Gait Analysis after Total Knee Arthroplasty — Comparison of Cemented Type and Cementless Type —

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Abstract. The purpose of this study was to investigate the difference between the effects of cementless and cemented total knee arthroplasty (TKA) through gait analysis. The subjects were 23 patients with osteoarthritis of the knees who were operated on with cementless TKA (average age 72.1 ± 5.0) and 25 patients with the same complaint who were operated on with cemented TKA (average age 70.7 ± 4.9). Physical therapy after surgery was the same except that in the case of cemented TKA, full weight bearing started 2 weeks earlier than for cementless TKA. Four force-plates were used to examine the knee function during customary gait. The differences before and 3 months after the operation were examined for the 2 groups and evaluated for velocity, averaged vertical component of floor reaction force (for both knees) with normalization for weight, and ratio of single support (single support time/gait cycle time) (for both knees). There was a significant difference in the ratio of single support on the non-operated side (p<0.05). This was – 3% in the case of cementless and 1% for cemented. The result was that the non-operated sides in the cementless cases were weaker than in the cemented cases. The 2 groups exhibited no significant differences on the operated side.

Key words: TKA, Osteoarthritis, Gait analysis.

(INTRODUCTION)

Recently, total knee arthroplasty (TKA) has gained a prominent position as one of the therapies for osteoarthritis (OA) of the knee. TKA has been shown to have excellent results after the operation. When conservative management is ineffective, the surgical treatment of choice for individuals with severe, end-stage OA is often TKA1). In Japan, more than forty thousand cases of reconstruction in joints, including knee arthroplasty, are performed a year2) (1997).

The expected postoperative advantages of TKA are a reduction of pain, an extension of ADL, an increased quality of life (QOL), etc. The evaluation of gait performance is one of the most important tasks following surgery, so, in recent years, in addition to the static evaluation methods, such as ROM-test, MMT and the special and conventional scale for OA3), dynamic evaluation has been carried out through gait analysis4–7). At our facility we typically compare a patient’s walking ability before
and after TKA.

Prosthesis development and research of the surgical technique have resulted in steady improvements to this treatment. The type of TKA has been changed from the cementless to cemented type in our hospital. According to a national survey, cemented prostheses were used by 95.2% of the Fellows of the British Orthopaedic Association in the United Kingdom (1996)\(^9\). Some researchers have studied prosthesis insertion with and without cement\(^9,10\), but these studies were done from an orthopedic point of view only, with an emphasis on the material used and operative management. In addition, some research has been done on gait analysis, however, there have been no reports to date that have compared the two types of TKA with regard to gait analysis.

**PURPOSE**

The purpose of this study was to investigate the difference between the effects of cementless and cemented TKA through gait analysis. We hypothesized that using cement would achieve better outcomes because the patients can start walking with full weight bearing two weeks earlier.

**SUBJECTS**

The subjects were 23 patients with OA of the knees who were operated on with cementless TKA (23 knees, 2 males, 21 females, average age 72.1 ± 5.0 years) from 1995 to 1996 and 25 patients with the same complaint who were operated on with cemented TKA (25 knees, 2 males, 23 females, average age 70.7 ± 4.9 years) from 1996 to 1998.

There were no significant differences in the physical characteristics of the members of the two groups (Table 1). The two groups did not have significant differences in gait parameters, either (Table 3). The operations for both groups were carried out at the same hospital, and the type of surgery depended on when the operation was carried out. Physical therapy after surgery was the same for members of each group, except that in the case of patients receiving cemented TKA, full weight bearing started 2 weeks earlier than for patients receiving cementless TKA (Table 2).

**METHODS**

Four force-plates (Kistler's) were used to examine the knee function during a patient's customary gait. The subjects walked barefoot and without any support (e.g., a cane or a brace), at their usual walking pace. Patients walked back and forth 5 times on a 4 m walkway and were measured on a 2 m way, the measurements were then averaged. We set up a computer to delete data automatically when measurements at the beginning and the end of the performance were smaller than 70% of a step. Some patients could not perform this test before their surgery because of pain in the knees. Therefore, we selected data that could be used to evaluate the patients both before the operation and 3 months after the operation. The differences in gait velocity, the averaged vertical component of floor walking with full weight bearing two weeks earlier.

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**Table 1. Physical Characteristics of Study Participants (Preoperation)**

<table>
<thead>
<tr>
<th></th>
<th>Cementless (n=23)</th>
<th>Cemented (n=25)</th>
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</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td>Female Male</td>
<td>Female Male</td>
</tr>
<tr>
<td></td>
<td>21 2</td>
<td>23 2</td>
</tr>
<tr>
<td><strong>Age (y)</strong></td>
<td>Mean 72.1 70.7</td>
<td>Mean 72.1 70.7</td>
</tr>
<tr>
<td></td>
<td>SD 5.0 4.9</td>
<td></td>
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<tr>
<td><strong>Height (cm)</strong></td>
<td>Mean 148.6 148.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range 58–82 62–82</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range 138.0–163.0</td>
<td>Range 141.5–160.3</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>Mean 58.5 58.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD 6.8 8.8</td>
<td></td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>45.9–74.4 41.4–81.6</td>
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</tbody>
</table>

**Table 2. Postoperative program**

<table>
<thead>
<tr>
<th></th>
<th>cementless</th>
<th>cemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM exercise (using continuous passive motion unit)</td>
<td>second day~</td>
<td>second day~</td>
</tr>
<tr>
<td>Muscle strength exercise</td>
<td>second day~</td>
<td>second day~</td>
</tr>
<tr>
<td>30% weight bearing is permitted</td>
<td>4w~</td>
<td>3w~</td>
</tr>
<tr>
<td>50% weight bearing is permitted</td>
<td>5w~</td>
<td>4w~</td>
</tr>
<tr>
<td>full weight bearing is permitted</td>
<td>8w~</td>
<td>6w~</td>
</tr>
</tbody>
</table>
reaction force (Fz) (for both knees) with normalization for weight and the ratio of single support (single support time/gait cycle time) (for both knees) before and after surgery were examined for the 2 groups. Statistical processing (unpaired Student’s t-test) was done to compare the two groups of subjects. Differences were deemed to be statistically significant at P<0.05.

**Parameters of gait**

- Gait velocity: If a patient has pain in the knee, he or she cannot walk with normal speed. If the pain is reduced, an improvement in gait velocity can be expected.
- Vertical component of floor reaction force (Fz) (for both knees): The measurements were averaged and normalized for each body weight. If the value is small, the patient will want to reduce weight bearing.
- Ratio of single support (single support time/gait cycle time) (for both knees): If this ratio is small, the patient will want to reduce weight-bearing time. This parameter seems to be influenced by walking speed, however, the data shows that there was no significant variation in estimated gait velocity before the operation between patients receiving cementless and cemented TKA (unpaired t-test). The same can be said for the estimated velocity after the operation (unpaired t-test). These data also demonstrate that there was no significant difference in change of velocity between before and after TKA for both groups.

**RESULTS**

Table 3 shows data from before surgery and 3 months after surgery. Table 4 outlines the differences between these sets of data. There was a significant difference in the ratio of single support on the non-operated side (p<0.05). There was a 3% decrease in the case of patients receiving cementless TKA and a 1% increase for patients receiving cemented TKA. The 2 groups exhibited no significant differences in the vertical component of reaction force on the operated side or gait velocity. The mean of body weight did not change significantly in either group during the evaluation.
DISCUSSION

Before studying the data, we hypothesized that using cement would produce better outcomes because the patients can start walking with full weight bearing two weeks earlier. However, we could not find any significant differences in outcomes to support this hypothesis, so we conclude that both the cementless and cemented TKA can be expected to result in the same good outcome.

Only the side that was not operated on showed a significant difference in the 2 groups of patients. This means that the non-operated sides in the cementless cases were weaker than in the cemented cases. The patients are past middle age; therefore, partial weight bearing is apparently hard work for the opposite lower limbs. This suggests that most TKA patients are too old to endure long periods of standing on one leg. Though the value was small, we could not determine for certain whether we could ignore the result or not. More cases must be investigated before this can be elucidated.

In a Danish study, the median age at operation of 926 TKA patients was 71 (23–88) years. The findings of this study were almost the same as our data. The more a society ages, the greater the need for joint reconstruction such as arthroplasty seems to become.

In this study, we looked at the effects 3 months after surgery, but Hatanaka et al. reported that compared to before surgery the average brake force at 4 and 12 weeks after surgery was significantly increased. Walsh et al. reported that one year after TKA marked physical impairments and functional limitations persisted. Walking speeds for men with TKA were 13% and 17% slower at normal and fast speeds, respectively. Walking speeds for women with TKA were 17% and 18% slower at normal and fast speeds, respectively. Finch et al. also suggested that even if a high score was obtained compared to the clinical knee evaluation before the operation, there was a significantly greater perceived difficulty with function in patients with TKA than in healthy individuals as measured by gait analysis (with walking speed and stair performance). It is not clear whether the outcome of the present study would still be true later in the postoperative period (e.g., one year after TKA).

CONCLUSION

We investigated the difference between the effects of cementless and cemented TKA through gait analysis, before and 3 months after surgery. The two groups of patients exhibited no significant differences on the operated side. Only the side that was not operated on showed a significant difference in the ratio of single support between patients receiving the two types of operations. We conclude that it would be helpful to take into consideration the condition of the opposite lower limbs when evaluating the effects of TKA.

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