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Experimental Study on SAFETY Estimation of Subgrade Modulus of In-Service Ballasted Tracks in KOREA

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Abstract

The subgrade modulus is an important parameter in the railway safety and the analysis of the behavior of a ballasted track. However, because such analyses often use the design subgrade moduli, their results seldom agree with those of finite element(FE) analyses, which use the theoretically determined subgrade moduli. Moreover, it is difficult to experimentally determine the subgrade modulus and spring stiffness of an in-service track because track components such as the ballast, sleepers, and rails are installed over the subgrade. In this study, the subgrade modulus of an in-service ballasted track was estimated by measuring the dynamic response of the track for railway safety. The subgrade modulus was further predicted from a proposed subgrade modulus map developed from the results of field tests and empirical equations for comparison with the design value. The rail displacement of the ballasted track was also predicted by an FE model that considers the spring stiffness at the rail support point, which includes the subgrade stiffness. It was confirmed that the subgrade modulus of an in-service ballasted track could be reliably predicted on the basis of the dynamic wheel load and rail displacement using the proposed subgrade modulus map.

[Keywords] ***Railway Safety, Ballasted Track, Subgrade Modulus, Field Test, Finite Element Analysis***

1. Introduction

The terms "subgrade modulus", "ballast modulus", and "coefficient of ballast" are used interchangeably to describe the same physical parameter, which is the surface pressure load per unit displacement of the loading surface[1]. The subgrade modulus is an important parameter in investigating track safety, deterioration, maintenance, and settlement of ballasted tracks[2][3][4]. It is estimated by a plate load test(PLT) during the preparation of the railway substructure, or subgrade, before the construction of the track. Whereas the characteristics of the subgrade of in-service tracks have not been extensively studied, it is possible to gather relevant information by field measurements. It is difficult to experimentally estimate the subgrade modulus of in-service tracks because the track components such as rails, fastenings, sleepers, and ballast are installed on top of the subgrade. There have been recent attempts to develop a method for measuring the stiffness of the railway subgrade. However, these method requires several field tests and a special test machine and vehicle, which make it very expensive. Moreover, it does not sufficiently consider the behavior of in-service ballasted tracks.

In this study, the subgrade modulus(SM) was determined by an experimental field test on a conventional Korean railway line and compared with that obtained by empirical equations. The SM was thus calculated from the subgrade spring stiffness. Furthermore, a finite element(FE) model of the ballasted track was developed by finite element analysis(FEA).

The track displacement was analyzed and predicted using the FE model. The predictions were compared with the field test results. The theoretically designed SM was first calculated using an empirical equation that had been previously developed from the specifications of the railway subgrade. The measured rail and sleeper displacement, dynamic wheel load, and rail bending stress were substituted into the empirical equation and the result was compared with that estimated from a map of the SM of in-service ballasted tracks developed from the results of field tests.

2. Subgrade Modulus of Ballasted Track

In a ballasted track, the forces generated by the train axle loads are transmitted from the rails, through the sleepers, and to the ballast, foundation, and subgrade. The theoretical model developed by Zimmermann was used to determine the rail displacement[3][4][5]. The model considers the rail as a longitudinal beam that is uniformly and elastically supported at the sleeper support points by the assembly of independent springs that depict the ballast, foundation, and subgrade[3][4][6]. It is also assumed that the deflection of each spring is directly proportional to the generated force[1][4].

It is therefore important to indicate the exact path of a spring when the force and deflection of a ballasted track are discussed[5][6]. DB AG, a German national railway company, classifies springs in terms of the so-called ballast modulus(N/mm³), which is dependent on the rail displacement and surface pressure between the sleeper and the ballast bed(subgrade)[6]. On the other hand, a UIC project report[5] classifies springs in terms of the subgrade modulus, C(N/mm³), which is a measure of the vertical surface stiffness of the track support substructure, considering the pressure load and the load-bearing area, which includes the ballast and earthwork layers. Furthermore, the track compendium classifies springs in terms of the coefficient of ballast(N/mm³), which is also a measure of the vertical surface stiffness of the track support substructure determined by the PLT using the prescribed pressure load and surface area of the loading plate on the earthwork layers. The coefficient of ballast indicates the surface pressure load at which the sleeper subsides by 1mm[4]. The modulus can be defined more accurately as

$$C = \frac{p}{z} \tag{1}$$

Where p is the surface pressure on a hypothetical load-bearing area(N/mm²) and z is the vertical rail displacement(mm) induced by the surface pressure. To determine the SM of a particular section of a track, the rail displacement is measured and substituted into Eq.(1), together with the value for p, which is computed from the relevant wheel load and the hypothetical load bearing area of the sleeper[4][6]. The SM describes the stiffness of a support point taking into account the rail bending stiffness and the hypothetical load bearing area[5]. The vertical stiffness of the subgrade C_{sub}(kN/mm) is therefore considered as the spring constant[5]. Generally, the SM or surface stiffness is determined from the PLT, and the subgrade stiffness is obtained by dividing the SM by the hypothetical load bearing area[4][5][6].

$$C_{sub} = \frac{C}{A} \tag{2}$$

Where C is the SM(N/mm³) and A is the hypothetical load-bearing area(mm²).

Considering that the total elasticity of the ballasted track is the sum of the elasticity of its various components, the total support point stiffness C_{tot}, which characterizes the total elasticity below the rail, can be computed by adding the spring constants of the several springs connected in series[3][5][6].

$$C_{tot} = \frac{S_i}{z} \tag{3}$$

Where S_i is the force at the support point of the i_{th} sleeper(N), and z is the corresponding vertical rail displacement(mm). Because C_{tot} takes into account all the elastic components of the rail support, rigid components such as the concrete sleepers, and concrete structures of the subgrade are not considered in this study.

Only flexible elastic components such as the rail pad, ballast, and subgrade earthwork, which govern the displacement of the ballasted track, are considered. Therefore, the resultant displacement of the ballasted track running through a tunnel or over a bridge is only affected by the displacement of the elastic components between the rail and the concrete surface below. To compare the support point stiffness(C_{tot}) and the track stiffness(k), the relationship between the two is determined using Eq.(4)[5][6]. Practical values of the track stiffness are often used to simplify the relationship[5].

$$k = \frac{C_{tot}}{a} \quad \text{and} \quad C_{tot} = \left(\frac{1}{k_p} + \frac{1}{k_b} + \frac{1}{k_s} \right)^{-1} \qquad (4)$$

Where a is the spacing of the support points(m), k_p is the rail pad stiffness(kN/mm), k_b is the ballast stiffness(kN/mm), and k_s is the subgrade(soil) stiffness(kN/mm). The track settlement depends on the sleeper spacing, bending stiffness of the rail, spring stiffness of the rail pad, subgrade type, and subsoil properties. The proposed optimum SM of DB AG is within the very narrow range of 0.05–0.1N/mm³[4][6]. Based on the results of a recent study, the optimum ballasted track stiffness is within the range of 50–100kN/mm. Various empirical equations have been developed for this purpose[4][6]. Because the SM is based on design values, the results of analyses using the theoretically designed SM do not reflect the performance of in-situ ballasted tracks[4][6]. This has made it necessary to develop a method for estimating the SM and stiffness of in-service ballasted tracks to predict their behavior[4][5]. The SM is directly related to the overall track performance, safety, serviceability, and the amount of repair and maintenance required. For this reason, an estimation of the SM is complex and difficult and requires an extensive experimental case study[7][8]. The empirical equations use to determine the SM consider different factors such as rail displacement, rail bending stress, length of the bending wave, and spring stiffness at the rail supporting point, as well as different train and track conditions[4].

<Table 1> lists the various empirical equations used to determine the SM[4].

Table 1. Empirical equations used for determining subgrade modulus[8].

No	Method	Empirical equation
1	Rail displacement	$C = \frac{Q}{4 \cdot b \cdot y} \cdot \sqrt[3]{\frac{Q}{E \cdot I \cdot y}} = \frac{Q \cdot a}{2 \cdot A \cdot y} \cdot \sqrt[3]{\frac{Q}{E \cdot I \cdot y}}$
2	Rail bending stress	$C = \frac{4 \cdot E \cdot I}{b} \cdot \left(\frac{Q}{4 \cdot \sigma_m \cdot W} \right)^4$

Note: Q: Static vertical force acting on rail(N), E: Modulus of elasticity of rail(N/cm²), I: Moment of inertia of rail(cm⁴), y: Displacement of rail(cm), b: Theoretical rail width(cm), A: Half-sleeper support surface area(cm²), σ_m: Bending stress at middle of rail foot(N/cm²), W: Section modulus of rail(cm³), a: sleeper spacing(cm).

This makes the SM dependent on the rail displacement and surface pressure between the sleeper and the ballast bed. The subgrade moduli of old sections range between 0.05 and 0.15N/mm³, whereas those of newly constructed sections range between 0.3 and 0.4N/mm³. The simplest method to determine the SM is to measure the rail displacement and use Eq.(1) in <Table 1>. It is also possible to determine the SM from the bending stresses generated under load at the middle of the rail foot using Eq.(2) in <Table 1>.

3. Field Measurements

Field measurements of the dynamic response of a test track were conducted. A section of an in-service ballasted railway in the Republic of Korea was used for this study. The test section was a straight and continuously welded rail(60kg/m) in the earthwork(operational speed is average of 120km/h). The design SM(k_{30}) of 0.15N/mm³ was quoted according to the Korean standard(KSF2310) for subgrade materials[9][10][11]. The photographs of the test site and vehicle are shown in <Figure 1>.

The dynamic wheel load acting on the track segment was measured by installing a two-axis strain gauge on the rail web between the two test sleepers. The vertical dynamic wheel loads were measured using shear strain gauges coupled to a full Wheatstone bridge circuit[12].

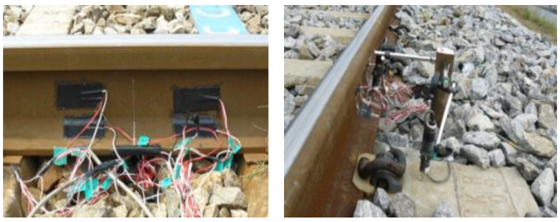
Figure 1. Photographs of test track and train.

(a) View of test section. (b) Test train(EMU).

As shown in <Figure 2(b)>, the displacements were measured using displacement transducers(LVDTs) mounted on a jig anchored under the ballast layer of the track.

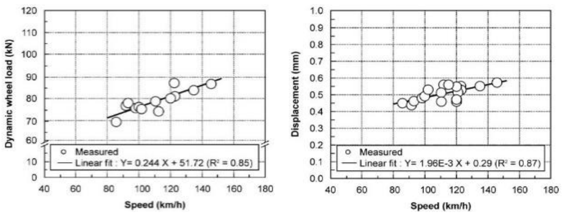
<Figure 3> shows the dynamic wheel load and rail displacement were affected by the train speed. The sleeper displacements and the rail bending stresses increased slightly with the train speed.

Figure 2. Photographs of sensor instrumentation.

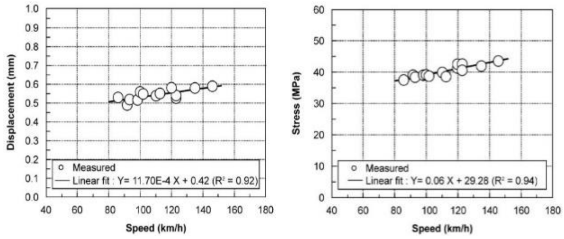


(a) Wheel load and rail bending stress. (b) Rail and sleeper displacement.

Figure 3. Variation of dynamic response of test track.



(a) Dynamic wheel load. (b) Rail displacement.



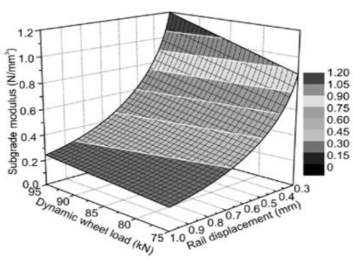
(c) Sleeper displacement. (d) Rail bending stress.

4. Prediction of Subgrade Modulus by Qualitative Analysis

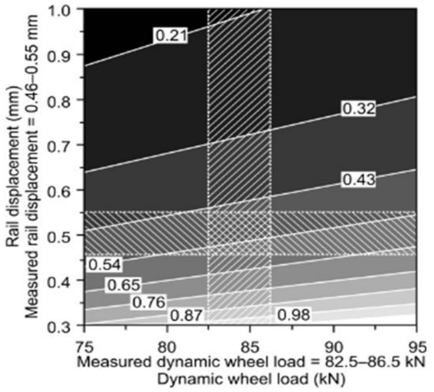
In this study, basic concept of qualitative analysis was used to estimate and predict the SM of a real field, which is presented as a SM map. The measured wheel load and rail displacement for the test speed of 120km/h were prepared as reference data(i.e., indicating the range of the discrete space area). The SM was defined as a dependent variable of the qualitative analysis. The following parameter values were adopted based on the results of the field test and design values[9][10].

<Figure 4> shows the variation of the SM with the rail displacement and dynamic wheel load for a vehicle speed of 120km/h. <Figure 4(a)> is a SM diagram that portrays the SM as a function of the dynamic wheel load and rail displacement. The SM of the in-service ballasted track could be predicted from the intersection region of the SM map shown in <Figure 4(b)> and the range of the test results in both the vertical and horizontal directions. In other words, the intersection region of a duplicated zone between the vertical and horizontal directions in <Figure 4(b)> represented the predicted SM of the in-service ballasted track.

Figure 4. Subgrade modulus map.



(a) SM vs. dynamic wheel load and rail displacement.



(b) SM(value in white box) vs. dynamic wheel load(block in vertical direction) and rail displacement(block in horizontal direction) with measured data.

As shown in <Figure 4>, the discrete space area of the SM decreased with increasing rail displacement and dynamic wheel load. For a rail displacement of less than 0.5mm, the rate of increase in the SM was high. It had a maximum value of 1.2N/mm^3 for a dynamic wheel load of 95kN and rail displacement of 0.3mm. As can also be seen from <Figure 4>, the rail displacement had a greater effect on the SM than the dynamic wheel load. Because the test section of the track was newly constructed(about 2 years old)[11] and the conventional empirical values were taken into account[4][6], the SM could be between 0.3 and 0.4N/mm^3. However, the results of the predictions based on the measured data ranged between 0.43 and 0.76N/mm^3(the intersection region of a duplicated zone shown in <Figure 5(b)>). This means that the SM of the in-service ballasted track was higher and more roughly distributed over a wider range than the design value used for the construction.

To ensure an in-service value comparable to the design value, the rail displacement, which is affected by the vertical track stiffness, was kept constant at 0.7mm while the dynamic wheel load was varied. The ballasted track model used for numerical simulation, developed using the FEA package LUSAS[13]. To investigate the train-induced track displacement of the test track, a time-history analysis was performed and the results were compared with those of the field test.

The rails and sleepers comprised frame elements, whereas the rail pad, ballast, and subgrade comprised spring elements[4][13]. The nodal points between the rail and sleeper elements were connected by spring damper elements with the same properties as those of the rail pad[13][14]. The ballast conditions under the sleeper base were simulated by a spring element with the same properties as those of the ballast[13]. The subgrade conditions under the ballast layer were simulated by a spring element with the properties listed in <Table 2>.

Table 2. Comparison of spring stiffness of subgrade estimated by different methods.

Method	SM(N/mm^3)	Spring(kN/mm)
Design value[a]	0.15	104.0
Proposed map[b]	0.53–0.58	388.3

Note: [a] Design value obtained by PLT, [b] using the proposed subgrade map with measured data(refer to <Figure 5(b)>).

The spring stiffness of the rail pad was 400kN/mm and the corresponding properties of the ballast were 200kN/mm, according to the design data[10][11]. The spring stiffness of the subgrade for the modulus shown in <Table 2> was calculated, assuming the hypothetical load bearing area to be 7.628×10^{5}mm^2[11][13].

<Table 3> compares the SM and vertical rail displacement of the test track obtained by different methods. The measured rail displacements are compared with those of the FEA for the different subgrade moduli in <Table 3>.

Table 3. Comparison of FEA and measured results.

Load (kN)	SM(N/mm^3)		Rail displacement(mm)		
	A	B	Test	FEA(1) C	FEA(2) D
82	0.15	0.58	0.461	0.604	0.456
86	0.15	0.53	0.507	0.634	0.476

Note: A : Design value, B : Obtained using proposed SM map, C : Obtained using design value of SM, D : Obtained using proposed value determined from proposed SM map.

It is interesting to note that the displacements corresponding to the design subgrade moduli by the PLT were greater than those corresponding to the moduli estimated from the proposed SM map. Consequently, the analytically obtained displacement based on the design SM(FEA(1)) underestimated the behavior of the in-service track.

Moreover, the analytically obtained displacement based on the SM estimated from the proposed SM map(FEA(2)) was less than that of FEA(1). The design SM was approximately 70% less than that estimated from the proposed SM map.

It is therefore considered that the SM directly affects the displacement of an in-service track. Furthermore, the difference between the experimental and FEA(2) displacements was less than that between the experimental and FEA(1) displacements.

The FEA(1) displacement was approximately 1.2 times the experimental displacement, whereas the FEA(2) and experimental displacements were in good agreement with only approximately 5% discrepancy. It is supposed that the FEA results obtained using the SM estimated from the proposed SM map are sufficiently reliable indicators of the behavior of an in-service track.

5. Conclusion

The SM of an in-service ballasted track was assessed by performing field tests using actual vehicles running along service lines. For comparison with the design value, the modulus was predicted using a proposed SM map developed from the results of field tests and empirical equations.

A comparison was performed between results obtained from conventional theory and results of the field test, and the comparison results contributed toward the development of simple estimation methods(not requiring expensive experiments and equipment) for the SM of an in-service ballasted track. The SM of an in-service track can thus be qualitatively predicted by the proposed SM map and a simple field test.

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Assessment of Relative Kidney Function in KOREA NUCLEAR Medicine Study Evaluation of the Effectiveness of Geometric Mean According to Kidney Depth

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Abstract

When measuring relative renal function ratio(RRFR) in nuclear medicine tests, radiation is usually counted using a posterior detector. However, when there is a difference in the depth of the left and right kidneys, counting of the radiation using only the posterior detector may result in a lower counting rate of the deeply located kidneys.

In this study, we investigated the usefulness of geometric mean in measuring the RRFR by applying a geometric mean after counting radiation using the anterior-posterior detector when the depths of the left and right kidneys are different.

Kidney model studies and clinical studies were performed using the Symbia T16 gamma camera system to obtain anterior and posterior images. For RRFR calculations, RRFR was measured by applying arithmetic mean, once with information only counted by the posterior detector. Again, with the information counted by the anterior and posterior detectors, the geometric mean was applied to measure the RRFR.

The results of the kidney model study were y = 0.23 + 0.38x, R2 = 0.986(p = 0.000), and the clinical results were y = 0.25 + 0.16x and R2 = 0.823(p = 0.000). It can be seen that as the depth difference of the elongation increases, the function ratio of the deeply located elongation increases gradually among the RRFRs in which the geometric mean is applied with the information counted by the anterior and posterior detectors.

In kidney examinations conducted by the nuclear medicine department, the RRFR is generally measured using only the posterior detector. However, when the RRFR was measured using the geometric mean with the information from the anterior and posterior detectors, it was confirmed that the function ratio of the deeply located kidney rises. The above results suggest that the attenuation between the kidney and the detector is corrected. For patients with different depths of the left and right kidneys, it would be useful to measure the RRFR by applying a geometric mean with the both detectors.

[Keywords] ***Nuclear Medicine Safety, Kidney Model, MAG3 Renal Scan, Geometric Mean, Relative Renal Function***

1. Introduction

The kidney is a bean-shaped organ, weighing about 150 mg and it exists bilaterally in the back of the lower abdomen. Typically, as the right kidney is located inferior to the liver, so the left kidney is slightly more superior than it. The kidney is an organ that maintains a uniform in vivo environment and excretes waste product. It also, has endocrine functions, which maintain homeostasis and produce and activate hormones[1].

Evaluations of kidney size, shape, function and disease include urinalysis, pyelography, sonography, computed tomography(CT), magnetic resonance imaging(MRI), and nuclear medicine scan; nuclear medicine scans are utilized for the diagnosis of renal disease, decisions regarding therapeutic intervention, and follow-up[2].

99mTc-DTPA(99mtechnetiumdiethylene-mine pentaacetic Acid), or I-131 OIH(Iodine-131 orthoiodohippurate) in bolus[3][4][5].

99mTc-MAG3 is currently the most widely used radiopharmaceutical for the dynamic renal scan in many hospitals instead of 99mTc-DTPA and hippuran. It is a type of tri-amidemercaptide(N_3S) complex, with an excretion rate of 0.6-0.7, which is three times that of 99mTc -DTPA. It shows higher binding to plasma protein than hippuran(90%), has smaller distribution volume, and shows about 5% erythrocyte consumption. Kidney/background site ratio is 3.7 on average, which is about twice that of 99mTc-DTPA[6].

Dynamic renal scan using 99mTc-MAG3 dynamically provides continuous visualization of the process of radiopharmaceutical uptake into the kidney and its excretion. After 99mTc-MAG3 is injected-intravenously, the scan dynamically visualizes the kidney and urinary tract. The acquired image is used to evaluate renal function after quantitative analysis[7].

99mTc-MAG3 dynamic renal scan comprises of three phases. The first phase is the vascular, filling phase in which radioactivity rapidly increases in the kidney during the first 60 s after bolus injection, and the second phase is the secretory phase in which a tracer in the blood is consistently excreted from the kidney; in 3-5 min, the tracer's concentration is expeditiously decreased. The third phase is the excretory phase in which the radioactivity decreases after its peak. The radioactivity half-life in the excretory phase is approximately 7-10 min. In the second phase, the relative renal function can be measured using the ratio of bilateral kidneys during the 1-to-2.5 min post injection period, and based on total renal function, relative renal function can be shown in ratio[8].

The measurement of the relative renal function is an important indicator for the therapeutic plan of a patient with unilateral kidney disease. Relative renal function in the range of 45%-55%, is considered normal[9].

A premise for measurement of the relative renal function is an attenuation of radioactivity between the kidney and gamma camera. If normal, 90% or more shows depth differences of 2 cm or less between the two kidneys, based on the body surface. However, with a deformity of either the spine or an ectopic kidney, it must be compensated for in-depth difference. The effective attenuation coefficient for technetium is 0.12/cm, and the linear attenuation coefficient is 0.153/cm[10]. For example, a preceding study reveals that for a kidney with 50:50 function, a 1cm difference in depth of the two kidneys shows a ratio of 53:47, whereas a 2 cm difference shows a ratio of 57:43, which signifies a shift in the functional ratio between the kidneys[11].

The kidney is a retroperitoneal organ located between the 11th thoracic vertebra and 3rd lumbar vertebra. During a renal scan using a gamma camera, the patient, generally, is in a supine position with the detector located under the table. The detector counts the gamma rays and creates an image. In the case of a transplanted kidney, the detector is located in front of the patient in a supine position for detection of gamma rays[12].

A commonly used attenuation correction software utilizes the Tonnesen equation, which is based on kidney depth data-established in non-Asians[13]. However, as the Tonnesen equation measures kidney depth using a sonography probe at a tilted angle, a precise attenuation correction is difficult. As expected, it shows the disparities associated with calculating with the detector on a supine patient in the renal scan. Moreover, since the data are based on a normal population without an unusual condition of the kidneys, there are limitations to its application on a transplanted kidney, enlarged kidney or a shrunken kidney, due to a lesion[14].

This study is based on the assumption that the depth of kidneys is different for each individual. Additionally, the kidney counting rate, acquired from the conventional method that places a detector in the back of a supine patient, may show a smaller result for more deeply located kidneys than more superficially located kidneys. This change in the depth of the kidney can be due to a renal lesion, ectopic kidney, or simultaneous possession of a transplanted kidney and own kidney. After measuring the precise depth of both kidneys in patients administered 99mTc-MAG3 by CT of the abdomen, the relative renal function ratio, acquired from the arithmetic mean of data collected with only a posterior detector, conventional kidney assessment, and relative renal function ratio (RRFR) acquired from the geometric mean of data collected with both posterior and anterior detector were compared. These measures were studied to determine the effectiveness of attenuation compensation according to the differences in the depth of the kidney.

For convenience, the difference in the depth of the two kidneys shall be phrased the kidney depth difference(KDD). Regarding the relative renal function(RRF), the difference between an RRFR calculated from the arithmetic mean acquired with only a posterior detector and an RRFR calculated from the geometric mean acquired with a posterior and anterior detector is called the RRF, difference(RRFD).

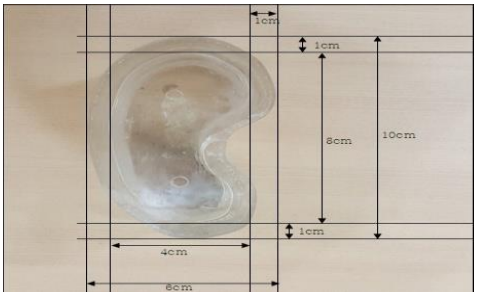
2. Method

2.1. Kidney model experiment

2.1.1. Kidney model

A kidney model was made with a 1cm thick acryl and size for a normal adult. It is 8cmx4cmx4cm internally and has a hole where the radioactive isotope can be injected <Figure 1>.

Figure 1. Kidney model.



2.1.2. Method

2.1.2.1. Change in depth of left and right kidney

On the patient examination table, an acrylic plate(25cm×25cm×1cm) was placed level. The experiment was conducted with the left and right model kidneys on the plate. Then, 20mL of 99mTc-pertechnate 2 mCi(74 Mbq) was administered into the left kidney, whereas 20mL of 99mTc-pertechnate 1.5 mCi(55.5Mbq) was administered into the right kidney. The difference in administered radioactivity signifies the difference between functions of the kidneys.

A piece of acryl(10cm×15cm×0.5cm) was placed under the right model kidney one by one, raising the height by 0.5cm, and height was raised from 0 to 0.5cm, 1cm, 1.5cm, 2cm, then 2.5cm with five acrylic plates to reflect difference in depth of the kidneys by 2.5cm.

The total height including the acrylic plates was made to be level by placing another piece of acryl on top of the left kidney when one acryl is placed under the right kidney <Figure 2>, <Figure 3>.

Figure 2. Expression of difference in depth of right and left kidneys using kidney models.

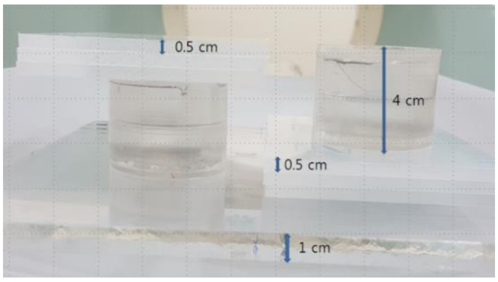
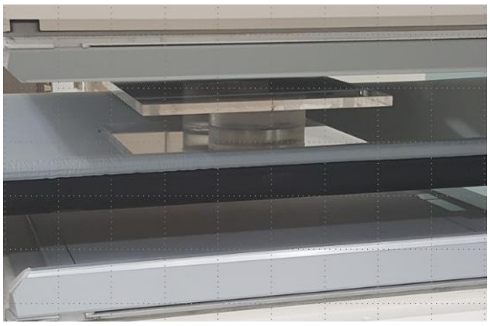


Figure 3. Radiation counting using kidney models.



2.1.2.2. Acquirement of image and calculation of relative renal function ratio

Anterior and posterior images were acquired using the Symbia T16(Siemens Healthineers, Germany) gamma camera. The matrix size was 256×256, and size of the energy window was 140 keV ± 15%, and zoom 1.45 to be calculated for 60 seconds. For confirmation of reproducibility, five images were taken at different kidney depths, for a total of 30 images.

The RRFR of the kidneys was compared with arithmetic mean using the data detected by only the posterior detector, then the, RRFR of the kidneys with geometric mean of data collected from anterior and posterior detectors.

Syngo workstation processing tool(Siemens Healthineers, Germany) was utilized. To minimize the error in establishing the region of interest(ROI), the uniform ROI was established by using a copy and paste method.

2.1.2.3. Relative renal function ratio

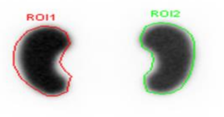
ROI in both kidneys is established in the renal scan image, then, total counts and pixels are measured in, which the number of pixels in ROI of kidney and ROI of background site is corrected <Figure 4>,<Figure 5>.

Figure 4. Measurement of relative renal function ratio using kidney model(arithmetic mean).

Posterior

Parameters	ROI 1	ROI 2	Total
Split Function (%)	47.77	52.23	
Kidney Counts (cpm)	1029843	1126041	2155884

Figure 5. Measurement of relative renal function ratio using kidney model(geometric mean).



Anterior + Posterior

Parameters	ROI 1	ROI 2	Total
Split Function (%)	53.38	46.62	
Kidney Counts (cpm)	1320233	1153271	2473504

The formula that calculates RRFR of the kidneys with data collected from the posterior detector(1) and formula hat calculates RRFR of the kidneys with geometric mean of data collected from anterior and posterior detectors(2) is as following.

(1) RRFR using arithmetic mean of posterior detector.

$$Rt = Rt \div (Rt + Lt) \times 100\ (\%)$$
$$Lt = Lt \div (Rt + Lt) \times 100\ (\%)$$

(2) RRFR using geometric mean of anterior and posterior detectors.

$$Rt = \frac{\sqrt{Rt_{ANT} \times Rt_{POST}}}{\sqrt{Rt_{ANT} \times Rt_{POST}} + \sqrt{Lt_{ANT} \times Lt_{POST}}}\ (\%)$$
$$Lt = \frac{\sqrt{Lt_{ANT} \times Lt_{POST}}}{\sqrt{Rt_{ANT} \times Rt_{POST}} + \sqrt{Lt_{ANT} \times Lt_{POST}}}\ (\%)$$

2.1.2.4. Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Science software(version 23.0; SPSS Inc, USA). Linear regression analysis was performed on the influence of KDD on the difference between RRFR acquired from data calculated from posterior detector and RRFR acquired from data using geometric average of the results from anterior and posterior detectors. If the p value was less than 0.05, it was considered statistically significant.

2.2. Clinical patient study

2.2.1. Patient information

Among the patients who had undergone a 99mTc-MAG3 renal scan in our nuclear medicine department from Jan. 2015 to Dec. 2016, 57 patients(21 males, 36 females; average age, 47.08; age range, 5-70 years; average height, 160.47cm; and average weight 57.80kg) were selected as subjects.

Patients were excluded who had not undergone an abdominal CT scan or had only one kidney after surgical removal or a horseshoe kidney.

2.2.2. Experimental method

2.2.2.1. Measurement of kidney depth

The depth of the kidneys was measured based on the method proposed in a preceding study published in 2000, which was applied in this study[10].

Based on the abdominal CT images of the patients, the depths from the skin to the most anterior point of the kidney(a) and the most posterior point of the kidney(b) were measured from an image that included the renal hilum of the kidney, which was added, and divided in half to calculate kidney depth. To procure reproducibility, it was measured three times <Figure 6>.

Figure 6. Kidney depth measurement.

Note: Abdominal CT image of one of the patients, the measurement of kidney depth was obtained by adding the respective depths from skin to front and back of kidney and dividing the sum in half based on the image that depicts the renal hilum.

2.2.2.2. Acquirement of image and calculation of relative renal function ratio

The test was conducted using the Symbia T16(Siemens Healthineers, Germany) gamma camera. Anterior and posterior detectors would be closed onto the patient in supine position, with injection of 99mTc-MAG$_3$15 mCi(555 MBq).

After making a calculation with the anterior and posterior detectors, the RRFR was calculated using the data collected from the posterior detector only. Next, the RRFR was calculated with the geometric mean of the data collected from the anterior, posterior detectors. The RRFR was measured 1-2 min after the injection.

The Syngo workstation processing tool(Siemens Healthineers, Germany) was used in the measurements, and to minimize the error in establishing ROI, uniform ROI was established by using copy & paste method <Figure 7>, <Figure 8>.

Figure 7. Radiation counting.

Note: a) Radiation counting conducted with only posterior detector, which is a conventional renal test method. b) Radiation counting conducted with anterior and posterior detector for application of the geometric mean.

Figure 8. Time-activity Curve and relative renal function ratio(%) of left and right kidneys, Counts per min(cpm).

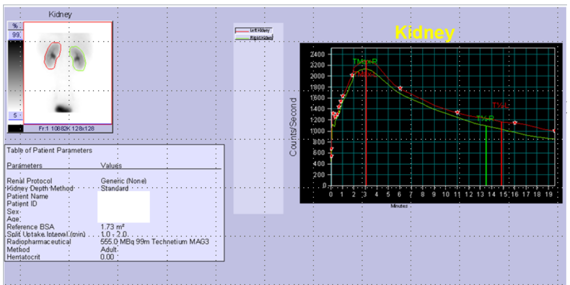


Table of Result Summary

Parameters	Left	Right	Total
Split Function (%)	51.5	48.5	
Kidney Counts (cpm)	109968	103618	213586
Time of Max (min)	3.002	3.002	
Time of ½ Max (min)	14.8	13.5	

2.2.2.3. Relative renal function ratio

ROI in the both kidneys is established in the renal scan image, then, total counts and pixels are measured, which the number of pixels in ROI of kidney and ROI of background site is corrected.

The formula that calculates RRFR of the kidneys with data collected from the posterior detector(1), and the formula that calculates RRFR of the kidneys with the geometric mean of data collected from the anterior and posterior detectors(2) is as following <Figure 9>.

(1) RRFR using arithmetic mean of posterior detector.

$$Rt = Rt \div (Rt + Lt) \times 100\ (\%)$$
$$Lt = Lt \div (Rt + Lt) \times 100\ (\%)$$

(2) RRFR using geometric mean of anterior and posterior detectors.

$$Rt = \frac{\sqrt{Rt_{ANT} \times Rt_{POST}}}{\sqrt{Rt_{ANT} \times Rt_{POST}} + \sqrt{Lt_{ANT} \times Lt_{POST}}}\ (\%)$$
$$Lt = \frac{\sqrt{Lt_{ANT} \times Lt_{POST}}}{\sqrt{Rt_{ANT} \times Rt_{POST}} + \sqrt{Lt_{ANT} \times Lt_{POST}}}\ (\%)$$

Figure 9. Application of the geometric mean.

Note: Anterior image(first row) calculated from detector 1, and posterior image(second row) calculated from detector 2, are calculated from their geometric mean to be shown in another image(third row).

2.2.2.4. Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Science software(version 23.0; SPSS Inc, USA). Linear regression analysis was performed on the influence of KDD on the difference between RRFR acquired from data calculated from posterior detector and RRFR acquired from data using geometric average of the results from anterior and posterior detectors. If the p value was less than 0.05, it was considered statistically significant.

3. Results

3.1. Result of model kidney experiment

When RRFR was measured with data acquired from the posterior detector, it was an average of 51.27:48.64 if there was no difference in kidney depth. With greater KDD, RRFR would decline in the right kidney, which was located deeper. In maximum KDD of 25mm, it showed average RRFR of 62.31:37.68 <Table 1>.

Table 1. Measurements of RRFR according to the difference in kidney depth, which ranges from 0 to a maximum of 25mm(Average of five measurements in each depth difference).

	Posterior detector		Both detector	
Difference	Left	Right	Left	Right
0 mm	51.27	48.64	51.68	48.31
Right. 5 mm	55.15	44.90	53.39	46.60
Right. 10 mm	56.99	42.99	53.48	46.50
Right. 15 mm	59.00	40.98	53.37	46.61
Right. 20 mm	60.62	39.36	53.32	46.78
Right. 25 mm	62.31	37.68	53.29	46.70
Mean±SD	57.56±3.99	42.43±3.98	53.09±0.69	46.92±0.69
CV	6.93	9.38	1.29	1.47

Note: SD(Standard Deviation) / CV(Coefficient of Variation).

After comparing RRFR the using geometric mean of data collected from both anterior and posterior detectors, when there was no difference in KDD, the average was 51.68:48.31, which was not so different from the RRFR acquired from the posterior detector only. Even if KDD increased, there was little difference in RRFR when compared to that of 0 KDD.

The absolute value of KDD was set as an independent variable, and the difference between RRFR calculated from the arithmetic mean acquired with only posterior detector and RRFR calculated from geometric mean acquired with posterior and anterior detector(RRFD) was set as the dependent variable for linear regression analysis.

Regression equation between KDD and RRFD is y=0.23+0.38x, R2=0.986(p=0.000).

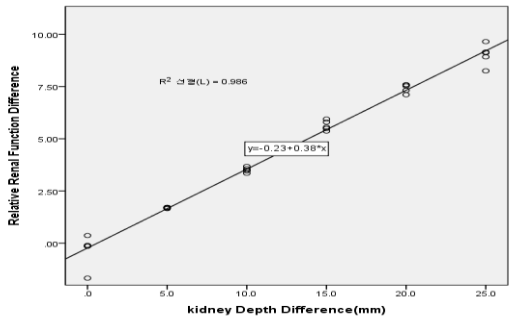
As p< 0.05, the regression model is statistically significant with R2=0.986, which changes in RRFR according to KDD and can be explained in the high standard of 98.6% <Table 2>.

Table 2. Statistics in model kidney experiment.

Variables	B	S.E	β	t	*p*	Adj-R^2	F
	.377	.008	.993	44.572	.000	.986	1986.650***

It is shown that the geometric mean of RRFR in kidneys that are located deeper increases when it is measured with anterior and posterior detectors, compared to the RRFR measured using the data collected with posterior detector as KDD increases <Figure 10>.

Figure 10. Scatter plot of model kidney experiment outcome.



3.2. Results of the clinical study

As for the depth of kidney, the left kidney was an average depth of 72.03 mm, and 78.28 mm of the right. Male showed an average depth of 81.39 mm of the left kidney and 87.06 mm of the right, whereas Female showed an average of the left kidney 66.56 mm, and 73.16 mm of the right. Both sexes showed a deeper location of the right kidney than the left, with the difference in depth of the kidneys ranging from 0.34 mm up to 60.46 mm <Table 3>.

Table 3. Average depth of the kidney in male and female.

Depth	N	Mean(mm)	SD(mm)
Left	57	72.03	20.93
Right	57	78.28	22.13
Male left	21	81.40	26.22
Male right	21	87.06	28.38
Female left	36	66.57	14.98
Female right	36	73.16	15.81

When comparing RRFR acquired from the arithmetic mean of data collected from the posterior detector with the patient in supine position to RRFR acquired from geometric mean of data collected from anterior and posterior detectors, 50 of 57 patients showed higher RRFR in the deeper-located kidney when both detectors are used rather than when only the posterior detector is used. In addition, it showed reduced RRFR in more superficial kidney.

Absolute value of KDD was set as an independent variable, and the difference between RRFR calculated from the arithmetic mean acquired with the only posterior detector and RRFR calculated from geometric mean acquired with both posterior and anterior detectors(RRFD) was set as the dependent variable for linear regression analysis <Table 4>.

Table 4. Statistical outcome of clinical experiment.

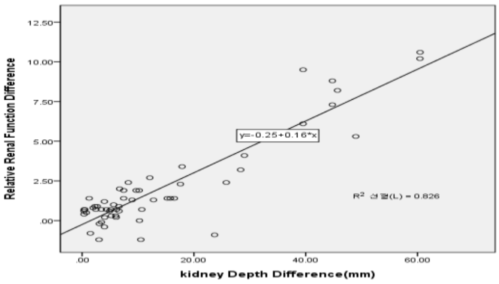
Variables	B	S.E	β	t	*p*	Adj-R^2	F
	.163	.010	.909	16.175	.000	.823	261.642***

The regression equation between KDD and RRFD was y=0.25+0.16x, R2=0.823(p=0.000).

As p< 0.05, the regression model is statistically significant with R2=0.823, which changes in RRF according to KDD can be explained in the high standard of 82.3%.

With a greater difference in KDD, RRFR of the deeper kidney was shown to be greater when it is calculated from geometric average of both anterior and posterior detectors outcomes than when calculated from the measurement of only posterior detector <Figure 11>.

Figure 11. Scatter plot of clinical experiment out- come.



4. Discussion and Conclusion

99mTc-DMSA is simple and short when comparing RRFR using the geometric mean, but in our hospital, most of the patients taking 99mTc-DMSA are infants, and it is rare for the 99mTc-DMSA scan and abdominal CT scan to be conducted simultaneously, 99mTc-MAG3 Renal Scan patients with a greater number of the experiment subjects were set as the subject for sampling.

Dynamic renal scan using 99mTc-MAG3 is a typical method of evaluating renal disease that dynamically provides continuous visualization of the process of radiopharmaceutical uptake into the kidney and its excretion.

In this study, we performed static renal scan using kidney models and dynamic renal scan using 99mTc-MAG3.

This study was a comparative analysis of the method that calculates RRFR based on Arithmetic mean of the data acquired from only posterior detector to another method that calculates RRFR based on geometric mean of the data acquired from anterior and posterior detector when conducting dynamic renal scan using 99mTc-MAG3, studying the effectiveness of applying geometric mean according to KDD.

In renal scans conducted in nuclear medicine, it is more conventional for patients in a supine position to be scanned by only the posterior detector, as. most of the population shows little difference in depth of their kidneys. However, for patients undergoing a renal scan in a hospital, they may have a higher risk of abnormality in renal function or alteration of location compared to the general population. From the outcome of this study, 23(40.35%) of 57 patients showed KDD of at least 10mm.

According to a preceding study published in 2006, 99mTc-MAG3 scan may influence RRFR when there is a difference in kidney depth[15], In addition, according to a study published in 2011, when the location of the kidney is altered by liposarcoma, RRFR calculated with only posterior detector showed RRFR of 85:15, whereas RRFR calculated with geometric mean changed up to 41:59[16].

For children with severe hydronephrosis, it was reported that more precise result could be acquired when using geometric mean in a 99mTc-DMSA scan[17]. There is also a study reporting that when there is an anatomical abnormality in the kidney, using the geometric mean in 99mTc-DMSA can result in more reliable outcomes[18].

A study argued that when conducting 99mTc-MAG3 scans of kidney donors, the conventional method and the method that uses the geometric mean show differences of up to 46% in the function ratio, thus, geometric mean must be used to heighten the precision of the renal function evaluation[19].

This study has also achieved a similar outcome as seen in preceding studies.

When there is a difference in the depth of the kidney, a renal scan performed with only a posterior detector has a disadvantage in that the attenuation of radioactivity between detector and deeply-located kidney is not reflected appropriately. However, when applying the geometric mean to the anterior and posterior detector calculation, the radiation that is discharged from the kidney that is located deeper can be counted more easily using an anterior detector, which can be considered to compensate for the reading of the posterior detector in the attenuation of relatively deeper-located kidney.

This study measured the depth of the left and right kidneys using abdominal CT image, which had not been utilized in former studies. It distinct from preceding studies that analyzed the influence in RRFR based on the image. In addition, this study has increased its credibility by supporting the outcome of the clinical experiment with model kidney experiment. However, 34 patients of 57 subject showed a difference in depth of kidneys of less than 10 mm, whereas 23 patients showed a difference of 10 mm or greater. As the measurement of kidney depth in abdominal CT image is within the range of error if the difference is minimal, the influence to RRFR would be small when the difference is minimal. Therefore, additional experiments with a greater number of samples and more distinct categories for different kidney depths would achieve more statistically balance results.

The renal scan, conducted in nuclear medicine, generally uses only posterior detector to calculate RRFR. However, when data are acquired from both anterior and posterior detector, adjusted with the geometric mean, the RRFR of a deeper-located kidney is higher than the RRFR calculated with only the posterior detector.

The results, as previously mentioned, are considered adjusted for the attenuation between kidneys that are located deeper and the detector, If there is a difference in the depth of the left and right kidneys due to a lesion in or around kidney, deformity in spine, or ectopic kidney, or in the case of a patient who received a kidney transplant and did not remove an original kidney, the kidney located deeper would compensate for its function. Therefore, when compared to a conventional scan method (posterior detector counting), a more precise calculation of kidney function is anticipated to be possible without additional cost or time consumption.

* This project was confirmed to be exempt from a review by the Institutional Review Board(IRB).

* We declare that this study is based on previous study published in 2016. In this study, We have procured additional samples and supplemented with a model kidney experiment[20].

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A Communalistic Approach for the Realization on Gender-Equal Society to Overcome a Social CRISIS

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Abstract

Equality between men and women is one of the social questions that will sustain as long as sex-based discrimination remains unchanged. Various approaches have been made from many different aspects to do away with it. All this notwithstanding, it remains a sensitive issue until now, indicating that all approaches so far made are of no avail with immanent limits. Furthermore, there has lately been a transformation in national leadership from government-initiation to the joint participation of the government and civil society, both of which having its own respective role in what may be called participatory reform. Likewise, all social sectors are to join in recognizing, sorting and redressing social issues at hand.

From this point of view, "a gender-equal community" is suggested in this study as a means of resolving the structural and sustaining issue of inequality between men and women under communalism. To provide a theoretical background, the details of the proposed community of gender equality are discussed on the basis of communalism. This is to realize a society in which men and women stand on an equal footing. This study signifies a new approach as has never been attempted to tackle the problem of gender inequality, though the model presented here is of an initiative nature.

[Keywords] ***Social Crisis, Communalism, Gender Equality, Gender-Equal Community, Local Autonomy***

1. Introduction

In this study, an approach is suggested under communalism in view of the limit institutional approach has in dealing with the question of gender equality at present, instead of an up-down approach intended to change existing systems in search of new social behavior or understanding, it goes the other way around for a bottom-up process towards institutional reform. This approach is more fundamental than institutional in that it tries to realize equality between the two sexes through common understanding or a transformation in the way of thinking. In this context, this study is to initiate a change in approaching the issue of equality between sexes with a proposal for a gender-equal community movement. This proposal is based on communalism, which provides a theoretical ground for a series of community movements designed to redress social problems.

The question of women remains one of the major social issues until the 21st century. On the one hand, this question has been approached with women as the weak in society as a whole, or on the other hand, for a very long time, women as the weak in their relation with men. Therefore, how to support women in welfare programs in consideration of their weaker social position has been one aspect of this issue. The other aspect is more fundamental in that the equality of men and women in terms of personality and human rights is in question. At the initial stage, when discrimination of women as compared to men became an issue from the standpoint of personality and human rights, the matter of primary concern were their suffrage and other political rights. Later, as women advanced to society in full with widening opportunities for higher education for them, new attempts were made to do away with discrimination between the two sexes in economic and social aspects as well, not only political as before.

This change has contributed in a considerably measure to enhancing the rights and interests of women at the initiative of the government alone or through cooperation between the government and women's organizations. However, for a number of centuries, efforts to resolve the question of women have been far from being satisfactory with noticeable difference between countries. It was so because the issue of gender equality, to a great extent, is a matter of culture and because efforts to resolve this issue concentrated in the main on institutional changes. In the cultural point of view, discrimination toward women derived from family and social systems over a long period and there were not enough efforts to change it. Any attempt to reform the existing systems or to set up new systems takes a long time to be realized and is likely to touch off cultural crash to make the whole work unproductive.

In Korea, the role of the government and its scope have changed in recent years. The government is no longer as initiative, exclusive and unilateral in locating, classifying and tackling social issues because it now has to share information and work with interest groups representing various facets of society for participatory governance. This change of ruling environment has made old systems impractical in policy programs at national as well as community levels, requiring the government to respond to social demand with all interest groups in consideration[1].

2. Gender Equality and Communalism

2.1. Gender equality and the limit of various approaches

Gender equality is another way to express the question of women. Since gender equality was first brought up as a matter of practical and social concern, it has always been women who were at the center. In other words, the question of women has its theoretical root in the issue of discrimination of women and it is just the same in all related arguments. Still, to some extent, discrimination between men and women has been understood as an issue subordinate to institutional structure of the times. However, discrimination by sex has not always been a dominating paradigm in human history. In the primitive age, both sexes were equal. It was social changes in the later ages that made them unequal.

Approaches so far made to remove discrimination by sex have come through many changes with the passage of time, concentrating on institutional reform. Until now, efforts to make women equal as men in their rights have focused on the reform of systems and therefore, had a limit in that various groups interested in women's question failed to share common understanding. Due to the lack of common understanding, it was difficult for them to make a multi-faceted approach for the sake of institutional and mental reform. Required to help women win equal rights as men is a new mechanism in which all interested parties are represented in full consideration of institutional and mental aspects of the issue. From this point of view, communalism, in which institutional and mental aspects of this question are in due consideration, may be worth discussing as an effective way to realize equality between men and women.

2.2. An approach based on communalism

The participatory government model under study here is for a new type of national governance, which represents views and opinions on a broad basis as to what makes a good government. The participatory model considers traditional bureaucrat as blocking the way to an efficient government, stressing the participation of low social classes and civil society. Emphasized in this model is the need of a new way of public service and community movement as a tool needed to make the government more efficient. The exchange of views and opinions between public officials and their customers and their joint participation in communalism are considered to be of a great necessity[1].

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From the viewpoint of communalism, how to keep community active in public service is a matter of great significance. Joint production and individual participation are necessary in a broader scope, much more than the bureaucrat[2]. All community members are called on to work together to improve the quality of community life and for this, their participation and suggestions are welcomed at all stages. If community members are to achieve their common cause, they should work hand in hand to locate and resolve problems. Their fullest participation is a must for the success of community devoted to their common interest.

2.2.1. The understanding of communalism

Community is a concept hard to give a clear definition but is regarded as an ideal type of social relation more valuable than society in which citizens are free and equal. It was at the time of the Industrial Revolution and rapid urbanization that such community was in full discussion as having common objective, practice, relation and moral standard[3]. Despite the arrival of an era of reason and industrialization, community begin to grow strong again in reaction to individualism, social split and material-centered phenomena in the wake of the fall of medieval practices. In the 19th century, community was viewed as a valuable blueprint for wishful society in contrast to what it was at that time. At the advent of the 20th century, the simple and monolithic community began to decentralize, breaking into territorial subdivisions[4].

In a further diversion from state-centered society as in the 19th and 20th centuries, the government, business enterprises and civil society cooperate for a new type of governance in the 21st century, the participation of civil society and the progress of local communities, For the efficiency of the government and for better public service in terms of quality, the government, the private sector and civil society work together in a tripartite network. Furthermore, community movement is being expanded as an institution for joint production and cooperation between the public and private sectors. It encourages local residents to join in view of the increasing importance of local autonomy[5].

The organization of community is possible under the great principle of "solidarity and participation" and in community so organized, people at last become free and social individuals capable of expanding their participation to the maximum. As members of community, they enjoy strong sense of belonging, solidarity and responsibility. They are heavily inclined to collectivism in solving problems they have in common. Since they are ready to give up individual interests for that of their community, cooperative efforts are readily available among themselves. The dilemma of collective actions is overcome and the supply of goods for common use becomes possible[6].

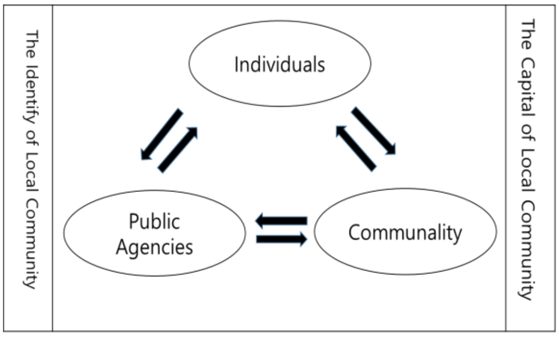
In Korea, researches have been made on community from in the main three different standpoints, observing it as a regional unit, as a historical remain that will disappear at the rise of capitalistic production system, and as one of the basic theories of social organization or conglomerate[7]. Quite often and traditionally, the academic world in Korea regards community or the like as kinship society such as family, relatives, neighbors or villages, and regional or ethnic groups. Residents getting together in these kinship society interact in a sense of oneness or commonness in their areas, identifying themselves closely with their groups in pursuit of a common purpose.

2.2.2. The realization of communalism

Traditionally, communalism is characteristic of regionalism, close social ties and homogeneous relation, and is understood as resulting from esprit de corps of the members of regional society[8].

On the other hand, in modern society, this characteristic nature of community does not count for much in itself but is viewed as a kind of active and cooperative network consisting of its members rather than a way of life. In reality, however, due to the lack of civic education on commonality and unstable bonds and trust between interested parties, it is necessary to promote the participation of private or civil organizations and the cooperation of other organizations of various nature in the same region. Local autonomy to the true sense of the word is possible when local residents, business concerns and local governments are ready to work in concert. Social norms and network as well as mutual trust among local residents are essential for local autonomy[9].

Figure 1. The types of community network.



Externally, the better way to utilize the strength and activities of community is to allow it to go by itself or in alliance with others in social and political arena rather than attempting to place it under patriarchal or oppressive power of state[10]. Communalism favors a bottom-up type of power relation for common good. For community to be receptive and democratic, its members should be active in the exchange of opinions and in the follow of thought from bottom to top.

It is important for local society and the government to operate in the form of partnership to achieve communalism. Partnership reflects an active relation of partners of various nature towards the objective they have agreed on, every one of them sharing a unified view on reasonable division of labor and their comparative advantages. This type of partnership features mutual respect, equal participation in decision-making, mutual responsibility and transparency, and individual autonomy. The application of the principles of competitive market to Weberian bureaucracy means the least of new public management, which is realized to the fullest extent by leaving the function of the government to the market completely. Partnership leaves the power of decision-making to the responsibility of the government while the production and supply of service are in the hand of other partners. This means a transformation in which partners, not state, play the role of manipulation and coordination on an equal footing with each other[11].

Partnership as described above has two aspects, "mutuality and organization identity," the former signifying the principle of partnership and the latter the basis of the production of its added value. The effect of mutuality and organization identity expand to the maximum when one partner has what the other does not. This is a kind of "joint gain" attained in synergy effect or value addition, which are out of reach for individual partners.

3. A Proposal for the Gender-Equal Community

3.1. The significance of the gender-equal community

The changing labor market and the spread of the ideals of gender equality, the question of women is no longer an issue of personal concern. Rather it has now become a social issue in Korea. Efforts have been made for a drastic reform in this respect in government policy and from many different angles. A new office has been set up in the government and along with this, the First Women's Policy Basic Program went into implementation in 1998 to expand the participation of women in social activities, Laws and systems discriminating women have been changed for women's equality on the same footing as men. Other changes are obvious in all sectors of society. Currently, the second such program is under way with new visions and objectives. However, the direct and indirect discrimination toward women exists in the mind and practice of many people as in the past. The social infrastructure is not yet enough for women to work outside the boundary of family and to make the full use of their valuable capabilities[12].

To promote gender equality is to change the mentality and practice that make women unequal in the use of their ability and in the roles they perform. It is to eliminate discrimination and violence at home and in all sectors of society. It is to enhance understanding and cooperation for them to do what they can and what they want. The free and equal expression of personality and ability is a way to guarantee their individual rights and the quality of their life. The development and utilization of their potential resources will make them equal, socially and economically. Through this will be achieved family welfare at home and the development of democracy at the national, regional and other levels. Society in which men and women are equal is society where the latter is provided with equal opportunities to be recognized as they deserve and to function as they are able to.

In countries where local autonomy is well in practice, all members of society, men and woman, are fairly represented in local autonomy at every stage from planning to decision-making in realization of participatory democracy and customer-tailored public administration, making every policy transparent and fair to all related parties.

In Korea, women are increasingly active in local autonomy, especially for women-related policy and programs. As local autonomy takes root, all residents work together to make equality of men and women a reality in everything in their everyday life. Since local autonomous bodies are closest to the everyday life of residents, all women are encouraged to take part in making decision on local living environments and other issues of common concern on the same basis as men.

It is not only women's own endeavors but also the cooperation and continued efforts of various forces in local communities that is necessary for the realization of gender-equal society. It is from this point of view that the Gender-equal Community Movement is suggested. This movement is believed to help promote cooperation of local residents to establish facilities for female population, facilitate the exchange of ideas and opinions through local networks, and enhance common understanding on the issue as a whole.

3.2. Promotional model for the gender-equal Town

Community movement needs well-designed and practically-minded planning as well as feasibility and justification to start and continue. All parties concerned should be well aware of its goal to improve the quality of individual life in the framework of overall social progress. Organizational strength and financial capabilities are no less important.

In order for communalism to be realized, its goal must be clear to everyone and all factors essential to its promotion and operation must be ready to be mobilized. The same is true for the realization of gender-equal community.

3.2.1. Objective

What should be in mind first to promote gender-equal community is the good knowledge of its goal, it is important for all those who work for this movement to share the same idea and the same way of thinking. Only when they know what they are really up to will they be able to work effectively together. The objective of respective gender-equal communities may differ slightly, depending on geographical and other factors. But its ultimate goal will remain the same because inequality between the two sexes is a matter of universal understanding, not system. Other accompanying conditions like environment, local needs, resources available, and so on may well be utilized the way they best fit the individual objectives.

3.2.2. Driving forces

Principal driving forces of the gender-equal community movement are promoters, network, and what they do.

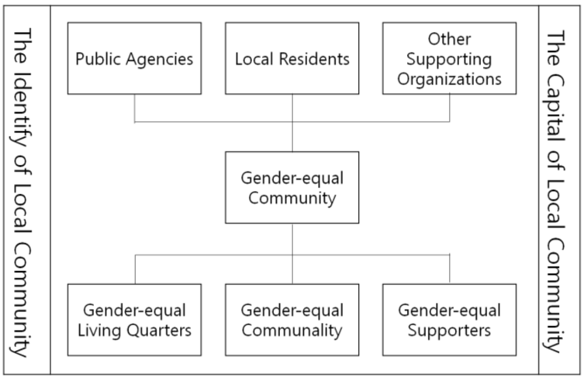
First of all, promoters are those who play key roles in organizing the gender-equal community movement. In general, they are interested individuals, organizations and the government. Local residents and local public agencies are the principal promoters of this movement. Devoted to the elimination of inequality between the two sexes, they are supported by civil organizations, professional groups and business concerns.

Next, network refers to various channels through which promoters get together to create gender-equal community. These channels facilitate the exchange of ideas and opinions at a low level or function at a higher level in the form of multi-faceted structure to enhance understanding and cooperation.

Lastly, the promoters and their network prepare detailed and concrete programs for the gender-equal community movement, changing old public facilities into new community centers and restoring close neighborhood relations to take care of matters of common concern. These channels will help facilitate the lively flow of ideas and opinions for the common benefit. Individuals will grow interested in what they have in common for good or bad and will learn and experience the way to resolve problems they have in their neighborhood. Thus will be created a new type of neighbor relation in what may be called the remaking of neighborhood. In a nutshell, the new community movement is to renovate public places and facilities as part of efforts to improve the quality of life for all, to organize them to work together for this and other benefits, and to help them to be more sociable among themselves.

Likewise, the process of creating gender-equal community is same as that of renovating public places and facilities as new community centers, organizing residents for stronger dedication to the common cause, and helping them to learn how to work together to realize new society in which men and women will live on an equal footing. For example, the whole work may start from improving public places and facilities and then move to build up a consensus by way of reorganization and reconciliation. <Figure 2> shows how promoters and their network function to realize gender-equal community.

Figure 2. The creation of gender-equal community (promoters, network and implementation).



3.2.3. The creation of gender-equal community

Of crucial importance for the effective promotion of gender-equal community are promoters, work process and budget. This movement, to some extent, is rather objective-driven than self-motivated or voluntary. So, it is hard to be successful without systemized preparation made beforehand.

For example, at the starting stage, public agencies initiate the movement to provide groundwork as needed and then recede into background for local residents and civil organizations to take it over and continue on the tracks laid for them. Though may again be assisted by public agencies as the project goes on, it in essence is a project to be carried out by individuals concerned on their own.

Coming next is the step-by-step approach. For instance, at the initial stage, promoters may start to work with local residents in a simple way, handling simple matters of common interest. Slowly, as work progresses, they may get closer together in their relation as the nature of work they do growing more complicated. Budget also requires due care. At the starting point, financing may come from the local autonomous authorities because the local residents may not have quite agreed on this movement yet. By the time when it begins to roll on itself, other sources of financing must be sought one way or another and the use of volunteers will help reduce costs.

The last important step to be taken is evaluation at all stages to make it sure that the community of gender equality is well in the making as desired. Who will make this evaluation by what standard, and how to use its results also require careful planning. To make the evaluation credible and objective, citizens and civil organizations should have free access to it. Especially, the participation of civil organizations will not only make evaluation itself credible but help draw wider interest from various sectors of society.

4. Conclusion

Gender equality will remain as a social problem until discrimination by sex is rooted up. In view of the universal value of man, this sort of discrimination is a social evil which has every reason to be eradicated. It is for this reason that efforts have been made in many ways for such a long time to do away with it. Successful though it has been to some extent, inequality of women is still a matter of serious concern and is yet to be fought.

This study takes up communalism as a new way to tackle the structural and long-standing question of inequality between men and women in favor of the former. The community of gender-equality as proposed in this study is to realize gender equality on the basis of understanding instead of the change of systems as in the past. Based on common understanding of the issue, this approach is believed to remove the basic cause of the problem with voluntary cooperation of all parties concerned. Since this approach has not been used before and seems to require a considerable amount of time to try, how it may work is yet to be observed.

This approach is of significance in that it is new as has never been tried before and presents a prototype for community in which gender equality may be achieved. It is hoped that it will be discussed and elaborated in comparison with the approaches so far made and will help prepare a new and workable alternative to resolve the long-lasting question of inequality faced by women.

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Quality Characteristics of Puffed Rice Muffin SAFETY from Gluten in Republic of KOREA

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Abstract

Purpose; CD(Celiac Disease) is a genetic disease caused by gluten, which is one of the most common diseases among modern people. The only way to prevent this is by eating gluten-free foods. Our rice, which is a main food, is a popular food. It is thought that it is appropriate to use this rice for the development of gluten - free food because it is made from such high. In this study, we tried to measure muffin quality, texture, color and sensory evaluation by using puffed rice. For the preparation of puffed rice muffins, first add the puffed rice flour, baking powder, sugar and salt, water was added and mixed at low speed to complete the dough(23 ± 1 °C). The puffed rice muffin was prepared by placing 70 g of dough in a muffin cup (7.5×4 cm) and baking in a preheated oven at 200 °C and 200 °C for 20 minutes. After cooling, it was used for the experiment. The hardness of the muffins added with puffed rice was significantly lower than that of the muffins prepared with wheat flour. The chewiness and hardness were significantly lower as the amount of puffed rice was increased, and the number of muffins prepared with puffed rice was the lowest among the samples. The results of the color measurement of muffins showed that the lightness decreased significantly with the increase of the amount of expanded rice. The sensory evaluation showed that PM2 produced by adding 50% puffed rice flour and 50% wheat flour was the best, and the taste of muffin was PM1 added with puffed rice 25% were significantly higher than the other samples. Therefore, PM2 with 50% puffed rice flour and 50% wheat flour were most preferred.

Therefore, it has been found that the preparation of muffins by adding puffed rice is preferable to consumers' preference, and it is thought that it will be useful for the development of gluten free products, and various products using puffed rice should be developed.

[Keywords] ***Safety, Gluten, Muffin, Puffed Rice, Sensory Evaluation***

1. Introduction

CD(Celiac Disease) is a genetic disorder caused by gluten contained in wheat, barley, rye, oats, etc.[1], inflammation of the small intestine is not absorbed nutrients properly, And skin diseases. Gluten is found in bread, which is a typical convenience for modern people. In addition, it contains a lot of foods such as confectionery, beer, and cereal which are common to us. The only way to treat gluten is by eating gluten-free foods. Rice is known to be the most suitable raw material for the development of gluten-free foods with excellent nutrition[2], and there have been various studies on rice flour milling methods for producing breads and confectionery[3][4][5][6].

Puffing rice was made by putting rice in a container with high pressure and sealing it and heating it to bloom rice flour several times. During this process, the tissues of rice become porous and the starch is split into dextrin and digested well even when it is eaten as it is, and it is marketed as flour. Puffed rice is widely used for *making makgeolli*, and related researches are very limited such as yogurt[7], rice porridge[8], bread[9][10], and pound cake[11].

At present, the market for gluten-free foods is reported to have a high growth potential[12]. Therefore, it is urgent to develop a product suitable for various consumer's preferences using puffed rice, and it is desirable to apply it to the development of a baked product rather than a product such as bread which does not have much gluten. Therefore, this study aims to contribute to the development of gluten-free foods by developing a simple-type expanded puffed rice flour muffin suitable for consumers' preference using the rice puffiness.

2. Experimental Methods

2.1. Texture measurements

After sugaring of the puffed rice muffin, its Hardness and chewiness were measured using Texture analyzer(TA-XT Express, Stable Micro Systems, UK) with 70 mm cylinder probe(Pre-test speed: 3 mm/s, Test speed : 2 mm/s, Post-test speed: 3 mm/s, Distance: 1.5 mm, Time: 3 sec, Trigger Force: 5 g).

2.2. Lightness measurements

The lightness was measured using color meter(Color meter, JC-801, Color Techno Co, LTD, Japan); the puffed rice muffin was put into cylindrical container(35×10 mm); each sample was measured five times and its average was used.

2.3. Sensory evaluation

The sensory evaluation items were measured on a 5-point scale with flavor, taste, texture, and overall preference. 5 points were most preferred

2.4. Statistical methods

The results of puffed rice muffin Hardness, chewiness, lightness and sensory evaluation were analyzed using ANOVA, and the significance test was done through Duncan's multiple test at p<0.05. The analysis used SPSS WIN program 20.0.

3. Results and Discussion

3.1. Texture of puffed rice muffin

<Table 1> shows the results of the texture measurements of puffed rice muffins.

The hardness of puffed rice muffins prepared with 100% of wheat flour was 1689.66 g/cm^2, which was significantly higher than other samples. The PM1 added with 25% of expanded wheat flour was 1409.38g/cm^2, the PM2 added with 50% expanded wheat flour was 1256.63 g/cm^2, PM4 was 1129.80 g/cm^2 and 990.80 g/cm^2, and the hardness of muffin was significantly decreased as the amount of puffed rice flour was increased

The chewiness of muffins was 1124.96 g/cm^2, which was significantly higher than those of the other samples. The chewiness of muffins was significantly lower(710.07 g/cm^2 - 944.61 g/cm^2) as the proportion of added loaf increased.

Therefore, it was found that the hardness and chewiness were significantly decreased with the addition of the loosening lotion as a result of adding the loosening lotion to the puffed rice flour and preparing the muffins.

Table 1. Texture of puffed rice muffin(g/cm^2).

	Hardness	Chewiness
Control[1)]	[2)]1689.66±23.70^{a}[4)]	1124.96±38.01^{a}
PM1	1409.38±81.33^{b}	944.04±61.91^{b}
PM2	1256.63±38.60^{cd}	867.43±16.98^{b}
PM3	1129.92±92.24^{cd}	836.53±11.31^{b}
PM4	990.80±8.89d	710.07±12.81^{c}
F - Value	135.023***[3)]	81.943***

Note: [1)]Control , PM1, PM2, PM3, PM4, PM5 Flour: Puffed Rice flour; 100:0, 75:25, 50:50, 25:75, 0:100

[2)]Mean±S.D.

[3)]***p<0.001

[4)a-d]Means in a row by different superscripts are significantly different at the *p*<0.05 by Duncan's multiple range test.

3.2. Lightness of puffed rice muffin

<Table 2> shows the results of measuring the degree of Lightness of muffins by added with Puffed Rice flour.

The lightness of the muffins made only with wheat flour was 82.64, which was the most lightness compared to the other samples. PM1 and PM2 added 75% and 75% of PM1 and PM2 with 76% and 75% respectively. PM3 added with 75% of puffed rice was 73.17 and 71.25 was added with 25% added puffed rice. As the amount of puffed rice increased, the lightness of muffin gradually dimmed.

Table 2. Lightness of puffed rice muffin.

	Lightness
Control[1)]	[2)]82.64±0.00[a4)]
PM1	76.53±0.02[b]
PM2	76.52±0.03[b]
PM3	73.17±0.00[c]
PM4	71.25±0.02[d]
F - Value	19205.505[***3)]

Note: [1)]Control , PM1, PM2, PM3, PM4, PM5 Flour: Puffed Rice flour; 100:0, 75:25, 50:50, 25:75, 0:100
[2)]Mean±S.D.
[3)]*** $p<0.001$
[4)a-d]Means in a row by different superscripts are sig- nificantly different at the $p<0.05$ by Duncan's multiple range test.

3.3. Sensory evaluation of puffed rice muffin

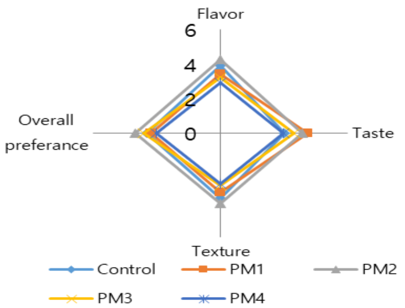
The results of the sensory evaluation of the muffins added with Puffed Rice flour were shown in <Figure 1>.

As shown in the <Figure 1> PM2 produced by adding 50% Puffed Rice flour and 50% wheat flour were the best evaluated. The muffin taste was 25% PM1 added, and the texture was 50%. The added PM 2 was found to be the most favorable compared to other samples. Therefore, PM2 with 50% Puffed Rice flour and 50% wheat flour were most preferred.

Cho Sook-ja(1998) also reported that breads with 10-50% Puffed Rice flour were evaluated favorably, suggesting a similar tendency to this study[10].

As a result of the sensory evaluation of the muffins, it is considered to be a preferable method to prepare by adding the Puffed Rice flour, Cho Sook-ja(1994) also reported that Puffed Rice flourbread was preferred to wheat flour bread by adding Puffed Rice flour, which was similar to the results of this study[9].

Figure 1. The sensory evaluation of puffed rice muf QDA.



4. Summary and Conclusion

This study was carried out to investigate the quality characteristics of the prepared puffed Rice muffin.

(1)Results of hardness and chewiness measurement as the amount of puffed rice added increased, the hardness and chewiness decreased significantly.

(2)Results of color measurement as the amount of puffed rice added increased, the lightness decreased significantly.

(3)Sensory evaluation showed that the flavor, taste, texture, and overall preference of muffins added with puffed rice were highly preferred. Therefore, we think that it is possible to develop gluten-free confectionery product by adding puffed rice.

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