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Original Article

Relationship between motor FIM improvement (corrected motor FIM effectiveness) and age in proximal femoral fractures

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ABSTRACT
Tokunaga M, Nakanishi R, Kiyota K, Kubota K, Takahashi T, Shigemoto H, Takahashi S, Nakane N, Yonemitsu H. Relationship between motor FIM improvement (corrected motor FIM effectiveness) and age in proximal femoral fractures. Jpn J Compr Rehabil Sci 2014; 5: 131−135.

Objective: The objective of the present study was to determine the differences in FIM improvement (corrected FIM-M effectiveness) in proximal femoral fracture patients due to age.

Methods: The subjects were 886 proximal femoral fracture patients. For the formula, Corrected FIM-M effectiveness = FIM-M gain / (A − FIM-M at admission), we determined values of A that would yield a mean FIM-M effectiveness of roughly 0.65. We divided the subjects into seven groups each covering an age range of five-year increments, and we determined the mean corrected FIM-M effectiveness for each group.

Results: For FIM-M of 13−18, 19−24, 25−30, and 31−90 points at admission, the value of A was 47, 70, 85, and 91 points, respectively. Corrected FIM-M effectiveness declined with advancing age, especially above 80 years old.

Conclusion: Mean FIM improvement in proximal femoral fracture patients begins to decline at age 80, while it was reported to be at age 70 in stroke patients.

Keywords: proximal femoral fracture, corrected FIM effectiveness, FIM gain, operation procedure, stroke

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Introduction

The Functional Independence Measure (FIM) [1] is a technique used for evaluating activities of daily living (ADL). Improvement of ADL is often used to compare the outcomes in proximal femoral fractures. FIM evaluates ADL as 1−7 points each for 18 items. The scale consists of 13 motor items (FIM-M) with a score range of 13−91 points, and 5 cognitive items with a score range of 5−35 points [1]. The results indicate to what extent an individual is capable of independent ADL.

The mean gain in FIM (FIM score at discharge − FIM score at admission) is greatest for patients requiring moderate assistance [2]. On the other hand, patients with low FIM scores at admission exhibit little improvement, while those with high FIM scores at admission demonstrate a ceiling effect, and both groups display little gain in FIM [2]. When FIM at admission differs significantly between rehabilitation hospitals, simple comparison of FIM gain in proximal femoral fractures is impossible. In addition, we have not seen any reports of inter-hospital FIM improvement comparisons corrected for differences in severity depending on the hospitals.

To solve the problem of the ceiling effect in FIM gain, FIM improvement scores, such as FIM effectiveness [3] and corrected FIM effectiveness [4], have been reported. FIM-M effectiveness is calculated as FIM-M gain / (91 points − FIM-M at admission) [3]. This is used to check what percentage of potential improvement has been achieved by setting the points that might improve as the denominator and the points that actually improved as the numerator. Values of FIM-M effectiveness are therefore between 0 and 1 [3]. Changing the “scores that may improve” in FIM-M effectiveness to the “scores that actually can improve” yields an index of FIM improvement that is largely unaffected by FIM at admission; this index is called the corrected FIM-M effectiveness, which is calculated as [FIM-M gain / (A − FIM-M at admission)] [4]. The value of A, which yielded a corrected FIM-M gain of around 0.65, was estimated as 42, 64, 79, 83, 87, 89, and 91 points (in the case of FIM-M of 13−18, 19−24, 25−30, 31−36, 37−42, 43−48, and 49−90 points at admission, respectively) in stroke patients [4]. The corrected FIM-M effectiveness can be used as an outcome indicator in which the influence of FIM-M at admission is corrected [5]. Using the corrected FIM effectiveness, FIM improvements were compared among *Kaifukuki* rehabilitation hospitals with different mean FIM at admission [6].

The value of A is considered to differ depending on the disease; however, searches cannot be conducted for diseases other than stroke. Therefore, inter-hospital comparisons of FIM improvement that use corrected FIM effectiveness are currently limited to evaluations of stroke patients [6].

The objectives of the present study were to determine the value of A in corrected FIM-M effectiveness in proximal femoral fracture patients, and to determine the effect of age on FIM improvement (corrected FIM-M effectiveness) in proximal femoral fracture patients.

Subject and Methods

A retrospective epidemiological study was conducted. Proximal femoral fracture patients, who were admitted to K Hospital between Jan 1, 2008 and May 3, 2014, and received surgical treatment (osteosynthesis or artificial femoral neck replacement) and rehabilitation, were enrolled in the study. The following patients were excluded: those with reoperation, those admitted more than 19 days after injury, those whose duration from admission to operation was more than 14 days, those who spent less than 14 days in the hospital, those who died in the hospital, and those with motor FIM score at admission of 91 points or with motor FIM gain of less than 0 points. As a result, 886 patients were included in the present study. All the required items were available from all subjects, with no missing data. Table 1 shows the basic attributes of the 886 patients in this study.

Study 1: FIM-M gain and FIM-M effectiveness

We divided FIM-M at admission into ten groups (13−18, 19−24, 25−30, 31−36, 37−42, 43−48, 49−54, 55–60, 61–66, and 67–90 points). The first nine groups were in six-point increments. However, there were only seven patients with FIM-M ≥ 73 points at admission; therefore, we combined those with scores of 67−90 points into one group. We investigated the mean values of FIM-M gain and FIM-M effectiveness for each of these ten groups.

Study 2: Corrected FIM-M effectiveness

Corrected FIM-M effectiveness was calculated using the method reported by Tokunaga et al. [4]. The

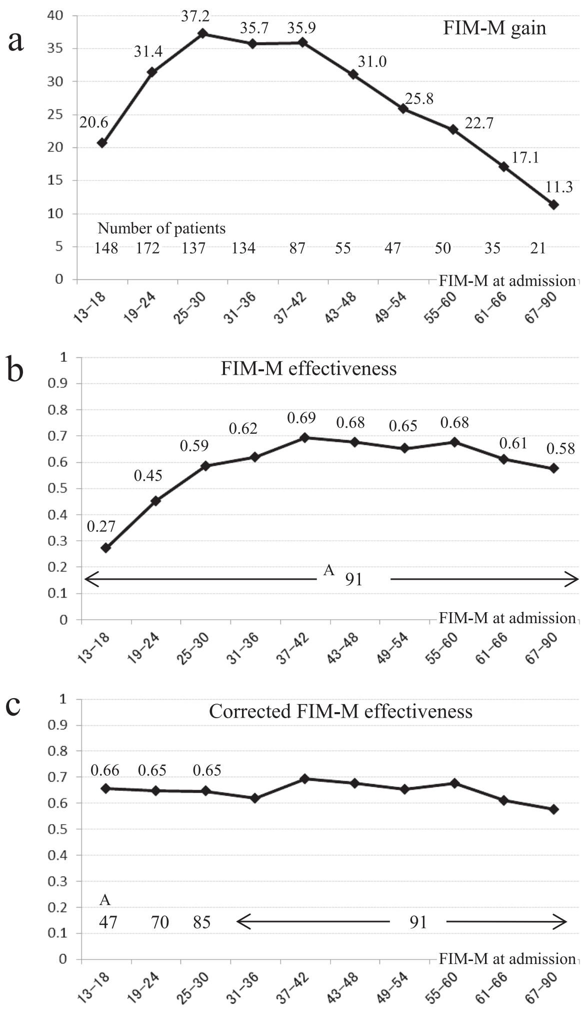

Figure 1. FIM-M gain (a), FIM-M effectiveness (b), and corrected FIM-M effectiveness (c).
"A" is the parameter from the following equation: Corrected FIM-M effectiveness = FIM-M gain/(A – FIM-M score at admission). Figures on the polygonal lines are average values.

average FIM-M effectiveness for 429 patients with an FIM-M score of 31−90 at admission was 0.649 (Fig. 1b). On the other hand, for an FIM-M score of 13−30 points, the lower the FIM-M at admission, the lower the average FIM-M effectiveness. So, for an average FIM-M effectiveness also around 0.65 for an FIM-M score of 13−30 points at admission, the denominator of 91 points of the FIM-M effectiveness [FIM-M gain / (91 points − FIM-M at admission)] was corrected. Specifically, the FIM-M gain (X) for 137 patients with an FIM score of 25−30 at admission averaged 37.20 points and FIM-M at admission (Y) averaged 27.30 points (Table 2). X/(85−Y) was 0.645, X/(84−Y) was 0.656, and it was predicted that if the denominator decreased from 91 points to 85 or 84 points, then the corrected FIM-M effectiveness would be approximately 0.65 (Table 2). Next, with regard to the 137 patients whose FIM-M score at admission was 25−30 points,

Table 1. Clinical characteristics of subjects in this study.

Number of patients	886
Age	82.1±9.9 (35−101, 83)
Sex	Males 141, females 745
Affected side	Right 433, left 453
Duration from injury to admission	0.4±1.5 (0−18, 0)
Duration from admission to operation	3.0±2.5 (0−14, 2)
Operation	Osteosynthesis 619, femoral neck replacement 267
Length of hospital stay	59.3±24.9 (14−189, 58)
FIM-M at admission	32.8±15.0 (13−88, 30)
FIM-C at admission	25.5±9.2 (5−35, 28)
FIM-M at discharge	62.5±21.5 (13−90, 68)
FIM-C at discharge	26.2±8.5 (5−35, 28)
FIM-M gain	29.7±16.9 (0−68, 29)
FIM-C gain	0.7±3.2 (−15−21, 0)

Data for this study are expressed as mean ± standard deviation (minimum – maximum, median) FIM, Functional Independence Measure; FIM-M, motor items of FIM; FIM-C, cognitive items of FIM.

Table 2. Corrected FIM-M effectiveness.

FIM-M at admission	13−18	19−24	25−30
Number of patients	148	172	137
Mean FIM-M effectiveness	0.273	0.452	0.585
X: average of FIM-M gain	20.65	31.42	37.20
Y: average of FIM-M at admission	15.07	21.41	27.30
X/(91−Y)	0.272	0.451	0.584
X/(86−Y)			0.634
X/(85−Y)			**0.645**
X/(84−Y)			0.656
X/(83−Y)			0.668
X/(71−Y)		0.634	
X/(70−Y)		**0.647**	
X/(69−Y)		0.660	
X/(48−Y)	0.627		
X/(47−Y)	**0.647**		
X/(46−Y)	0.668		
Corrected FIM-M effectiveness	0.656	0.648	0.647

FIM-M effectiveness＝FIM-M gain/(91 points−FIM-M at admission).
Corrected FIM-M effectiveness＝FIM-M gain/(A−FIM-M at admission).
The values of A that yielded corrected FIM-M effectiveness at around 0.65 were 47, 70, 85 points for FIM-M score at admission of 13−18 points, 19−24 points, and 25−30 points.

the corrected FIM-M effectiveness [FIM-M gain / (85 points − FIM-M score at admission)] was calculated, and the average of 0.647 for the 137 patients was found. The average of FIM-M gain / (84 points − FIM-M score at admission) was 0.658. Thus we set the value of A in the corrected FIM-M effectiveness [FIM-M gain / (A − FIM-M score at admission)] as 85 points. Using the same method for groups with an FIM-M score at admission of 13−18 and 19−24 points, the value of A was set so that the corrected FIM-M effectiveness would be approximately 0.65.

Study 3: Stratification by age

We stratified the subjects into seven groups by age: < 69, 70−74, 75−79, 80−84, 85−89, 90−94, and ≥ 95 years. We then investigated the number of patients, mean FIM-M at admission, and mean FIM-M effectiveness for each of these seven groups.

This study complied with the regulations of the Clinical Research Ethics Committee of our hospital, and was performed with the permission of the staff previously designated by the Clinical Research Ethics Committee.

Results

Mean FIM-M gain was highest in subjects with FIM-M scores of 25−30 points at admission (Fig. 1a).

For the formula, Corrected FIM-M effectiveness = FIM-M gain / (A − FIM-M at admission), the values of A that yielded a corrected FIM-M effectiveness of roughly 0.65 for FIM-M of 13−18, 19−24, and 25−30 points at admission were 47, 70, and 85 points, respectively (Table 2, Fig. 1c). Correction was performed for three of the ten groups (for subjects with FIM-M of 13−18, 19−24, and 25−30 points at admission); these groups accounted for 457 subjects, or 51.6% (457/886) of all subjects.

When stratified into seven groups by age, the age group with the highest number of patients was 85−89 years (Fig. 2a). Mean FIM-M at admission declined with advancing age (Fig. 2b). Corrected FIM-M effectiveness also declined with advancing age, especially above 80 years old (Fig. 2c).

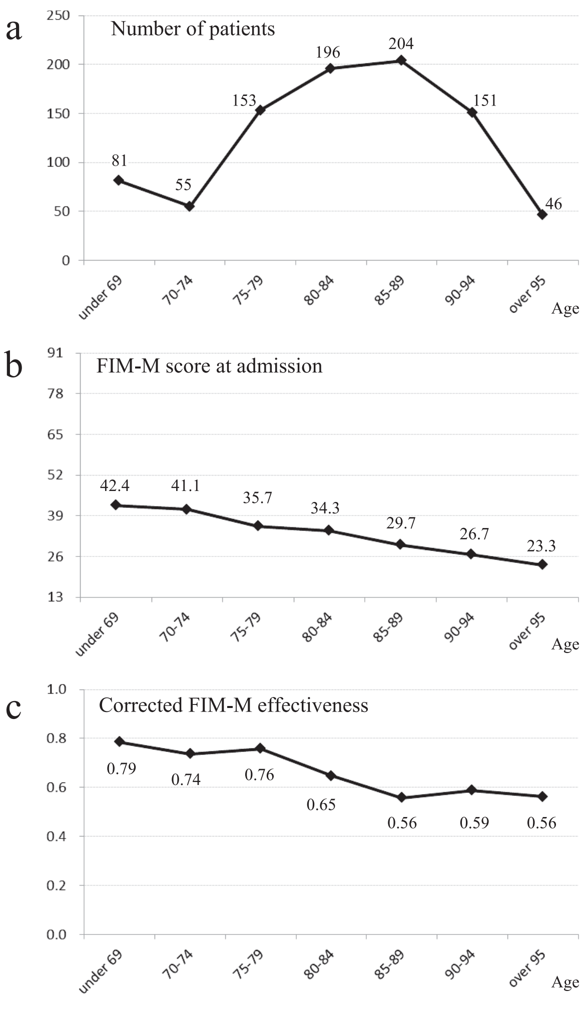

Figure 2. Numbers of patients, FIM-M at hospitalization, and corrected FIM-M effectiveness by age.
Figures on the polygonal lines are average values.

Discussion

The present study identified the value of A in the denominator of the formula for corrected FIM-M effectiveness in proximal femoral fracture patients, and demonstrated that the mean FIM improvement (corrected FIM-M effectiveness) in proximal femoral fracture patients begins to decline at the age of 80.

ADL improvement in stroke patients has been compared between hospitals after correcting the differences in mean ADL at admission between rehabilitation hospitals using the following four methods: correction of ADL gain using a standard severity distribution [7, 8]; limiting patients based on ADL at admission [9]; the corrected FIM effectiveness [6]; and case-control studies matching age and FIM at admission [10]. However, we could find no reports that compared FIM improvement in proximal femoral fracture patients between hospitals. The present study determined the value of A in corrected FIM-M effectiveness in proximal femoral fractures; therefore, inter-hospital comparisons of FIM improvement (corrected FIM-M effectiveness) in proximal femoral fracture patients are theoretically possible even when there are differences between hospitals in mean FIM at admission.

In regard to the association between age and FIM improvement in proximal femoral fracture patients, Maeshima et al. [11] conducted an investigation of 50 cases in which they observed a positive correlation between FIM gain and the duration of hospitalization and amount of rehabilitation; however, FIM gain was not significantly correlated with age (correlation coefficient = −0.26). In another investigation of 557 cases of femoral fracture, Semel et al. [12] also did not observe a significant correlation between age and FIM gain (correlation coefficient = 0.02, $p = 0.65$). However, other reports have stated that FIM improvement is poor in elderly proximal femoral fracture patients [13, 14]. In a study of 946 femoral fracture patients aged 65 and older, Lieberman et al. [13] performed multiple regression analysis with the total FIM effectiveness score (total FIM gain score / (126 − total FIM score at hospitalization)) as the response variable; they reported that of 40 explanatory variables, eight items including age were selected (adjusted R^2 = 0.319). The eight items selected were: pre-fracture FIM (standardized regression coefficient $\beta = 0.261$), serum albumin at discharge ($\beta = 0.222$), Folstein Mini-Mental State Examination ($\beta = 0.174$), visual impairment ($\beta = -0.089$), dyspnea at mild exertion ($\beta = -0.080$), age ($\beta = -0.080$), poststroke motor impairment ($\beta = -0.072$), and decreased serum folic acid (β = −0.055) [13]. Even when taking several factors into consideration, age significantly inhibited FIM improvement. FIM improvement is considered to decline further in elderly individuals with cognitive decline or undernutrition. Arinzon et al. [14] reported that FIM gain was smaller in proximal femoral patients aged 85 or older (46 cases) than in those aged 65−74 (56 cases). However, none of the reports had determined the exact age at which FIM improvement begins to decline.

The present study showed that in proximal femoral fractures, the level of improvement in FIM-M (corrected FIM-M effectiveness) declines with advancing age. In stroke patients, corrected FIM-M effectiveness is reported to decline beginning at age 70 [15], whereas in proximal femoral fracture patients, this decline begins at age 80. However, the reasons for this difference have yet to be determined, as does the issue of whether this difference is significant; these are topics for future studies.

The limitations of the present study include the following. First, the results were obtained from only one facility. In order to compare FIM improvement in proximal femoral fracture patients between hospitals, the value of A in the corrected FIM-M effectiveness must be determined based on data from throughout Japan (or throughout a given region).

Second, we did not investigate pre-injury ADL or comorbidity; we did not distinguish between neck fractures and trochanteric fractures; and we did not stratify the subjects based on the number of days from injury to surgery. Third, corrected FIM effectiveness is still limited in terms of prevalence, and its validity as an FIM improvement index resistant to the effect of FIM at admission has not been established [5].

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