuming a circular inclusion and adopting the higher SR of 2.2 for sensitivity, the MR is estimated to be 4.13. Usually BIRADS 5 lesion is regarded as highly likely malignant; however, the low MR value suggests that this lesion should not be malignant. Biopsy confirmed that this lesion is a benign fibrosis with a necrotic hemorrhage.

IV. Data Analysis and Discussion

Among the 44 lesions examined, biopsy results indicated that 21 were benign and 23 were malignant, as summarized in Table 3. The most common malignant tumors were invasive mammary carcinoma and invasive ductal carcinoma (n = 9 for both), and the most common benign tumor was fibroadenoma (n = 7). As shown in Figure 13, the mean SR of malignant tumors was 6.26 ± 2.06, and that for benign entities was 1.39 ± 0.80. However, the mean MR of malignant tumors and benign lesions was 12.71 ± 4.33 and 1.88 ± 1.82, respectively.

The significances of the differences in SR and MR were tested by applying Tukey's post hoc test using q score determined by the following formula:

$$q = \frac{M_1 - M_2}{\sqrt{\frac{MS_w}{n}}}, \tag{13}$$

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where M_1 and M_2 are the mean value of each group, MSw is mean square within, and n is the number per each group. The relevant variables are listed in Table 4. From the Tukey's significance/probability table,[47] critical Tukey's score (qcrit) corresponding to 95% confidence is 2.86. The q score determined for SR and MR are 14.01 and 15.39, respectively, thus it can be concluded that unequal variances exist within the groups, and the differences are significant.

This can be further verified with unpaired two-sample t test.[48] For SR, t statistic is calculated to be 2.35. For the degree of freedom (df) of 43, t value for 95% confidence level was 2.0181; thus the SRs between malignant tumors and benign lesion were significantly different ($p < 0.05$) with a small margin. However, t statistic for MR was 11.09; thus, the difference of MRs between malignant tumors and benign entities were statistically significant with a much higher confidence level ($p < 0.00001$).

Using the receiver-operating characteristic (ROC) curve of SR, the area under the curve (AUC) was 0.9341, and the best cutoff SR value of 3.1 was obtained at the maximum Youden's index of 0.86957. With this cutoff SR, the sensitivity, specificity, and accuracy were 91.3%, 90.5%, and 90.9%, respectively. For ROC curve of MR, AUC was 0.94824, and the best cutoff MR was 5.67 at the maximum Youden's index of 0.95238. The sensitivity, specificity, and accuracy were 100%, 95.2%, and 97.7%, respectively.

Table 3: Histologic Diagnoses in 44 Patients with Benign or Malignant Breast Lesions.

Benign Lesions (21)		Malignant Lesions (23)	
Diagnosis	n	Diagnosis	n
Fibroadenoma	7	Mammary carcinoma (invasive, infiltrating)	9
Cyst	5		
Fibrocyst	1	Ductal carcinoma (invasive, infiltrating)	9
Fibro fatty tissue	2		
Fibrosis	1	Ductal carcinoma in situ (DCIS)	3
Benign fibro-epithelial tissue	2	Neuroendocrine carcinoma	1
Benign lactating adenoma	1	Metaplastic carcinoma	1
Other benign tissue	2		

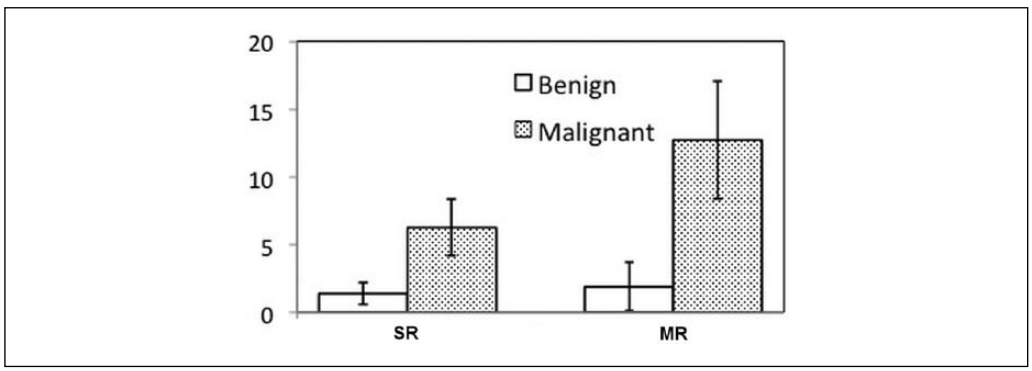


Figure 13: Mean values of SR and MR for benign and malignant cases, respectively. SR = strain ratio; MR = modulus ratio.

Table 4: Relevant Variables for Tukey's Post Hoc Test.

Variables	SR		MR
M_1 (Mean, Malignant) M_2 (Mean, Benign) n (Number of samples)	6.261 ± 2.063 1.390 ± 0.804 21		12.712 ± 4.329 1.882 ± 1.817 23
k (Number of groups)		2	
df Among groups		1	
df Within groups		42	
SS_{within} (Sum of squares within groups)	106.566		478.341
MS_{within} (Mean squares within groups)	2.537		11.389
q (Tukey's score)	14.014		15.389
q_{crit} (Critical q score, 95% confidence)		2.86	

SR = strain ratio; MR = modulus ratio.

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The proposed surface regression model considers only two input parameters, a/c and SR, to predict MR. Nevertheless the adoption of MR in breast cancer screening could significantly improve both confidence level and the diagnostic performance, compared with SR. In statistical analysis, the mean of SR was different by 4.87 between benign and malignant lesions, whereas the difference of the mean of MR increased up to 10.83. Considering the standard deviation (2.06 and 0.80 for SR and 4.33 and 1.82 for MR), the difference between benign and malignant SR can be even smaller, increasing the ratio of gray cases that require further invasive testing. However, the means of MR for benign and malignant lesions are different enough to differentiate between benign and malignant lesions, thus benign biopsy could be reduced by using MR.

The proposed approach has an artifact that a/c ratio can be varied depending on the application angle of US probe, but by manipulating the probe angle with imaging the lesion, maximum a/c for oblate lesion or minimum a/c for prolate lesion can be obtained for conservative assessment of MR. Also, the proposed approach is still limited to relatively simple ellipsoidal shapes and the protocols for irregular shapes of lesion have been yet established, which may be the next milestone of the future research.

V. Conclusion

We investigated the transfer characteristic of observed contrast, SR, from elastography in predicting the true contrast, MR, by using the Eshelby's solution. It was found that SR not only significantly underestimates MR, but also varies with the shape and the modulus of the lesion. A surface regression model to predict MR from axial ratio and SR was proposed and verified through the application to gelatin phantoms. The model was further applied to human breast elastograms containing different types of lesions, and statistical analysis indicated that significant improvement in both confidence level and diagnostic performance could be achieved by adopting MR predicted by the model. The model can be utilized for the screening of breast cancer by comparing the correlated MR from elastography with actual modulus data of various tissues from mechanical testing.

Appendix

Supplementary Materials

Matlab codes for Eshelby's solution associated with this article can be found in the online version. Please run Eshelby_GUI.m, which can be found from Eshelby.rar.

Declaration of Conflicting Interests

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Use of Electrocardiography in Identification of Culprit Vessel and Localising the Lesion in Acute Myocardial Infarction with Angiographic Correlation

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Abstract- *Aim:* To evaluate the use of electrocardiography (ECG) in identifying the culprit artery and localizing the lesion in acute myocardial infarction (AMI) patients.

Methods: This was a single-center, prospective study conducted at a tertiary-care center in India. A total of 100 patients diagnosed with AMI who underwent coronary angiography between November 2014 and October 2015 were included in the study. Patients diagnosed with AMI were evaluated, and the ECG findings of each patient were correlated with that of coronary angiogram to localize the culprit vessel involved.

Results: A total of 100 patients diagnosed with AMI with a mean age of 55 years were included in the study. Of these, the majority of the patients were male (91%). Out of 100 AMI patients, left anterior descending artery (LAD) was found to be the most common culprit artery [70 (70%) patients] followed by right coronary artery (RCA) [25 (25%) patients] and left circumflex (LCX) artery [5 (5%) patients], respectively. Among this 70% of patients who had LAD as a culprit artery, 10% of patients had additional insignificant lesions in LCX and 5% patients in RCA.

Keywords: *acute myocardial infarction; electrocar- diogram; ST-segment elevation.*

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Conclusion: This study concluded that ECG can reliably predict the culprit artery in AMI patients and can be used in identifying the level of occlusion in the artery. Particularly in hospitals without angiographic facilities, simple 12 lead ECG could become pivotal in guiding management decisions.

Keywords: acute myocardial infarction; electrocardiogram; ST-segment elevation.

I. Introduction

We are in the middle of a true global cardiovascular disease outbreak. Coronary artery disease (CAD) is one of the most important public health problems in India and worldwide. The prevalence of CAD in India has been increasing steadily with prevalence varying from 1-2% in the rural population and 2-4% in the urban population (1). About, 80% of deaths occur in developing countries and 30% of all deaths worldwide each year due to CAD (2). The 30-day mortality rate from acute myocardial infarction (AMI) is 30% with more than half of these deaths occurring before the affected individual reaches the hospital (3). Approximately, one of every 25 patients who survive the initial hospitalization dies in the first year after AMI (4). Mortality is about four-fold higher in elderly patients (over age 75 years) compared with younger patients (3).

Myocardial infarction (MI) is one of the most common presentation of CAD requiring immediate diagnosis and management in emergency settings. Acute risk stratification in AMI is based on laboratory parameters and 12-lead electrocardiogram (ECG). The 12-lead ECG has been a preliminary screening and one of the most useful diagnostic investigations in AMI (5). The early and accurate identification of the culprit artery in the setting of ST-elevation myocardial infarction (STEMI) is important because of the prognoses and the potential complications associated with a particular artery regarding the urgency of revascularization (6). ECG is a chief marker of microvascular blood flow and consequent prognosis. ECG reflects the electrophysiology of myocardium during acute ischemia whereas the coronary angiography shows the vessel anatomy (7). Since ECG has prognostic implications, several ECG criteria have been developed to identify the culprit artery in MI. Thus, this study has been undertaken to evaluate the use of ECG in identifying the culprit artery and correlating these ECG changes with coronary angiography for localizing the lesion in acute MI patients.

II. Methods

a) Study design and patient population

This was a single-center, prospective study conducted at a tertiary-care center in India. A total of 100 patients diagnosed with AMI who underwent coronary angiography between November 2014 and October 2015 were included in the study. Patients diagnosed with AMI were evaluated, and ECG findings of each patient were correlated with that of coronary angiogram to localize the culprit vessel involved. The AMI patients with chest pain lasting 30 minutes, ECG criteria of ST-segment elevation >1mm in at least two contiguous leads in limb leads and >2mm in chest

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leads and those who underwent coronary angiogram subsequently were included in the study. Patients with the history of previous MI, prior coronary artery bypass graft (CABG), congenital heart disease, ECG showing features of left ventricular hypertrophy (LVH), left bundle branch block in baseline ECG and patients with non-ST-elevation myocardial infarction (NSTEMI) were excluded from the study. Signed informed consent was obtained from all the patients before the investigations.

b) Electrocardiography evaluation

In 2006, Hein J. J. Wellens et al. (8) summarized the ECG criteria for identification of the culprit artery in myocardial infarction as follows:

A. Anterior ST-elevation (leads V1-2 to V4-5) suggests left anterior descending artery occlusion.
B. Inferior ST-elevation (leads II, III, aVF) suggests occlusion of either right coronary artery (RCA) or left circumflex artery (LCX). In the patients with inferior ST-elevation, ST-elevation in II>III is suggestive of occlusion of LCX and ST-elevation in III>II is suggestive of occlusion of RCA.
C. If ST-elevation is there in leads aVR and aVL along with ST-depression in the lead II, III and aVF indicates occlusion is proximal to first septal and first diagonal branch.
D. If ST-elevation is in leads I and aVL along with ST-depression in the lead III and ST-elevation in leads V2 to V6 indicates occlusion is distal to the first septal branch but proximal to the first diagonal branch.
E. If there is ST-depression in lead aVL and ST-elevation in inferior leads with highest in lead III along with ST-elevation in leads V1 to V4 indicates occlusion distal to the first diagonal branch and proximal to the first septal branch.
F. If there is ST-depression in aVR along with ST-elevation in inferior leads with highest in lead II and ST-elevation in leads V3 to V6 indicates occlusion of distal LAD.
G. ST-elevation in lead V4R with positive T-wave suggests RCA occlusion proximal to right ventricle (RV) branch, whereas isoelectric or isoelectric ST-segment in V4R suggests RCA occlusion distal to RV branch.

These set of criteria was applied to all the patients included in the study to identify the culprit vessel and the level of occlusion in the vessel involved by ECG obtained at the time of presentation. Later, these patients underwent coronary angiography at our hospital. The results obtained after applying the ECG criteria were compared with the results obtained from coronary angiography.

c) Statistical analysis

The data obtained was analyzed, and the results were presented in the form of numbers and percentages. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of individual parameters were calculated to study the efficiency of ECG criteria applied for identifying the culprit's vessel.

III. Results

A total of 100 patients diagnosed with AMI with a mean age of 55 years were included in the study. Of these, the majority of the patients were male (91%). The LAD artery was found to be the most common culprit artery [70 (70%) patients] followed by RCA [25 (25%) patients] and LCX artery [5 (5%) patients], respectively. Among this 70% of patients who had LAD as a culprit artery, 10% of patients had additional insignificant lesions in the LCX and 5% of patients in RCA. Of this 25% of patients who had RCA as a culprit artery, 6% of patients had additional lesions in LAD and 2% of patients in the LCX artery. These lesions caused an insignificant obstruction. Baseline demographics, sites of occlusions in LAD and RCA of the study population, were displayed in Table 1.

Table 1: Baseline demographics, site of occlusions in LAD and RCA of the study population

Characteristics	Patients (N=100)
Age (mean, years)	55
Male, n (%)	91 (91%)
Culprit artery	
LAD, n (%)	70 (70%)
RCA, n (%)	25 (25%)
LCX, n (%)	5 (5%)
Occlusion in LAD	
Proximal to S1 and D1, n (%)	8 (11.4%)
Proximal to D1 but distal to S1, n	50 (71.4%)
Distal to D1 but proximal to S1, n	7 (10%)
Distal to S1 and D1, n (%)	5 (7.2%)
Occlusion in RCA	
Proximal RCA, n (%)	15 (60%)
Distal RCA, n (%)	10 (40%)

LAD: left anterior descending; RCA: right coronary artery; LCX: left circumflex artery

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Table 2: Comparison of various ECG criteria used in predicting the levels of occlusion

Variables	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Occlusion in LAD				
Occlusion distal to S1 but proximal to D1	95	5	90	70
Occlusion proximal to S1 but distal to D1	50	95	70	90
Occlusion in proximal LAD	85	67	75	80
Occlusion in distal LAD	67	85	80	75
Occlusion in RCA				
Proximal RCA	83	61	80	66
Distal RCA	61	83	66	80

LAD: left anterior descending; RCA: right coronary artery.

a) Distribution of occlusion in LAD artery

In this study, ECG criteria were applied to all the patients to identify the culprit vessel with 100% sensitivity and specificity. Out of 70 patients who had occlusion in LAD artery, 50 (71.4%) patients had occlusion proximal to D1 but distal to S1, eight (11.4%) patients had occlusion proximal to both S1 and D1, seven (10%) patients had occlusion distal to D1 but proximal to S1 and five (7.2%) patients had occlusion distal to both S1 and D1, respectively. Out of 50 patients having occlusion proximal to D1 but distal to S1, 45 (90%) patients were found to have lesion distal to S1 and proximal to D1, and five (10%) patients were found to have lesion distal to D1 and proximal to S1. Of the eight patients having proximal LAD involvement, merely six (75%) and two (25%) patients were found to have proximal and distal LAD involvement, respectively. Among the seven patients identified as having lesion distal to D1 and proximal to S1 were alienated as: five patients had lesions at the same site and two patients had lesion distal to S1 and proximal to D1. Of the five patients having distal LAD involvement, one and four patients were found to have proximal and distal LAD involvement on angiography. In cases of LAD occlusions distal to S1 but proximal to D1 the ECG had good sensitivity (95%) but moderate specificity (50%). For occlusions proximal to S1 and distal to D1 the sensitivity was moderate (50%) but specificity was high (95%). For proximal LAD occlusions the sensitivity was found to be high (85%) while the specificity was found to be moderate (67%), and for distal LAD occlusions ECG had moderate sensitivity (67%) but high specificity (85%). The sensitivity, specificity, PPV and NPV values for the ECG criteria applied to identify the level of occlusion in LAD in the study population were shown in Table 2.

b) Distribution of occlusion in RCA artery

Out of 25 patients having RCA occlusion, 15 (60%) patients had proximal RCA occlusion, and 10 (40%) patients had distal RCA occlusion. Of these 15 patients who had proximal RCA involvement, merely ten and five patients found to have proximal and distal RCA occlusion, respectively. Among the ten patients identified as having distal RCA involvement, eight and two patients were found to have distal and proximal RCA involvement, respectively. In case of RCA proximal occlusions ECG had good sensitivity (83%) but moderate specificity (61%), and in case of RCA distal occlusions, ECG had good specificity (83%) but moderate sensitivity (61%). The sensitivity, specificity, PPV and NPV values for the ECG criteria applied to identify the level of occlusion in RCA in the study population were shown in Table 2.

IV. Discussion

Though coronary angiography is the gold standard for determining the infarct-related artery (IRA) in AMI, the ECG can be a clinically valuable tool in identifying the culprit artery (9). In the current study, various ECG criteria was used for the diagnosis of IRA in AMI with angiographic findings. In the previous study (10) it was reported that the mean age of CAD patients in India was 49 years and also proved that the prevalence of CAD increases with age. In this study, the mean age of the study population was 55 years which is consistent with a study by Yusuf S et al. (11). The mean age of patients was 58.6 years in the CREATE-ECLA (12) randomized controlled trial which is comparable to this study results. Age and sex are the most powerful independent risk factors for CAD. Among the study population, the majority of the population were males (91%) which is similar to a study by Markandeya G.K.M et al. (6). A study in Washington State (13) concluded that CAD is an equal opportunity killer in men and women over their lifetimes which is in contrast to the current study showing that incidence of CAD was about four times high in male than that of the female.

Accurate localization of IRA from surface ECG is crucial in the formulation of management and need for early primary percutaneous coronary intervention (PCI). The recent findings of Masoudi et al. (14) suggest that failure to identify high-risk ECG patterns in AMI patient's results in lower quality care in emergency and highlights the importance of system changes to enhance the accuracy of ECG elucidation. Among the 100 patients included in the study, 70% of patients had anterior wall

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myocardial infarction (AWMI), and 30% of patients had IWMI which is similar to a study by Markandeya G.K.M et al. (6) and Chakraborty S et al. (15). In AMI patients, Hein J.J. Wellens et al. (8) ECG criteria have been used to identify the culprit artery and site of the occlusion. In case of the site of occlusions in LAD artery, most of the results of this study were comparable to a study done by Engelen et al. (16) and Salunke KK et al. (3).

In 2006, application of ECG criteria was described by Hein J. J. Wellens et al. (8) Similarly, in the current study, these ECG criteria were able to identify the culprit artery in MI correctly with 100% sensitivity and specificity. In cases of LAD occlusions distal to S1 but proximal to D1 the ECG had good sensitivity (95%) but specificity (95%) was high for occlusions proximal to S1 and distal to D1, for proximal LAD occlusions the sensitivity was found to be high (85%) while the specificity was found to be high (85%) in distal LAD occlusions. These sensitivity and specificity results were comparable to a study conducted by Vasudevan et al. (5) and Engelen et al. (16). In case of RCA proximal occlusions ECG had good sensitivity (83%) but moderate specificity (61%), and in case of RCA distal occlusions, ECG had good specificity (83%) but moderate sensitivity (61%). The diagnostic accuracy of this ECG abnormality in this study was comparable to a study by Glancy et al. (17) who showed a sensitivity of 96% and specificity of 40% for RCA involvement.

Thus, ECG has been a useful tool in identifying the lesions in the coronary arteries at the time of presentation in the emergency department. Any health personnel involved in emergency care should have in-depth knowledge of assessing ECG in AMI. It is important for emergency physicians to identify a very proximal LAD occlusion in acute AWMI. If the infarct site is proximal to the LAD artery, a large portion of the left ventricle (LV) is at risk for infarction. Such high-risk patients may require urgent transfer to a cardiac catheterization laboratory for primary PCI. The ECG need to be recorded and is important to identify patients with RCA occlusion because hypotension in these patients is usually caused by inadequate filling of LV and by poorly contracting right ventricle. By reflecting the pathophysiology of the myocardium during AMI or acute ischemia, important information to determine and prognosis guide management can be derived from ECG.

V. Conclusion

This study concluded that ECG is a good predictor in detecting the culprit artery and can be used in identifying the level of occlusion in the artery. Although coronary angiography remains the benchmark method for determining the infarct-related artery in AMI, ECG information can help to expect culprit artery involved before angiography, particularly in hospitals without angiographic facilities. In such settings, a simple 12 lead ECG could become pivotal in guiding management decisions.

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Keywords: *anomaly scan, antenatal ultrasound, fetal anomalies, perinatal mortality and morbidity.*

GJMR-D Classification: *NLMC Code: WF 141*



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Rubina Mukhtar [α], Mukhtar Hussain [σ], M. Ahmad Mukhtar [ρ], Isharat Sherood [ω], Rubaida Mehmood [¥] & M. Saqib Khan [§]

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Conclusion: Congenital anomalies are one of the causes for perinatal mortality and morbidity that can be reduced by different measures including avoidance of risk factors and by Antenatal screening for congenital anomalies on grey scale USG. The risk factors can be reduced by the public as well as obstetricians awareness. Ultrasound is simple, noninvasive and sensitive enough for anomaly detection and may have a vital role in reducing perinatal mortality and morbidity by screening and early detection of anomalies. Therefore, screening of all pregnant women by second-trimester ultrasound especially by experienced radiologist should be done.

Keywords: anomaly scan, antenatal ultrasound, fetal anomalies, perinatal mortality and morbidity.

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I. Introduction

WHO defines any gross structural or functional disorder recognized at the time of birth as Congenital anomaly (1). According to one study, congenital anomalies affect 1 in 33 infants. Worldwide 3.2 million of babies born with congenital abnormalities may suffer from mental or physical disability every year (2). In developing countries like Pakistan having a lack of social support system, parents may have huge financial, psychological and social burden with bringing up a disabled child.

Congenital anomalies which are not diagnosed antenatal present as emergencies in pediatric surgical departments and is included in the list of significant causes for perinatal mortality and morbidity.(1)

Birth defect is a major cause of morbidity and mortality in infants worldwide; One study shows that birth defects were the cause of approximately 260,000 deaths in the year 2004 alone, 7% of these were neonatal deaths (3). The proportion of congenital defects related to perinatal deaths are increasing might be due to the reduction of other causes of mortality because of improvement of perinatal and neonatal care. (1) Congenital anomalies are the cause for 6-9% of perinatal deaths in Pakistan that makes a significant proportion which can be reduced by a prenatal diagnosis of gross fetal defects. (4)

The prevalence is variable among populations of the different area. Different studies show the prevalence of congenital anomalies as 2.5% in India and 3% in the United States and the United Kingdom (5, 6). Cardiac and orofacial anomalies, Down syndrome and neural tube defect are the most common anomalies reported worldwide (7, 8). Different risk factors have been recognized to contribute to these defects. These risk factors include Maternal age, maternal illness, radiation exposure, poor nutritional status with Folic acid deficiency, drug intake cousin marriage and smoking (9, 10).

Different measures can be utilized to reduce the congenital defects related to mortality and morbidity. Avoiding risk factors can reduce the incidence of fetal defects. Therefore, the knowledge about the risk factors in a specific region or population may help in reducing

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the risk. On the other hand antenatal anomaly scan for the screening of congenital fetal defects may assist in deciding the termination of pregnancy or therapeutic intervention including perinatal surgical planning in case of major anomalies (11).

Although there are different laboratory tests or radiological modalities are available for detection of fetal anomalies, but Grey scale ultrasound has well-established role for diagnostic abilities as it gives a large amount of structural information (11, 12). A fetal defect can be detected at any stage of pregnancy, but all depends upon when a patient visits Sonologist for anomaly scan. The most sensitive time for anomaly detection is the second trimester around 18 to 24 weeks (11, 13). Detection of anomalies at this stage carries significance for decision as termination of pregnancy in cases where major anomalies are detected (14).Overall success for detection on grey scale USG depends upon gestational age, available system, the skill and experience of radiologists (11).

II. Materials and Methods

We conducted this prospective study from January 2016 to December 2017at Radiology department of MINAR cancer hospital Multan in co-ordination with children hospital complex Multan, Pakistan. It is a tertiary care hospital covering most of the area of southern Punjab consisting of approximately more than 50% of the total country population. We enrolled 3098 patients for an obstetrical scan during the study period. The details of these patients including their age, gestational age, and parity, history of any medical disease, socioeconomic status, and folic acid intake were recorded in predesigned Performa. DATA recorded was analyzed statistically by applying SPSS-24.

III. Results

Out of 3098 patients, we detected 78 patients having at least one gross fetal defect. We categorized the anomalies detected on grey scale ultrasound according to body system involved including Central nervous system (CNS), cardiovascular system (CVS), gastrointestinal system (GIT), genitourinary system (GU) and musculoskeletal system MSK. Congenital fetal defects have a prevalence of 2.38 % of the study population. The mean age of patients was 25.89 years SD± 5.24 and mean gestational age was 26.5 weeks SD ±6.43. Only 5.4% of women were above age of 30 years. None was above 35 years of age. The congenital fetal defects involving (CNS) were highest contributing 48.6 % followed by (MSK) and (GU) 13.5 % and 8.1 % respectively. Involvement of (CVS), (GIT) and respiratory system (RS) was lowest with a prevalence of 2.7% of each. Oligohydramnios was found associated with polycystic kidney diseases, and poly hydramnios was common in patients with neural tube defects and gastrointestinal obstruction. Twelve of total patients (15% of total anomalies) were detected with major anomalies. Termination of pregnancy was suggested for them following the recommended indications as per literature (15, 16). Nine of these were having CNS anomalies including severe hydrocephalus with cortical thinning and myelomeningocele, cystic hygroma and anencephaly. Three of these were having Thonatophoric dysplasia, a type of dwarfism with associated anomalies of a narrow chest and underdeveloped lungs and is lethal with poor outcome (17).

Only 5% of women belonged to high socioeconomic status while rest of the 95 % belonged to the low and middle socioeconomic group with a p-value of 0.003. None of the women with detected fetal defects was taking folic acid. 81.1 % of women had Cousin Marriage with a significant p-value of 0.0016.

IV. Discussion

Approximately 2-3 % of live births are affected by congenital anomalies that contribute significantly to perinatal mortality and morbidity (18). It also affects the quality of life of survivors that may cause a social and financial burden on parents especially in developing countries like Pakistan.

Anomalies are classified as major or minor depending upon the fetal outcome and further management. Anomalies that need medical and surgical intervention are categorized as major, and these may have an impact on perinatal mortality and morbidity. An anomaly that does not require any medical or surgical intervention and is compatible with life expectancy is categorized as minor (11).

The incidence of antenatal detection of congenital anomalies is 2.38 % in our study group that corresponds with the figures given in the literature. The most commonly detected anomalies in our case are those of CNS constituting 48.6%. The literature review also shows the CNS anomalies as commonest followed by MSK and GU. The mean age of mothers and gestation was 25.89 years SD ±5.2 and 26.5 weeks SD ±6.4 respectively. The number of women presented in the second trimester was 36 (66.6%) and presented in the third trimester was 28 (33.3%). No anomaly was detected in the first trimester. Different studies show different gestational ages for anomaly detection. For example, a study by Fatema shows respondents between 34 to 36 weeks and a study by the Padma shows anomaly detection between 29 to 32 weeks of gestations (19, 20). The most sensitive and significant time for anomaly detection is second-trimester USG. The morbidity and mortality related to anomalies increase with increasing gestational age. Therefore to avoid such complications anomalies should be detected earlier (11).

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Literature shows cousin marriage which is highly practiced in our population is one of the main risk factors for congenital anomalies with a p-value of 0.0018 (21, 22) and was seen in 60 (81.1%) women of our study group with a p-value of 0.0016. Increased risk of anomalies in cousin marriage has been explained as the homozygous expression of a recessive gene inherited both parents (1). Folic acid deficiency is one of the recognized risk factor for congenital anomalies. Many studies have shown its association with neural tube defects. Folic acid intake reduces the risk of neural tube defect (23). In our study, none of the women was taking folic acid. Correlation of smoking with congenital anomalies has been shown by some studies (23), but none of the mothers in our study group had a history of smoking. Advanced mother age >35 years is a high risk factor for chromosomal anomalies (24), but in our study, none of the mothers was above 35 years of age as we did not conduct a chromosomal analysis. Both the maternal age and maternal smoking are not significant risk factors in our population.

V. Conclusion

Congenital anomalies are one of the causes for perinatal mortality and morbidity that can be reduced on the one hand by avoiding risk factors and on another hand by Antenatal detection of congenital anomalies on grey scale USG. In our population, the common important risk factors for congenital anomalies include Poor socioeconomic status, lack of folic acid intake and cousin marriages. These risk factors can be reduced by public awareness. USG is a simple, noninvasive and cost-effective investigation and has a significant established role in early detection of congenital anomalies. So we recommend antenatal screening for anomalies by second-trimester USG of all pregnant women.

Abbreviation list

CVS - Cardiovascular system.
CNS - Central nervous system
GUS - Genitourinary system.
MSK - Musckuloskeletal system.
RS - Respiratory system.
USG - Ultrasound.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethical approval

This study was done by the approval of ethical committee of the institute.

Contribution of authors

All the authors contributed significantly in manuscript writing. Dr Rubina Mukhtar is main author for manuscript writing (50%). Dr Mukhtar Hussain (10%), M. Ahmad Mukhtar (10%), Dr Isharat (10%), Rubaida Mehmood (10%) and Dr M. Saqib (10%) contributed in Data recording Data analysis and helped in manuscript writing.

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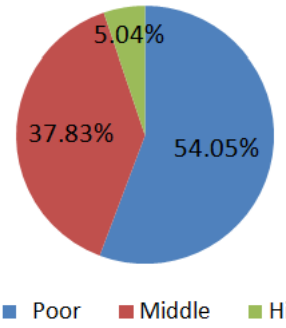
Table 1: Demographic Data of Patients

Total Number of Patients=76		
Types of anomalies	NO.	%
CNS	36	48.6
CVS	2	2.7
GIT	2	2.7
GU	6	8.1
RESP SYS	2	2.7
MSK	10	13.5
MULTISYS	16	21.6
Age of patients		
<20 years	10	13.5
20-25 years	28	37.8
25-30 years	28	37.8
>30-35 years	4	5.4
>35 years	0	0
Gestational Age		
<14 weeks	2	2.6
>14-20 weeks	22	28.9
>20-28 weeks	26	34.2
>28 weeks	26	34.2

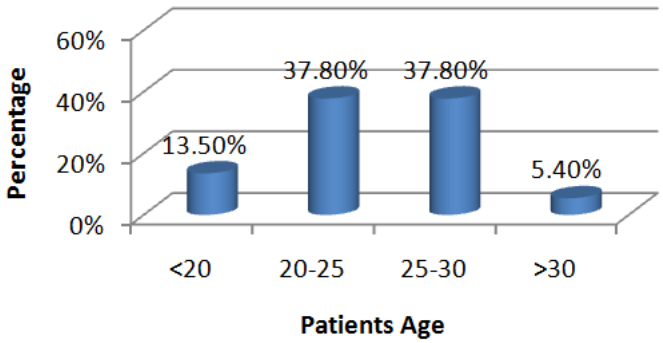
Table 2: Risk factors n=76

Risk Factors	Yes (%)	No (%)
Lack of Folic Acid intake	76(100%)	0
Cousin marriage	60(81.1%)	16(18.9)
Poor socioeconomic status	40(54.05%)	36 (45.95)
Maternal age>35	0	76 (100)
Smoking	0	76 (100)
Previous history of anomalies	18(23.7%)	58(76.3) (76.3)
History of medication of mother	4 (5.2%)	72(94.7)

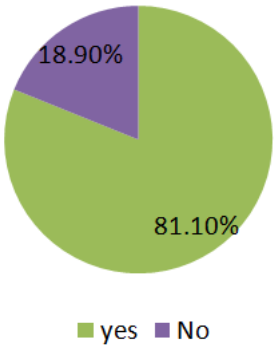
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Graph 1: Socioeconomic Distrubution of Patients



Graph 2: Age Distrubution of Patients



Graph 3: Distrubution of Patients by Cousine Marriage

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Measurement of Ischiopubic Index in Pelvic Radiographs

By B R Joshi & Sahana Kayastha

Abstract- *Objective:* The objective of this study is to measure pubic length and ischial length and to define ischiopubic index. This may be of value in physical anthropology, anatomy, gynecology to estimate the extent of labor, archeological analyses and in solving medicolegal cases.

Methodology: Data were collected over the period of 4 months from June to September 2018 with the total of 120 patients who underwent pelvic and KUB radiographs. The pubic length, ischial length and the ischiopubic index were measued.Pubic length is a straight line drawn on the radiograph from centre of the triradiate cartilage to the medial end of pubic symphysis. Ischial length is a straight line drawn on the radiograph from triradiate cartilage perpendicular to the line joining the bilateral lower ischial tuberosities.Ischiopubic index is determined from the pubic length divided by ischial length, and then multiplied by 100.

Results: The mean pubic length in male was 8.3±0.82 cms and 9.21±0.8 cms in female. Mean ischial length were 9.05±0.73 cms and 8.32±0.72 cms in male and female respectively. The ischial and pubic lengths exhibited statistically significant differences between males and females ($p<0.05$).

Keywords: *ischial length, ischiopubic index, pelvic radiograph, pubic length.*

GJMR-D Classification: *NLMC Code: WN 1*



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Results: The mean pubic length in male was 8.3±0.82 cms and 9.21±0.8 cms in female. Mean ischial length were 9.05±0.73 cms and 8.32±0.72 cms in male and female respectively. The ischial and pubic lengths exhibited statistically significant differences between males and females ($p<0.05$). In males and females, the mean ischiopubic index were 91.73±5 and 110.9±7 respectively. The ischiopubic index were found to be higher in females than in males.

Conclusion: This study concluded that the pubic length and ischial length are higher in females than in males and therefore have dimorphic potential.

Keywords: ischial length, ischiopubic index, pelvic radiograph, pubic length.

I. Introduction

The pelvis, the most sexually dimorphic area of the body, is essential for biological sex determination of the adult skeleton.[1] This is because one of the major biological differences between men and women, that of having babies, largely determines the shape of that part of the body. Various studies have shown extensively that the hip bone is an ideal bone for sex determination because it reflects not only the general differences between the sexes but also the special adaptation of the female hip bone for child bearing.[2] The innominate bone has long been recognized as one of the best skeletal indicators of sex in an adult individual. The ischiopubic index is useful in sex differentiation.[3] The sexual differences in the pelvis are of interest to anatomist, gynecologist, and even anthropologist. The extent of sex determination is so important to females with narrow cavity which find it more difficult to deliver babies naturally than those with wide pelvic cavity. The growth of the pelvis is in the width resulting to wide pelvic inlets as such, study will determine the sex difference using the ischiopubic measurement (index) of patients radiograph with no pathological abnormalities and fractures. The ischiopubic index is the measurement of the distance between the triradiate cartilage (acetabulum) and the pubic tubercle of the pelvic bone divided by the distance between the triradiate cartilage (acetabulum) and the ischial tuberosity of the pelvic bone, multiplied by hundred.[4]

This study reflects not only the general differences between the sexes but also the special adaptation of female hip bone for child bearing. It has been observed that the size of the ischiopubic index determines the size of the birth canal, which is an important criterion in vaginal delivery. This may be of value in physical anthropology, anatomy, gynecology to estimate the extent of labor, archeological analyses and in solving medicolegal cases. The objective of this study is to measure pubic length and ischial length and to define ischiopubic index.

II. Methodology

This study was conducted in a tertiary hospital in Nepal during the period from June 2018 to September 2018. Data were collected over the period of 4 months from June to September 2018 with the total of 120 patients. Inclusion criteria were normal AP radiographs aged between 18 to 70 years of male and female patients. Exclusion citeria were trauma of pelvis and underlying bone disease which could affect the intact pelvic bone.

All the AP pelvic and KUB radiographs fulfilling the selection criteria for during the study period were enrolled numbering 120 total patients. These radiographs were performed in anterior-posterior view by using Hitachi x-ray machine with capacity 150 kV and 500 mA. The x-rays were performed in Kv ranges from 65-70 and mAs ranges 35-40 using Computed Radiography image receptor (AGFA Company) of standard speed. The size of image receptor was 14"x17" with use of table bucky. These x-rays were processed in AGFA CR 30 readers.

The measurement were carried out with the measuring tools available on the software of the system. All the measurements were carried out with appropriate

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magnification. The parameters measured were pubic length and ischial length.Pubic length is a straight line drawn on the radiograph from centre of the triradiate cartilage to the medial end of pubic symphysis.Ischial length is a straight line drawn on the radiograph from triradiate cartilage perpendicular to the line joining the bilateral lower ischial tuberosities (Figure 1). All the measurement were taken twice and the average recorded as the actual distance to ensure accuracy. Ischiopubic index is determined from pubic length divided by ischial length and then multiplied by 100.



Figure 1: Measurement of pubic length (AB) and ischial length (AC) in male radiograph

Statistical analysis was carried out with the help of SPSS version 16 and Microsoft Excel. The mean,standard deviation of pubic length, ischial length and ischiopubic index and corelation between pubic length,ischial length and ischiopubic index with the gender were expressed in tables and figures.

III. Results

The data was collected from 120 normal subjects, 60 males and 60 females with the age from 18 years old up to 70 years old. Patient's age, gender, pubic length, ischial length and ischiopubic index were recorded. Data were presented as mean and standard deviation for all variables. Data obtained were analyzed using the descriptive statistics to summarize the information, and inferential statistics (independent samples t-test) to verify if there were significant sex differences. $P<0.05$ was considered to be statistically significant. Detailed results are shown in the tables and figures below:

Table 1: Distribution of sample size according to gender

Gender	Frequency	Percent
Male	60	50%
Female	60	50%
Total	120	100%

Table 2: Mean, S.D and Range of pubic length of male and female pelvis

Sex	Mean	S.D	Max.	Min.	Range
Male	8.3	0.82	10.48	6.80	3.66
Female	9.21	0.8	11.04	7.70	3.34

S.D: Standard Deviation; N: Sample Size.

Table 3: Test of significance difference between males and females pubic length

Parameter	Mean difference	T	df	P
Pubic length	-0.910	-6.16	118	0.000

The mean values of pubic length for males in pelvic radiograph were found to be 8.3cm±0.82 with maximum 10.48cm and minimum 6.80 cm and that of female were found to be 9.21cm±0.8 with maximum 11.04cm and minimum 7.70cm [Table2]. The pubic length in females was observed to be higher than in males. These differences were observed to be statistically significant ($p<0.05$) [Table 3].

Table 4: Mean, S.D and Range of ischial length of male and female pelvis

Sex	Mean	S.D	Max.	Min.	Range
Male	9.05	0.73	11.36	7.75	3.61
Female	8.32	0.72	10.04	7.07	2.97

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Table 5: Test of significance difference between males and females ischial length

Parameter	Mean difference	T	df	P
Ischial length	0.73	5.474	118	0.000

The mean values of ischial length for males in pelvic radiograph were found to be 9.05cm±0.73 with maximum 11.36cm and minimum 7.75cm and that of female were found to be 8.32cm±0.72 with maximum 10.04cm and minimum 7.07cm [Table 4]. The ischial length in males measured more than that of females. These differences were observed to be statistically significant ($p<0.05$) [Table 5].

Table 6: Mean, S.D and Range of ischiopubic index of male and female pelvis

Sex	Mean	S.D	Max.	Min.	Range
Male	91.73	5	103.16	81.78	21.38
Female	110.9	7	134.23	100.43	33.80

Table 7: Test of significance difference between males and females ischiopubic index

Parameter	Mean difference	T	df	P
Ischiopubic Index	-19.14	-17.264	118	0.000

The mean values of ischiopubic index for males in pelvic radiograph were found to be 91.73±5 with maximum 103.16cm and minimum 81.78cm and that of female were found to be 110.9±7 with maximum 134.23cm and minimum 100.43cm [Table 6]. The ischiopubic index of the females was higher than that of males. These differences were observed to be statistically significant ($p<0.05$) [Table 7].

Table 8: Male and Female Ischiopubic Index

Subject	N	Mean±S.D	Median	Range	95% Confidence Interval	
					Lower	Upper
Male	60	91.72±5.0	92.1124	81.78-103.16	90.4357	93.0195
Female	60	110.8±7	110.54	100.43-134.23	109.07	112.67

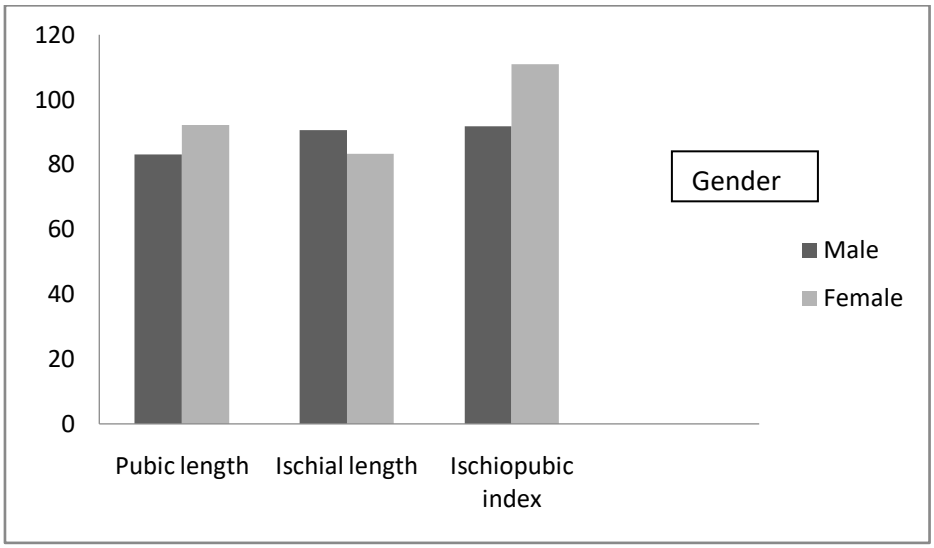


Figure 2: Bar-chart of different parameters according to gender

IV. Discussion

The objective of this study were to measure pubic length, ischial length and ischiopubic index. The sample consisted of 120 subjects with different genders, 60 males (50%) and 60 females (50%) [Table 1]. The mean values of pubic length for males were found to be 8.3±0.82cms with range 6.80 to 10.48cms and that for females were found to be 9.21±0.8cms with the range 7.70 to 11.04cms. The mean values for ischial length for males were found to be 9.05±0.73cms with range 7.75 to 11.36cms and for females were found to be 8.32±0.72cms with 7.07 to 10.04cms range. The mean values of ischiopubic index for males were found to be 91.72±5 with 81.78 to 103.16 range and that of female were found to be 110.9±7 with range 100.43 to 134.23.

It was observed that the males had higher ischial length than females while the females had longer

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pubic length and higher ischiopubic index in the present study. (Figure 2) The study done by Attah et al. in 120 radiographs(60 male and 60 females) resulted that the mean values of pubic length, ischial length and ischiopubic index of males in Maiduguri North Eastern Nigerian population were 81.0mm, 91.7 mm and 88.5 respectively while those of their female counterparts were 92.7mm, 87.1mm and 106.8 respectively. The mean ischial length was significantly higher in males than in females ($p<0.05$). The mean pubic length and the ischiopubic index of the females were significantly higher than that of the males ($p<0.05$) and the outcome from my study supports the same.[5]

The observation in this present study is similar with earlier reports from previous authors such as Igbigbi and Msamati (2000). Our observation was found with slight higher mean than on ischiopubic index of black Malawains with a mean index of 85.0 for males and 104.6 for females.[6] This dispersion might be due to the different techniques of measurement and also might be related to genetic and environmental factor.

Ekanem T. B, Udongwu A. and Singh S, (2009) who reported that the mean pubic length was significantly longer in females than males whereas the mean ischial length was significantly higher in males than females in Cross river people of Nigeria. The values for male ischiopubic index 94.2 and female ischiopubic index 118.8 are higher than ours. Nonetheless, the sex difference of pubic length, ischial length and ischiopubic index were found to be statistically significant when male and female x-ray films were compared ($p<0.001$). This study supports our study even when the sex differences of pubic length, ischial length and ischiopubic index were found to be statistically significant at $p<0.05$.[7]

My study supported the study done by Oladipo G.S, Okoh P.D and Suleiman Y.A on pubic length, ischial length and ischiopubic index of eastern Nigerians with a mean of 71.00mm, 84.4 mm and 84.0 for males respectively while in females was 85.00mm, 83.0mm and 102.6 respectively resulting in higher pubic length and ischiopubic index in females.[8] But this is of lower values than our study. The mean ischiopubic index of different parts of Nigerian population was also different. This may be a result of regional variation of the ischiopubic index.

A study among Portuguese subjects conducted by Phenice T W, 1969showed a reversal of this pattern which reported that the mean ischiopubic index in males with mean ischiopubic index 78.2±6.2 which was greater than in females whose mean ischiopubic index was 71.3±3.1. This dispersion might be related to genetic and environmental factors, which are known denominators for intra and inter-population variability .[9]

Despite the adequate sample size, it was still small for generalization of the study. We measured patient's parameter manually and the value may not be consistent. In addition, the measured parameters may not be considered true as the patients were referred having certain clinical condition which warrants the need of the pelvic radiograph. We measured the parameters of different patients so the level of the site of measurement might not be the same in all cases. The sample size was not adequate to generalize the result and required the measurement with large sample size.

Measurement of ischiopubic index should be taken at reproducible anatomic landmarks if measurements are taken by radiograph and CT pelvis that may provide high accuracy. CT pelvis may provide better anatomic landmarks for the measurement of pubic length, ischial length and ischiopubic index providing better results.

V. Conclusion

The mean pubic length for male was found to be 8.3±0.82cms and 9.21±0.8cms for female. Mean ischial length was 9.05±0.73cms for male and 8.32±0.72cms for female. The ischial and pubic lengths showed statistically significant differences between males and females ($p<0.05$) and therefore have dimorphic potential. In males and females, the mean ischiopubic index were 91.73±5 and 110.9±7 respectively. This may explain the significant higher sexual differences in ischiopubic index observed in the females when compared with that of male counterparts.

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Radiarte: A New Didactic Tool for Teaching Radiology. A Qualitative Study of the Sensory Perceptions of Students

By William Andres Prada Mancilla
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Abstract- *Objetive:* The primary care physician's performance is strengthened by his skills in teamwork and the transmission of ideas to the patient and his family. For the development of these skills, a didactic tool called RADIARTE has been designed. Which, seeks the correlation of the imaging findings through drawing by medical students.

Materials and methods: A qualitative ethnographic study was carried out with cumulative sampling. The data collection was done through field work and focus groups, achieving a triangulation of the students' perceptions of the research.

Results: The perception of the medical students about the didactic tool shows a positive effect on the significant learning being more practical the learning with the correlation by drawing in an established learning environment. The evaluation system proposed allows students to know the transmission of ideas.

Conclusions: The RADIARTE tool is an innovative didactic tool that allows the development of practical and useful skills in the medical student for the performance of medicine in primary care.

MeSh: *radiology, problem based learning, perception, advance medical planing.*

GJMR-D Classification: *NLMC Code: QT 34*



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I. Introduction

The adequate performance of the primary care physician is paramount in the care of patients nowadays in the Colombian health system. One of the most important problems is the development of skills in the work team and the transmission of ideas to patients; therefore, it should be a priority to work on these competences in undergraduate medicine.

One of the areas with the most problems in primary health care is Radiology, where the proper use of resources for making decisions with diagnostic images becomes crucial. Because of this, it is of vital importance that the primary care physician learn to optimize health resources by requesting and interpreting the most important diagnostic images in their area of work. Therefore, in Bogotá, Colombia, a didactic tool based on the schematic drawing for learning in the area of Radiology called RADIARTE has been created by the researcher. This tool is developed in an elective matter that seeks to correlate the imaging findings of the most prevalent diseases to which the primary care physician will be confronted using conceptual associations with drawings created by the students in the development of the subject. The evaluation method used is through equipment and evaluation of the transmission of ideas in an appropriate learning environment an art exhibition where students from other careers, teaching specialists and radiologists assess the information transmitted through the use of drawing. With this tool, they develop skills in meaningful learning, teamwork, and evaluation of the transmission of ideas in an appropriate learning environment (Figure 1-4).

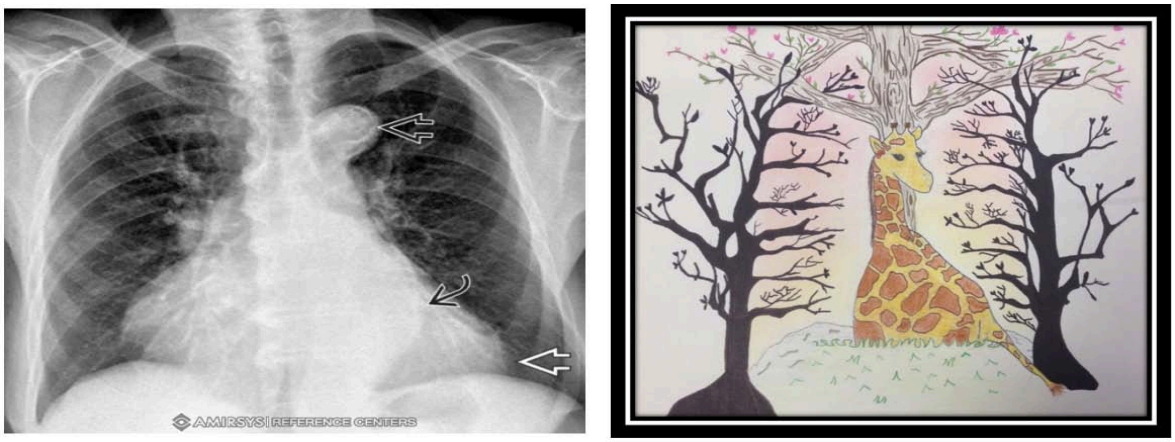


Figure 1: Chest x-ray

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Chest x-ray in AP (anteroposterior) view with severe aortic stenosis and cardiac dilation. A radiopaque image is observed in the apex cardiac caused by concentric ventricular hypertrophy (white arrow), and a tortuosity in the aorta with the presence of calcification (black arrows). In the drawing, the prominence of the aortic arch with the head of the giraffe is interpreted, while its body interprets the hypertrophy of the left ventricle. Likewise, the bony structures are interpreted with the branches of the trees. Image is taken from Amirsys by university platform.

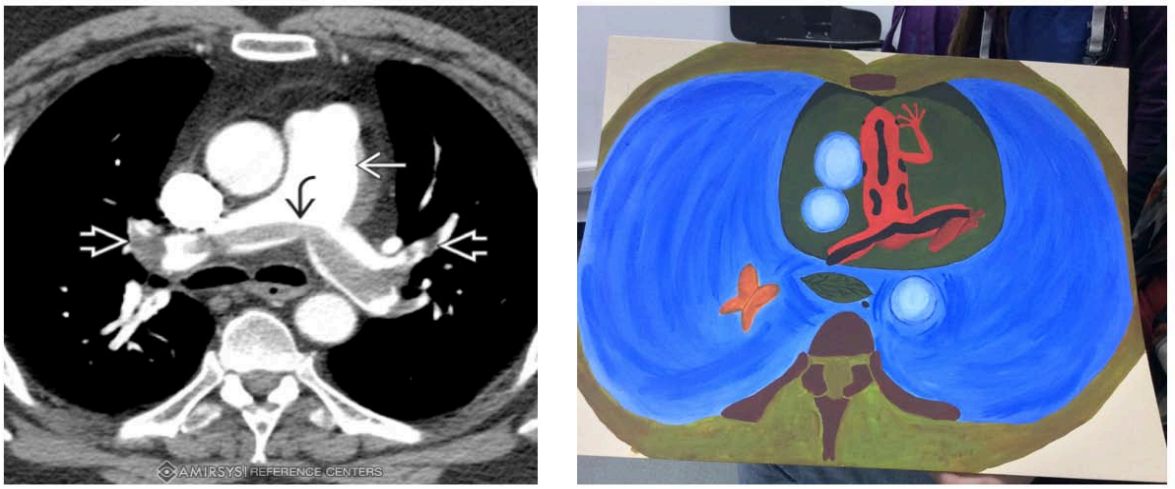


Figure 2: Thorax tomography

Axial reconstruction showing the presence of a thrombus (black arrow) in the pulmonary trunk extending to the pulmonary arteries. Additionally, the presence of a lobar thrombus (white arrow) with the presence of pulmonary hypertension is shown. In the drawing, the trunk of the pulmonary artery is interpreted as the body of a frog, which rests on a leaf that interprets the cardiac silhouette. The pathological finding of the thrombus within the artery is represented by the skin colors of the frog. Image is taken from Amirsys by university platform.



Figure 3: Magnetic knee resonance

Magnetic resonance of the knee in coronal section with the presence of multiseptated para meniscal cysts with medial horizontal meniscal lesions. In the drawing, the femoral condyle is interpreted through the eyes of the owl. Likewise, the cruciate ligaments are interpreted by the owl's beak and the tibia using the neck of the owl. Image is taken from Amirsys by university platform.

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Figure 4: Learning environment

A learning environment where students work in groups to solve learning problems in the development of drawings that correlate with pathological images.

The systematic review of the literature by the researcher shows the evidence of this didactic tool in related areas such as anatomy with positive quantitative results. However, in the area of Radiology, it has not been demonstrated that there are sensorial perceptions that students have with this tool for meaningful learning. For this reason, the present study focused on determining the sensory perceptions of the tenth-semester medical students of the faculty of health sciences at the Rosario Unevirsity with the Radiarte teaching tool (Radiología desde el arte) in the area of radiology. Through qualitative research with an ethnographic approach.

This research model allowed the researcher through ethnography to clarify the sensory perceptions of students in the learning sessions. Subsequently, a focus group session was held to collect data from the research actors. This design allowed to achieve triangulation of the inductive, deductive categories and the theoretical referents to build the conclusions proposed at the end of the project and obtain some recommendations for the improvement of significant learning in the medical students of the Rosario University.

II. Materials and Methods

For the collection of the existing information the state of the art was made with the search of the bibliography in international databases such as Medline, base, Ovid with search engines established by MeSH terms. This raised the questioning and problematization of what is known about this didactic tool in the general literature and learning in the areas of health. For this, the delimitation of the object of study for the use of the tool in medical students in the radiology area was carried out. With this, it was allowed to enter into the design of the elective class and to be able to pose how the research and field work would be developed to methodologically design the research study in the best way. With all this process it was found that the key informants for this study were the 10th-semester students of medicine who were previously exposed to a previous teaching tool in this area. Likewise, they had a more established income profile to be able to effectively develop the study of the variables.

The choice of the proposed methodology and the qualitative method was the ideal to establish the sensory perceptions of the students. The design chosen for this study was intentional and reasoned, where the sampling units were chosen by the discourse of the study where it was intended to obtain the information of the entire accessible population; therefore, the cumulative sampling of 45 students during 18 months was considered.

The development of the field work was carried out by the researcher, who got involved in the classroom with the students interacting with each group about their opinions of the tool used, developing little by little the field diary with the attitudes, expressions, verbal and non-verbal behavior of students, in order to continue building the reformulation of research within emerging design. In this period, the researcher analyzed the learning environment where the didactic tool was developed, completing the information with the opinion of the actors of the research. For the evaluation of the

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work of art, the researcher was present in the qualification of the works by the evaluators taking the verbal opinions and the expressions of the behavior at the time of the evaluation. For the collection of the data, the focused group session was obtained where the data was obtained with voice recording. In addition, the details of the non-verbal language of the interviewees were taken into account, which allowed obtaining additional information from the discussion.

The technique of data collection was carried out by the researcher using the ethnographic method described above, and subsequently two focus group sessions were carried out with random assignment for each semester. The data collection was done through audio recording in the focus group sessions established by the researcher. Subsequently, the transcription of the data was obtained with the help of the naturally speaking program "dragon" and it was exported to Word office 2010. For the analysis of the information was made in the Atlas. Ti program, completed with the use of images established by the researcher in the field work. Finally, the inductive categories that emerged from the voices of the actors were obtained (figure 5).

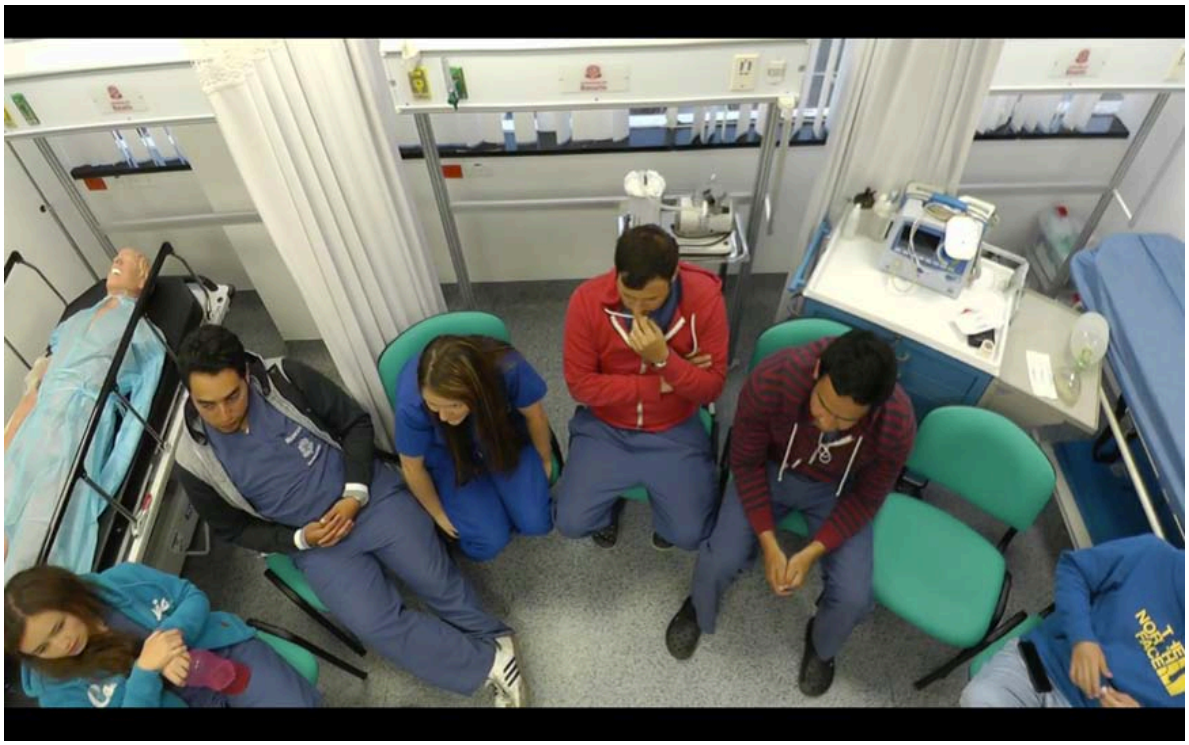


Figure 5: Photograph of students of the focal group located in a manner assigned by the researcher to obtain data collection

III. Results

All students (45) signed informed consent to participate in the research, where six focus groups of one hour duration were conducted, involving students of both sexes with a random assignment for each focus group. 96% of students belonged to the fifth year of medicine between 18 and 25 years old. The information collected for the triangulation was from the focus groups, field work, and theoretical references.

a) Sensory Perceptions

Students consider that it is more practical to learn with this didactic tool since having the option to draw to correlate allows to generate clearer concepts and long-term memory, "... This tool is more practical, we are seeing the image that you give us and one looks for the drawing, it seems to me that one is not going to forget one ... ". Likewise, this tool can generate a better association of the radiological findings of diagnostic images with instruments or figures of daily life. On the other hand, it seems to them that the way of interpreting the pathologies and the anatomical repairs in the images is better, since it allows them to generate a better learning link based on the analysis and the search of images that correlate with the described findings " ... it allows us to let the imagination fly so we can find the correlation; For example, our group in the last work took a long time to choose the image, but one realizes that you can always find an image that correlates with the most characteristic patterns of the image ... ".

The opportunity for this subject to cover more thematic content allows students to grow in their knowledge and correlate more pathologies seen in previous semesters in different specialties "... In this elective we have seen the complete modules with the difference of normal and abnormal, here we have had a

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little more knowledge, this is more creative, and you can stay one in mind ... ".

b) *Evaluation: objective qualification, Self-evaluation, co-evaluation, hetero-evaluation, Transmission of ideas*

The students express that the proposed evaluation process allows them to establish that the objectivity leads to the co-evaluation by pairs of students who do not have experience in the subject and for which it does not influence if the student has other weaknesses and abilities in the hidden curriculum, since the fact of evaluating a result allows to evaluate all the effort in a single work "... an external person or knowledge expert is a pair that sees the same thing and contributes to the result they are doing, or in other methods a personal or professional pair ; Likewise, a third evaluator with many years of experience in teaching is able to see things from various points of view and who can evaluate things as medical auditors do ... ". This allows them to extrapolate the results with what they are going to see as health professionals in a primary care setting where they should imply to the families the results of a medical care process and they who are not experts in the subject. They will have to qualify their work from a totally objective point of view without prejudice to the other characteristics of the doctor.

Students express the importance of transmitting ideas to patients in the professional field so that the fact of being able to express characteristics of the images in a drawing allows the evaluator to establish if what the author means is what expressed on paper "... It is a tool to be understood. Not only make yourself understood with the patient, but any person who comes forward. You must have many tools to be able to show what the patient has and also to your colleagues; also, show everything in the drawing because we are not going to be in the exhibition, which is why we have to show everything in the best possible way and this can be helped when we are later in a conference as speakers or with patients in the office ... ".

IV. Discussion

The society of the 21st century is focused on knowledge and learning throughout life; their individuals learn permanently, understand what they learn, select the appropriate for each context and adapt and transform in front of new situations (1). This reality supposes a major challenge in the university formation, it implies the substitution of a traditional transmissionist pedagogical model, for a model centered on the student, that is integrating and constructive, that possesses learning and teaching strategies that favor the achievement of meaningful learning.

Medical education does not move away from the profound changes in university education, and although historically the pedagogical model in the education of health sciences has been the traditional positivist, passive and content-centered model, in recent decades they have been implemented active teaching and learning methodologies (2); Therefore, a turn towards a constructivist pedagogical model has been initiated, centered on the student, on the development of competences and learning.

Thus, in the decade of the sixties, a group of teaching physicians from McMaster University (Canada) recognized that it was necessary to modify the teaching of medicine, positivist, by the method of Problem Based Learning (PBL). Of constructivist cut; because the disproportionate production of scientific knowledge and technological advances, demands a permanent change every day in the competencies of the health professional (2). There are many studies showing the great effectiveness of PBL in learning in health sciences (3).

Despite the great demonstrated global advantages of the ABP, it has been found that it has problems in the development of the working groups; for example, that learning is group and is not individual, if the group is conflictive does not allow to develop skills well and if the tutor in charge does not have enough skill for group management does not allow the development of skills (4). A cross-sectional study published in the Journal of Ayub Medical College, compared 100 third-year students of the University of Islamabad, finding statistically significant evidence (value of $p < 0.05$) that the most frequent problems of PBL are lack of commitment to students for the preparation of the topic and the clash of personalities within the group (4).

In addition to what the scientific evidence shows, currently in the first years of the medical career, especially in the basic sciences, many contents are still transmitted through lectures, since unlike the clinical areas (where the opportunity to acquire knowledge through practices with real clinical cases, which offers an active pedagogical perspective), in the basic areas the contents are often strictly theoretical and require orientation, structuring and organization of the teacher through the master classes (5). Likewise, the volume of university students growing (from 75 to 100 students per classroom), leads to the master class continues to be widely used, since it is cheaper, it is flexible, it consumes fewer hours of teaching work, it can be cover more topics and it is possible to instruct many more students at the same time (6).

Due to the drawbacks of the new learning models, some tools have emerged to improve learning in the health sciences. In anatomy, for example, a tool based on anatomical drawing has been designed for understanding concepts (7). This tool has shown good results in the learning of the anatomy subject; the students express to understand the concepts better with the anatomical drawing; however, introducing this method within the academic program is very difficult

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since it needs a great amount of time to be able to develop the learning workshops.

Designing teaching tools for learning in medicine is a real challenge. As the scientific evidence supports, the barriers that exist have been raised, despite being a field widely studied for meaningful learning. Likewise, the didactic tools based on drawing learning are very limited and for this reason there is no perception or impact of these tools on medical students.

The RADIARTE tool is a new tool with few bibliographic antecedents of its use in the area of Radiology, for which there is no approach of the perceptions of the students with this new didactic tool. With this investigation it was possible to determine that the didactic design of the tool allows obtaining a better clinical correlation in the association of diagnostic images with schematic images according to what the students describe concerning to their previous experience with other radiology subjects. Likewise, having theoretical contents in addition to the pathology of thorax allows expanding the significant knowledge on the part of students to face other areas of knowledge that require basic training for decision making.

The didactic tool RADIARTE is established as an excellent didactic tool to complement the radiology area in medical students, since it allows complementing previous concepts acquired with a traditional method.

The learning environment used with the RADIARTE tool is established as the ideal scenario to develop meaningful learning by teamwork, as it allows team communication to develop and to know the opinions of group members for decision making and to be able to solve a certain problem. On the other hand, the approach by the teacher and their role in this learning environment allows an optimal student teacher relationship for the resolution of doubts and the comfortable development of meaningful learning.

The form of evaluation of the RADIARTE tool allows developing elements of objective evaluation. The proposed evaluation model allows knowing the perception of an academic pair, a person with knowledge in teaching and a pair without previous knowledge. The co-evaluation model seeks the development of skills for the transmission of ideas, which can be extrapolated to the professional's management with the patient and family members.

V. Conclusions

This research allows us to determine what is more practical to learn with this didactic tool according to the perceptions of the students, since having the option of drawing to correlate allows to generate clearer concepts and long-term memory. Likewise, this innovative tool can better develop mental processes, as it allows improving sensory and cognitive connections for meaningful learning. Working in a group allows to nourish the decisions from the experiences and concepts of each one of the members for the decision making; as well as the coevaluation model allows an objective evaluation and seeks the development of skills for transmitting ideas, which can be extrapolated to the management of the primary care professional with the patient and their relatives.

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Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSM" title to individuals.The 'FARSM' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.



- The "FARSM" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall,Ph.D., FARSS or William Walldroff, M.S., FARSM.

FARSM accrediting is an honor. It authenticates your research activities. After recognition as FARSM, you can add 'FARSM' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSM designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSM title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA). The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.





You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

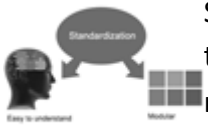


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The FARSM can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.



As FARSM, you will be given a renowned, secure and free professional email addres with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.



The FARSM will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.



The FARSM member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSM, you may send us a scanned copy of all of you credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

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The FARSM member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN MEDICAL (MARSM)

The ' MARSM ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.



The "MARSM" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSM or William Walldroff, M.S., MARSM.

MARSM accrediting is an honor. It authenticates your research activities. Afterbecoming MARSM,you can add 'MARSM' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.



MARSM designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSM, you willbe given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.



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The MARSM member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.





Once you are designated as MARSM, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

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AUXILIARY MEMBERSHIPS

Institutional Fellow of Open Association of Research Society (USA) - OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).



The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.





The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.



The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

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After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:



Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.



Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

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Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

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Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

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2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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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.

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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.



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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.



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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.



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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

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

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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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