

Correlation between the Laboratory Test Results and Knee Functional Improvement of Pre- and Post-Total Knee Replacement Operation

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Abstract

Objective: This study aimed to identify correlations of laboratory test results and knee joint function between pre- and post-operation of knee joint replacement surgery. **Methods:** The study covered 60 - 75 aged 50 patients who had operated with knee replacement surgery. 25 patients were male and another 25 patients were female. We compared laboratory test results of pre- and 3rd, 7th and 14th day of post-operation. Moreover, pre-operation knee joint function was compared with 3rd, 7th, 14th and 30th day of post-operation. Furthermore, we investigated the relationship among WBC, hemoglobin and function tests. Pre- and post-operative knee joint function tests were conducted by WOMAC (The Western Ontario and McMaster Universities Osteoarthritis), VAS (Visual Analogue Scale), TUG (Time up and Go) score, and MMT (Muscle Manual Test). **Results:** In pre-operation, patients' average WBC was 6.447 ± 2.115 cells/ μ L, monocyte was 6.554 ± 3.101 cells/ μ L, lymphocyte was 31.177 ± 9.512 cells/ μ L and C-reactive protein was 0.6205 ± 0.922 mg/dL. In 3rd day of post-operation, WBC was 8.901 ± 2.869 cells/ μ L, monocyte was 4.881 ± 2.332 cells/ μ L, lymphocyte was 17.048 ± 9.702 cells/ μ L and C-reactive protein was 4.2762 ± 2.293 mg/dL. There was a statistically significant difference reported on pre- and post- operation pain, stiffness and daily activity ($P < 0.001$). On the other hand, patients' post-operative TUG score was significantly higher than pre-operative TUG scores ($P < 0.0001$). Furthermore, hemoglobin, red blood cell and TUG score of the 3rd day of post-operation were raised up and they were statistically significant ($P < 0.036$).

In addition, WBC of pre-operation and 3rd, 7th, 14th day of TUG score was significantly correlated ($P < 0.04$). **Conclusion:** Results of WBC, hemoglobin, hematocrit, total protein, total bilirubin, and creatinine had increased in 3rd and 7th day of post-operation and had stabilized from 14th day of post-operation. Stiffness and TUG performance were controversially correlated in 3rd, 7th, 14th, 30th day of post-operation. However, in 7th and 14th of post-operation, patients' muscle strength and knee joint amplitude had become stabilized and improved from 30th day of post-operation. Moreover, after the operation, the number of WBC controversially affected patients' mobility. In addition, we found that as hemoglobin and red blood cells increased, walking ability improved as well.

Keywords

TUG, WOMAC, VAS, WHO

1. Introduction

According to the World Health Organization (WHO) study in 1998-2015, the prevalence of Osteoarthritis (OA) is increasing 10% - 15% year by year [1]. Moreover, the burden of musculoskeletal disability is increasing due to OA. In Mongolia, an incidence of OA and OA related surgery has been rising as well [1].

Knee joint replacement surgery is one of the effective treatments. Moreover, studying laboratory test before and after the surgery is important. In addition, there is no study having reported in Mongolia about laboratory test of knee replacement surgery [2].

Curtis *et al.* studied inflammatory factors after knee replacement surgery. The study reported that enhanced C-reactive protein, WBC and neutrophil percentage considered potential indicators to diagnose periprosthetic joint infection. It was usually developed by *Staphylococcus epidermis* and it was diagnosed by 5 - 6 pieces' tissue of biopsy [3].

They studied about 2 stages of antibiotic treatment for 4 weeks before surgical treatment of prosthesis for infection detected patients [4].

Alijanipour and Parvizi studied inflammatory markers for diagnosing periprosthetic joint infection (PJI). Inflammatory markers included 1β , IL-4, IL-6, IL-17A, TNF (ELISA), CRP, ESR and WBC and were considered important factors [5].

American Academy of Orthopaedic Surgeon (AAOS) classified the periprosthetic joint infection into 3 classifications.

- 1) Acute (less than 3 months);
- 2) Moderate (3 - 24 months);
- 3) Chronic (more than 24 months).

As AAOS defined, optimal threshold for CRP and ESR was 149 mm/hour and 14.5 mg/dL in PJI knee [6].

The average monthly cost for PJI knee was \$50,000 while the average cost of a year was 250 million dollars among United States patients [7].

In 1974, the first patellar replacement was introduced as well as joint surface replacing. After that, scientists developed the method of installing prosthesis with bone-cement and retaining anterior and posterior cruciate ligaments [8].

In modern days, there are more than 19 companies producing 3 types of joint prosthesis. Internationally, many scientists have been studying laboratory test results of pre- and post-operation of total knee joint replacement [9].

Knee joint replacement surgery was introduced in Mongolia in 2000 with the help of orthopedic surgeons from France. Nowadays, the prevalence of osteoarthritis has been increasing in Mongolia

Therefore, total knee joint arthroplasty is one of the notable treatments. Moreover, the study of serologic markers before and after joint prosthesis surgery has never been done in Mongolia.

2. Materials and Methods

We've covered 60 - 75 aged 50 patients who had operated with knee joint replacement surgery in National Trauma and Injury Hospital between June, 2017 and December 2018. 25 patients were male and another 25 patients were female.

We compared patients' pre- and 3rd, 7th, 14th day of post-operation laboratory test results and also pre- and 3rd, 7th, 14th and 30th day of post-operation knee joint function. Furthermore, red blood cell and hemoglobin indications were compared with walking test results.

The study all laboratory tests conducted in National Trauma and Injury Hospital.

Patients' knee joint function including pain, stiffness and daily activity were examined by WOMAC. Pain intensity was evaluated by VAS score. Walking test was assessed by TUG score. Moreover, MMT test assessed the muscle strength [10] [11] [12].

Exclusion criteria were foreign person, who has psychological disorder, bone cancer, osteomyelitis, thrombosis, lower extremities paralysis, cardiovascular diseases and diabetes mellitus type 2.

3. Statistical Analysis

All statistical analysis made with Stata 13.0 IC program. We've summarized calculation of median and standard deviation of more than 2 times of (4 - 5 times) laboratory tests measurements with a normal distribution. F value of Greenhouse Geisser test was used to find the correlation between groups. P value is less than 0.05 is considered as statistically significant. When it has a non-normal distribution, non-parametric Friedman test was used. Those repeated test results were represented by GraphPad Prism 7.0.

4. Ethical Statement

Ethical approval for this study was acquired from the Research Ethics Commit-

tee of the Mongolian National University of Medical Sciences on 18th May, 2018 with #3-09 order. Before data collection, the participants signed a written, informed consent

5. Result

In this study, we've covered 50 patients who have had total knee arthroplasty. Patients' average age was 66.5 ± 9 and the gender ratio was 1:1.

5.1. Complete Blood Count Test

Patients' average WBC of pre-operation was 6.447 ± 2.115 cells/ μ L, monocyte was 6.554 ± 3.101 cells/ μ L, lymphocyte was 31.177 ± 9.512 cells/ μ L and C-reactive protein was 0.6205 ± 0.922 mg/dL.

3rd day of post-operation, WBC was 8.901 ± 2.869 cells/ μ L, monocyte was 4.881 ± 2.332 cells/ μ L, lymphocyte was 17.048 ± 9.702 cells/ μ L and C-reactive protein was 4.2762 ± 2.293 mg/dL. 7th day of post-operation, WBC was 8.186 ± 3.125 cells/ μ L, monocyte was 6.266 ± 2.913 cells/ μ L, lymphocyte was 21.907 ± 7.955 cells/ μ L, C-reactive was 2.8954 ± 2.964 mg/d. 14th day of post-operation, WBC was 7.308 ± 2.385 cells/ μ L, monocyte was 6.918 ± 3.528 cells/ μ L, lymphocyte was 23.278 ± 8.966 cells/ μ L, C-reactive protein was 1.6676 ± 1.367 mg/dL (Table 1).

Patients' WBC correlation between pre- and post-operation was identified by F value of Greenhouse Geisser test. As a test result, it was correlated statistically significant ($P < 0.0001$) (Figure 1).

However, there was no significant correlation of monocyte test result between pre- and post-operation ($P > 0.405$) (Figure 2). Even though, there was a significant correlation was observed lymphocyte result between pre- and post-operation ($P < 0.05$) (Figure 3).

Moreover, there was no significant correlation observed on CRP ($P > 0.21$). Furthermore, there was no statistically significant difference in laboratory test result between male and female patients ($P > 0.09$) (Figure 4).

Table 1. Laboratory test results of pre and post operation.

	Pre-operation M \pm SD	Post-operation [M \pm SD]			95% CI		P-value
		3 rd day	7 th day	14 th day	min	max	
WBC	6.447 \pm 2.115	8.901 \pm 2.869	8.186 \pm 3.125	7.308 \pm 2.385	2.20	14.90	0.0001 [†]
Monocyte	6.554 \pm 3.101	4.881 \pm 2.332	6.266 \pm 2.913	6.918 \pm 3.528	2.00	21.10	0.71 [‡]
Lymphocyte	31.177 \pm 9.512	17.048 \pm 9.702	21.907 \pm 7.955	23.278 \pm 8.966	8.10	46.20	0.05 [‡]
C-reactive protein	0.6205 \pm 0.922	4.2762 \pm 2.293	2.8954 \pm 2.964	1.6676 \pm 1.367	0.02	5.12	0.241 [‡]
Hemoglobin	134.51 \pm 16.97	117.49 \pm 15.06	111.48 \pm 18.03	111.90 \pm 15.58	98	141	0.0001 [†]
Hematocrit	38.64 \pm 5.51	32.29 \pm 6.04	30.71 \pm 5.77	30.89 \pm 4.82	20	39	0.0001 [†]
Platelet	273.68 \pm 102.4	221.02 \pm 71.46	265.7 \pm 79.7	306.1 \pm 111.1	120	340	0.047 [‡]

Unit (+3 Em/ml, mg/dL); [†]Green House Geisser F-value used when it has normal distribution; [‡]Freidman test used for non-normal distribution.

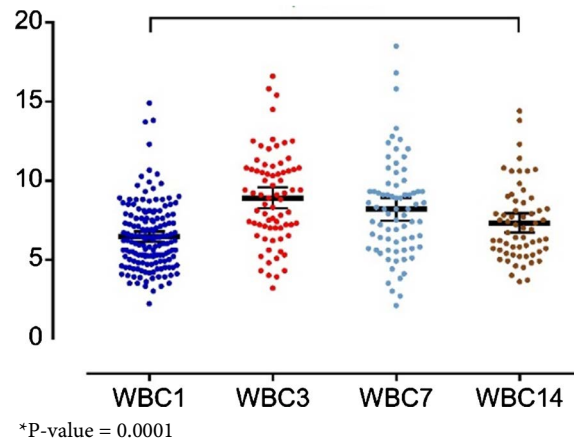


Figure 1. WBC number of pre- and post-operation.

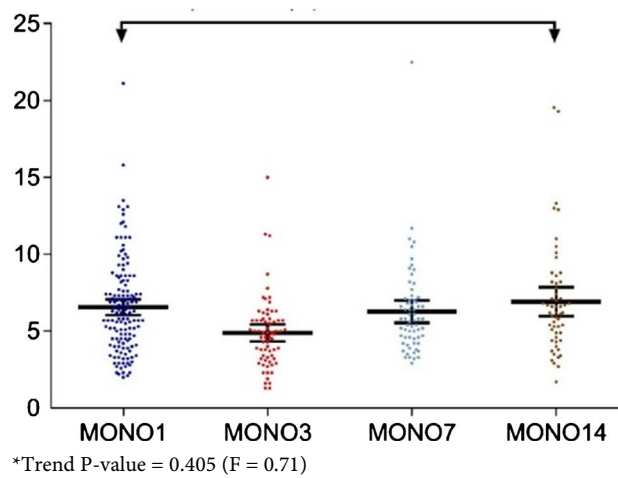


Figure 2. Monocyte number of pre- and post-operation.

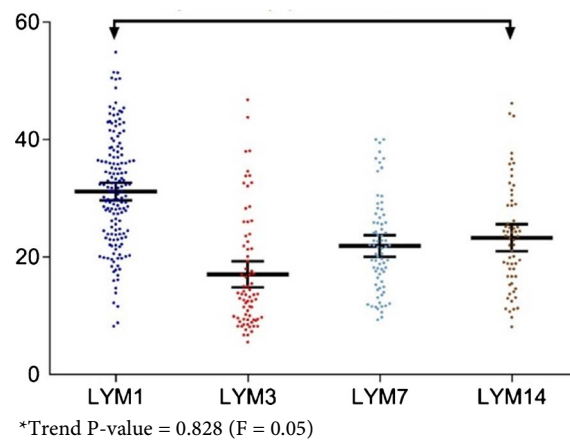


Figure 3. Lymphocyte number of pre- and post-operation.

When we identified the difference between pre- and post-operation red blood cell and hemoglobin, there was statistically, significant difference reported ($P < 0.001$) (Figure 5).

On the other hand, pre-operation hematocrit result was statistically dropped

in post-operation ($P < 0.001$) (**Figure 6**). The number of platelet cells was statistically dropped after the operation as well ($P < 0.047$) (**Figure 7**).

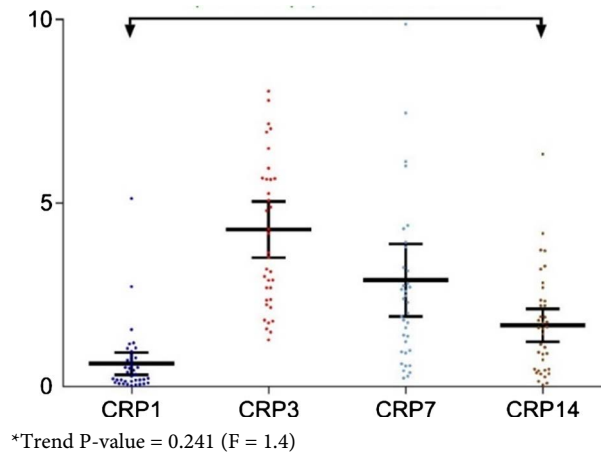


Figure 4. C-reactive protein number of pre- and post-operation.

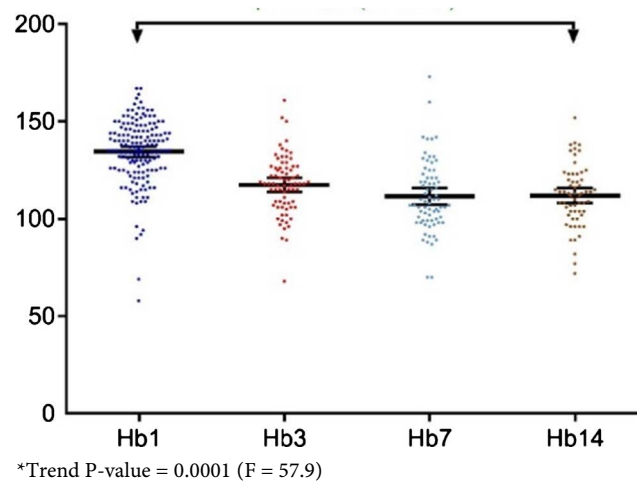


Figure 5. Hemoglobin number of pre- and post-operation.

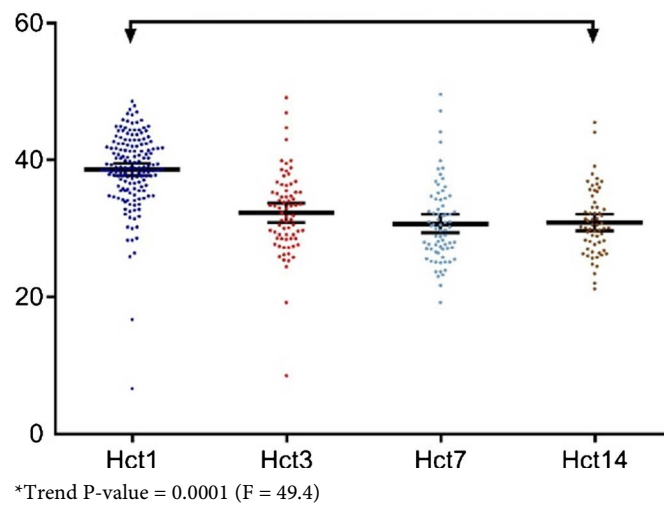


Figure 6. Hematocrit number of pre- and post-operation.

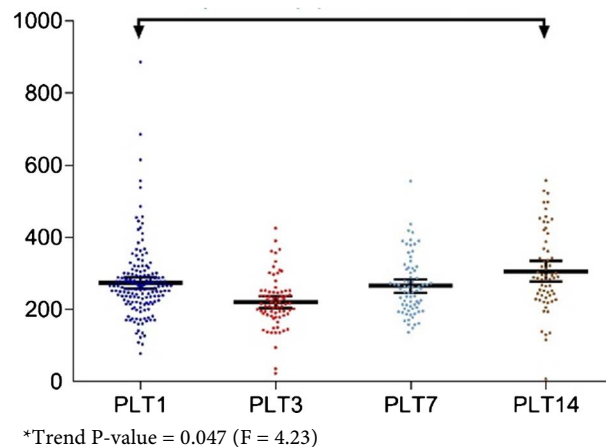


Figure 7. Platelet number of pre- and post-operation.

5.2. Result of Biochemical Analysis

The patients' average ASAT result of pre-operation was 25.7 ± 15.9 U/L, average ALAT result was 29.8 ± 22.6 U/L, average total protein was 7.72 ± 4.78 g/dL, average total bilirubin was 0.61 ± 0.29 mg/dL and average creatinine was 0.69 ± 0.28 mg/dL.

In 3rd day of post-operation, average ASAT result was 26.5 ± 13.6 U/L, average ALAT result was 27.6 ± 16.4 U/L, average total protein was 7.56 ± 9.24 g/dL, average total bilirubin was 0.86 ± 0.37 mg/dL and average creatinine was 0.66 ± 0.23 mg/dL.

In 7th day of post-operation, average ASAT result was 33.3 ± 29.7 U/L, average ALAT result was 33.2 ± 23.8 U/L, average total protein was 6.57 ± 0.67 g/dL, average total bilirubin was 0.91 ± 0.81 mg/dL and average creatinine was 0.61 ± 0.21 mg/dL.

In 14th day of post-operation, average ASAT result was 33.6 ± 33.2 U/L, average ALAT result was 49.3 ± 67.2 U/L, average total protein was 6.52 ± 0.75 g/dL, average total bilirubin was 0.79 ± 0.37 mg/dL and average creatinine was 0.58 ± 0.16 mg/dL (**Table 2**).

There was a statistically significant difference reported on result of ASAT of pre and post-operation. It was analyzed by Greenhouse Geisser test ($P > 0.061$) (**Figure 8**). However, there was statistically significant difference reported on result of ALAT of pre and post-operation ($P < 0.042$) (**Figure 9**). Total protein was statistically decreased after operation ($P < 0.001$) (**Figure 10**). Total bilirubin was statistically dropped as well ($P < 0.042$) (**Figure 11**).

Also, result of creatinine was statistically different in pre and post-operation ($P < 0.001$) (**Figure 12**).

5.3. Result of Knee Function Tests

There were statistically significant improvements reported on pre and post-operation WOMAC test including pain, stiffness and daily activity ($P < 0.001$) (**Figure 13**).

Furthermore, walking test result were significantly improved after surgery ($P < 0.0001$) (Figure 14).

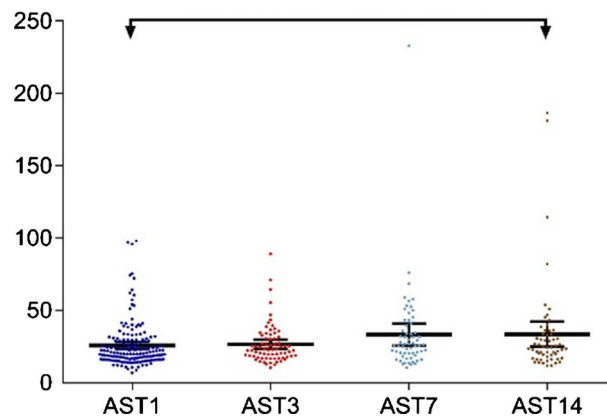
Pain intensity was assessed by VAS score and patients' pain intensity were significantly dropped after surgery ($P < 0.0001$) (Figure 15).

Muscle strength of post-operation was statistically improved as well ($P < 0.0001$) (Figure 16).

Table 2. Biochemical analysis result of pre- and post-operation.

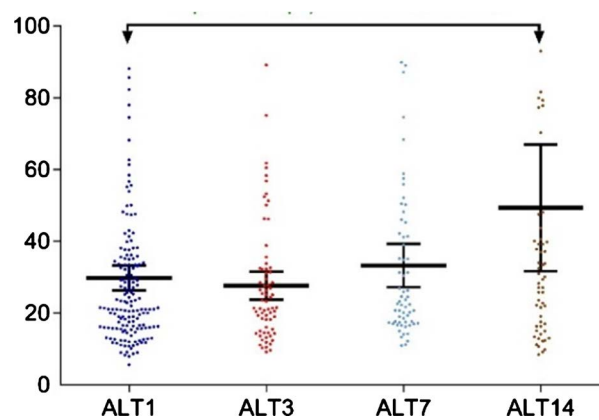
	Pre-operation M ± SD	Post-operation [M ± SD]			95% CI		P value
		3 rd day	7 th day	14 th day	Min	max	
ASAT	25.7 ± 15.9	26.5 ± 13.6	33.3 ± 29.7	33.6 ± 33.2	11.6	186.5	0.061 [†]
ALAT	29.8 ± 22.6	27.6 ± 16.4	33.2 ± 23.8	49.3 ± 67.2	8.4	427.30	0.042 [†]
Total protein	7.72 ± 4.78	7.56 ± 9.24	6.57 ± 0.67	6.52 ± 0.75	4.72	7.94	0.0001 [‡]
Total bilirubin	0.61 ± 0.29	0.86 ± 0.37	0.91 ± 0.81	0.79 ± 0.37	0.28	2.06	0.042 [‡]
Creatinine	0.69 ± 0.28	0.66 ± 0.23	0.61 ± 0.21	0.58 ± 0.16	0.37	1.1	0.0001 [‡]

Unit (+3 Em/ml, mg/dL); [†]Green House Geisser F-value used when it has normal distribution; [‡]Freidman test used for non-normal distribution.



*Trend P-value = 0.061 (F = 3.7)

Figure 8. Result of ASAT of pre- and post-operation.



*Trend P-value = 0.042 (F = 4.2)

Figure 9. Result of ALAT pre- and post-operation.

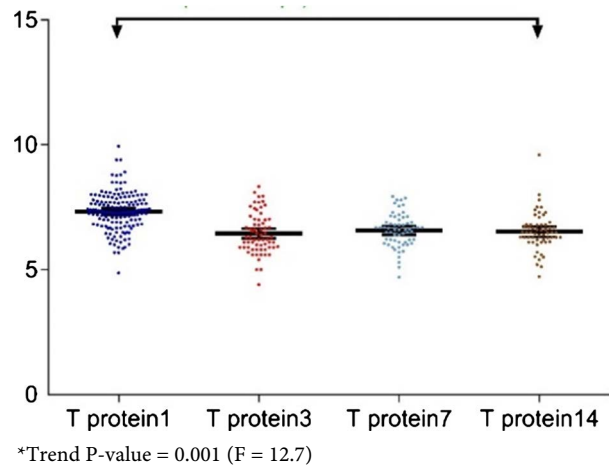


Figure 10. Result of Total protein pre- and post-operation.

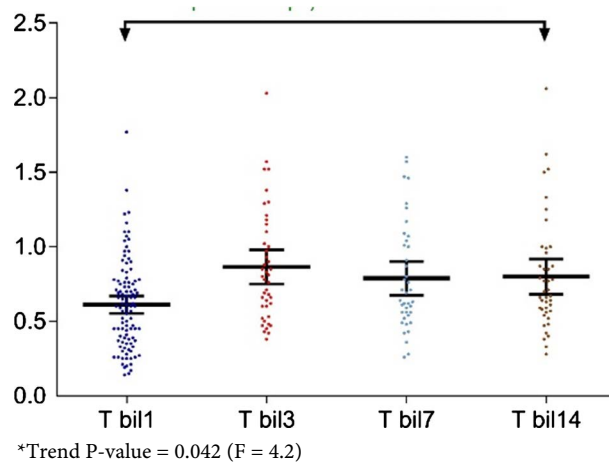


Figure 11. Result of total bilirubin pre- and post-operation.

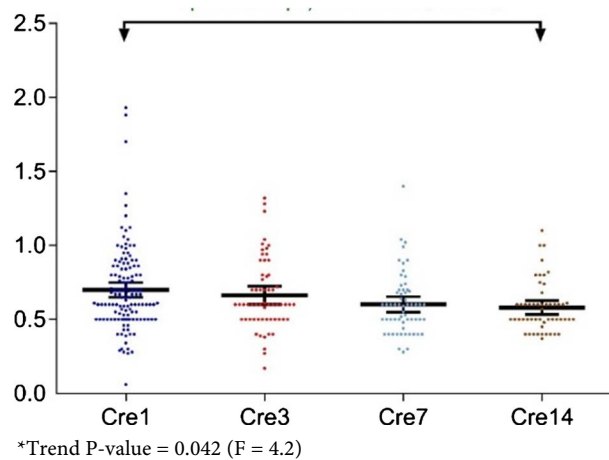


Figure 12. Result of creatinine pre- and post-operation.

Post-operation of knee joint arthroplasty, patients' extension, and flexion ability were significantly improved ($P < 0.0001$) (**Figure 17**).

There was a statistically significant correlation between result of hemoglobin,

red blood cell and walking test in a 3rd day of post-operation ($P < 0.036$) (**Figure 18**).

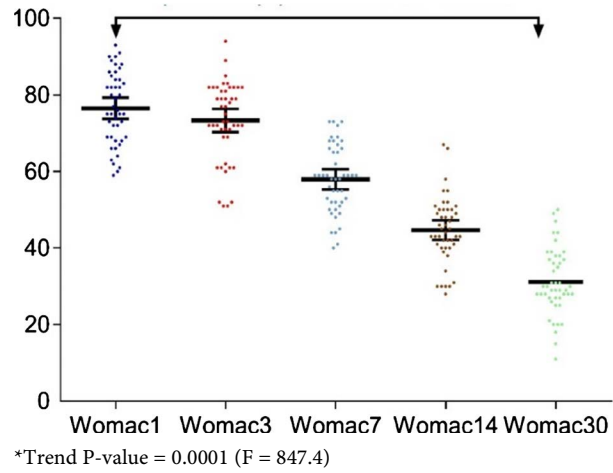


Figure 13. WOMAC test result of pre- and post-operation.

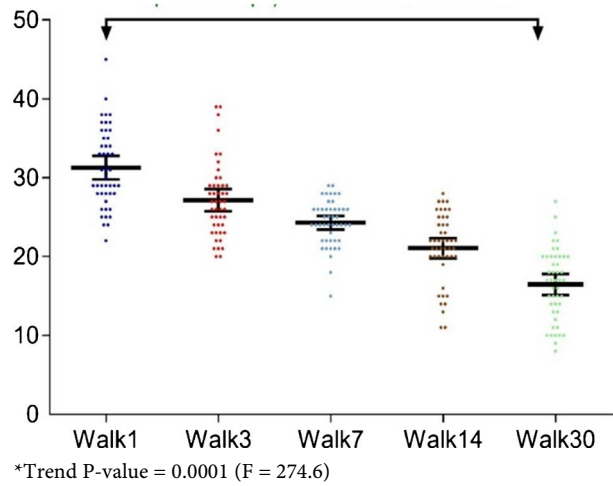


Figure 14. Walking test result of pre- and post-operation.

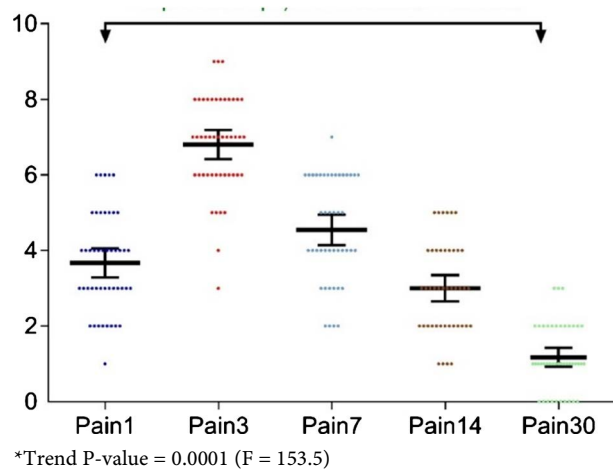
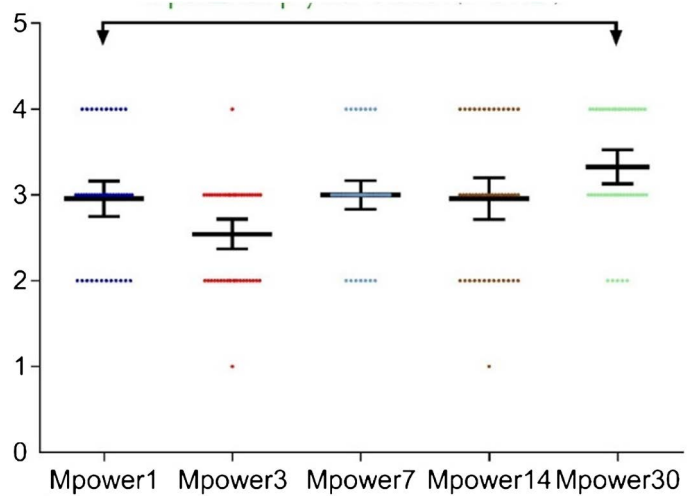
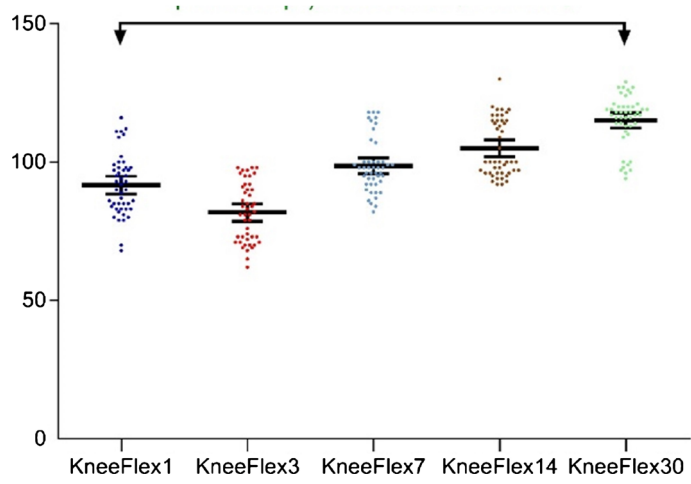


Figure 15. Pain intensity of pre- and post-operation.



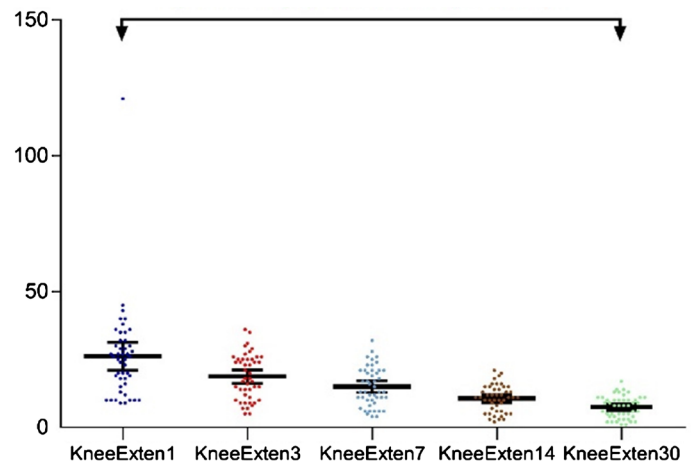
*Trend P-value = 0.0001 (F = 31.2)

Figure 16. Muscle strength of pre- and post-operation.



*Trend P-value = 0.0001 (F = 414.4)

Figure 17. Knee flexion test of pre- and post-operation.



*Trend P-value = 0.0001 (F = 75.8)

Figure 18. Knee extension test of pre- and post-operation.

6. Discussion

Kim *et al.* have reviewed 28 patients who had infection after total knee arthroplasty between 2003 to 2012. As a result of this study, 60.7% of the patients were successfully treated with irrigation and debridement with component retention. Moreover, preoperative ESR, microorganism, and polyethylene liner exchange were factors need to be considered [13].

Leylabadlo *et al.* have done study in Brazil. As a result of this study, 0.4% - 0.2% of the total knee arthroplasty had early an infection were and 3.2% - 5.6% of them had postoperative late inflammation. Mortality of periprosthetic joint infection after total knee arthroplasty was 0.4% - 1.2% among more than 65 years old of people [14].

Everhart *et al.* reported that 0.51% postoperative infection recorded from total 8494 cases of periprosthetic joint infection. The people who have obesity, diabetes, young age and higher than 40 BMI are affected by periprosthetic joint infection 3.3 times higher than others [15].

Leighton *et al.* studied preoperative WBC value of 16,989 patients who underwent total knee arthroplasty and average WBC value before surgery was 7.38×10^6 cells/ μ L. In our study result, patients' average WBC was 6.447×10^6 and a statistically significant ($P < 0.0001$) [11].

Furthermore, 2nd day of post-operation, average WBC value was 10.5×10^6 cells/ μ L. However, in our study average WBC was 8.18×10^6 cells/ μ L and it has statistically significant difference ($P < 0.0001$).

In additionally, 14th of post-operation, WBC was 8.03×10^6 cells/ μ L. In our study result of WBC was 7.30×10^6 cells/ μ L which means both studies recorded a drop of WBC result and it was statistically significant ($P < 0.02$).

7. Conclusions

In conclusion, pre- and post-operation laboratory test of total knee arthroplasty has changed following rehabilitation treatment. Therefore, an early exercise of post-operation is important.

Our study limitation is that patient follow-up time is short and can affect the absolute result of this study. However, we'll continue our study with longer follow-up time in the future. Moreover, we'll investigate prosthesis size for Mongolian people.

Acknowledgements

We'd like to express our appreciation to National Hospital of Trauma and Injury and Department of Trauma and Injury.

Conflicts of Interest

The authors have no conflict of interest.

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