Walking Ability following Total Hip Arthroplasty : A Comparison of Gait Analysis in Unilateral and Bilateral Cases

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人工股関節全置換術後の歩行回復過程の検討

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We studied 72 patients before and after bilateral total hip arthroplasty (THA), and using gait analysis, we compared them with 253 patients who had undergone staged unilateral THA. The average age of the patients was 59 years at the time of the first operation. The mean follow-up period was 40.5 months for the unilateral THA group and 40.2 months after the second THA for the bilateral THA group. The average interval between the first and second THA was 3 weeks. Using a force-measurement platform, we characterized the functional results of both groups. The platform allowed measurement of free-walking speed, step frequency, stride length, step length, and single- and double-support durations. The patients with bilateral THA successfully achieved optimal function similar to those with unilateral THA, except with respect to the step length at 2-6 months after the second THA. The patients in the bilateral THA group briefly demonstrated short-step walking. The 3-week interval between the THAs and early weight-bearing did not affect the improvement in gait when cementless THA was conducted.

本研究の目的は、片側のみ人工股関節全置換術 (THA) を行なった群と1回の入院中に両側ともTHAを行なった群の歩行の回復過程を比較・検討することである。対象はTHAを行なった325例 (片側THA群253例, 両側THA群72例) であり, 全例, 後側方進入を用いセメントレスにて行なった。術後3から4日で全荷重による歩行訓練開始とし両側THA症例の場合, 疼痛が強い方を先に, 3週後に反対側を行なった。術前, 術後2カ月, 6カ月, 12カ月の時間・距離因子を測定し両群を比較した。歩行速度, 歩調, 歩幅, 単脚支持時間率, 両脚支持時間率は両群ともに術後6カ月で有意に改善していた。両群で差が見られた項目は術後2カ月の歩幅のみであった。3週間という比較的短い間隔でセメントレスTHAを行ない, 且つ早期荷重を行なっても, 歩行の改善にはほとんど影響がないことが示された。

Key words : gait analysis (歩行解析), total hip arthroplasty (人工股関節全置換術), early weight bearing (早期荷重), time-distance parameter (時間距離因子)

Introduction

Lazansky et al reported that adult hip disease requires bilateral surgery in 15-25% of the cases, and reports on total hip arthroplasty (THA) often concern patients with unilateral and bilateral involvement^①. Charnley et al reported that assessment of the results in bilateral cases poses

special problems^②. If only individual hips are considered, the inclusion of bilateral cases may fail to provide a clear picture of the outcome; results should be reported separately after the first and second arthroplasties. Murray et al showed that the percentage improvement in many elements of walking is greater in patients with bilateral THA than in those with unilateral replacement^③, but

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this may not be evident until the contralateral painful hip has been treated. Indeed, surgery on the first hip may appear unsuccessful until the contralateral hip has been replaced.

During walking, the primary functions of the hip are facilitation of an adequate stride length and rapid limb advancement; the free-walking speed is the product of step length and step frequency. The second function, that of mobile weight-bearing, is indicated by the patient's single-stance duration⁵⁻¹⁰. Arborelius et al reported that hip function can also be measured by calculating the metabolic cost of walking, which strongly correlates with the maximal walking speed¹¹. The purpose of this study was to investigate the characteristics of the course of gait pattern in patients with unilateral and bilateral THA.

Patients and Methods

Patients

We examined 325 patients preoperatively and at 2 months, 6 months, and 1 year following THA. None of the patients demonstrated any symptoms involving the lumbar vertebrae, knee, or ankle joints. Among them, 72 patients had bilateral THA performed separately at an average interval of 3 weeks (3 to 4). This group included 8 men and 64 women; their average age was 58.3 years. The unilateral THA group included 253 patients with unilateral hip disease; none of them experienced pain or discomfort in the contralateral hip at any point of time. This group included 39 men and 214 women; their average age was 60.6 years. Their mean age, weight, and diagnostic range did not differ significantly from those of the bilateral THA group.

Methods

We used the Japanese Orthopaedic Association (JOA) hip score for clinical evaluation. Gait analysis was performed on a walkway consisting

of two 5 m-long force-measurement platforms, which provide a continuous record of the ground forces for a sequence of several steps for each foot during level walking. The patients were instructed to walk barefoot at a comfortable rate without using an assistive device. We recorded the free-walking speed, step frequency, stride length, step length, and the single- and double-support durations for each leg expressed as a percentage of the gait cycle.

We used the Mann-Whitney *U* test to analyze the bilateral group, and Student's *t*-test to compare the 2 groups. Significances of individual differences were evaluated using Dunnett's and Scheffe's tests if the analysis of variance (ANOVA) was significant. A *p* value of less than 0.05 was considered significant. The analysis was performed using SPSS version 12 for Windows.

Results

The mean JOA hip score of the patients in the bilateral THA group improved from 46.5 to 87.5 after the second THA; in the unilateral THA group, it increased from 47.6 to 88.1.

In the bilateral THA group, the free-walking speed increased from 567.4 to 825.5 mm/s after the second THA; in the unilateral THA group, it increased from 625.7 to 818.6 mm/s (Fig.1). No difference was observed between the 2 groups at 6 months after THA.

In the bilateral THA group, step frequency increased from 93.4 to 106.3 steps/s after the second procedure; in the unilateral THA group, it increased from 93.9 to 104.7 steps/s after THA (Fig.1). No differences were observed between the groups.

In the bilateral THA group, the stride length/height increased from 0.78 to 1.02 after the second THA; in the unilateral group, it increased from 0.85 to 1.02 (Fig.2). In the unilateral THA group, the step length improved gradually. In

Fig. 1 Free-walking speed, step frequency, and stride length/height.

In the bilateral group, the free-walking speed increased from 567.4 to 825.5 mm/s after the second THA; in the unilateral group, it increased from 625.7 to 818.6 mm/s.

In the bilateral group, the step frequency increased from 93.4 to 106.3 steps/s after the second procedure; in the unilateral group, it increased from 93.9 to 104.7 steps/s after THA.

In the bilateral group, stride length/height increased from 0.78 to 1.02 after the second THA; in the unilateral group, it increased from 0.85 to 1.02.

the bilateral THA group, the step length of the first THA side improved gradually. However, that of the second THA side decreased between 2 and 6 months after THA. No differences were observed 6 months after THA (Fig. 2).

The single- and double-support durations of both groups improved gradually and attained a normal value within 12 months (Fig. 3).

Discussion

In most studies regarding function after THA, a majority of the patients included have unilateral disability¹²⁻¹⁴. Wykman et al studied bilateral hip disease before operation and after each side had been replaced, and they showed that

optimal function was not achieved until both THAs had been performed^{15) 16)}. In this study, the patients with bilateral THA successfully achieved optimal function similar to those with unilateral THA, except with respect to the step length at 2 to 6 months after the second THA. The reason may be that different approaches, combination with great trochanteric osteotomy, different prosthesis, and the different manner of examination were mixed in their report.

Conclusion

The patients with bilateral THA successfully achieved optimal function similar to those with unilateral THA, except with respect to the step

Fig. 2 Step length.

In the unilateral THA group, the step length improved gradually. In the bilateral THA group, the step length of the first THA side improved gradually. However, that of the second THA side decreased 2 months after THA. No differences were observed 6 months after THA.

Fig. 3 Single- and double-support durations.

The single- and double-support durations of both groups improved gradually and attained a normal value within 12 months.

length 2-6 months after the second operation. The 3-week interval between the THAs and early weight-bearing did not affect the improvement in gait when cementless THA was conducted.

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