RECOVERY OF POST-SURGICAL SWALLOWING FUNCTION IN PATIENTS WITH ORAL CANCER.

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Purpose: The present study was focused on a comparison of post-surgical oropharyngeal swallow efficiency and medical status indicators.
Study design: The swallowing function was assessed in 25 patients (18 males and 7 females) with oral cancer. The swallowing function was assessed preoperatively, and 1, 6, and 12 months and in some cases more than 24 months after surgery. Assessment of the swallowing function consisted of videofluoroscopic evaluation (oropharyngeal swallow efficiency; OPSE) and details of the method of nutrition, diet level, nutritional condition, and occurrence of pneumonia.
Results: Post-surgically OPSE did not recover to the preoperative level more than 12 months after surgery. Twenty-one patients (84%) had full oral intake and only three patients (12%) showed poorer nutritional conditions compared to the pre-surgery state. Aspiration pneumonia did not occur more than 12 months after surgery.
Conclusions: The patients in the present study showed stable medical status and functional swallowing at the final evaluation despite of the insufficient recovery of the oropharyngeal swallow efficiency revealed by videofluoroscopic evaluation .

Introduction

Post-surgical oromandibular defects have been restored using microvascular free flaps with high rates of success. Nevertheless, the impairment of post-surgical functions such as articulation, mastication and swallowing has remained as an issue for such patients. Post-surgical dysfunction is strongly dependent on the extent of the surgery and type of reconstruction, and to plan and assess appropriate rehabilitation strategies, data on functional outcomes for specific resections and reconstructions are needed [1].

Swallowing dysfunction after oral and pharyngeal resection with primary closure, distal flap, and vascularized free flap has been discussed [1-7]. Evaluation of the post-surgical swallowing function was performed mainly with videofluoroscopic measures [1-6], but some authors use subjective methods such as questionnaires or similar with or without videofluoroscopic measurements [7-12]. Pauloski [4], Wagner [7] has reported one-year follow ups of the post-surgical swallowing function with a detailed quantitative method, but there are few reports focused on the recovery of the post-surgical swallowing function with comparing between videofluoroscopic measures and other medical status indicators in oral cancer patients.

To clarify the course of the recovery of post-surgical swallowing dysfunction between 1 and more than 12 months after surgery, and to determine the correlation among videofluoroscopic measures and medical status indicators, post-surgical oropharyngeal swallow efficiency, nutritional condition, type of nutrition, diet levels, and the occurrence of pneumonia were investigated.

Patients and methods

Patients

Twenty-five patients with carcinomas of the tongue, floor of the mouth, lower gum and retromolar trigone（cheek）were the subjects in the present study. Eighteen males and 7 females, with an average age of 62 years, treated with oral or oropharyngeal resection and reconstructed with vascularized free flaps. Twenty-one patients received 40 Gy of pre-operative radiotherapy, and no patients received post-operative radiotherapy or other surgical intervention after the first surgery. The stages of the oral cancers were 4 of stage II, 6 of III, and 15 cases of stage IV. The surgical extent and sorts of free flaps, as well as type of neck dissection performed are shown in Figure 1. All patients received pull through or commando operations. Resection of the base of the tongue was performed in one of the 9 patients of the hemiglossectomy group. Half to 3/4 portions of the base of the tongue was resected in the 4 patients of the subtotalglossectomy group, of these the surgical extent included pharyngeal wall in 2 patients as was the case for 2 patients with cheek carcinomas. Segmental resection of the anterior portion of the mandible was performed in 3 patients with carcinomas of the floor of the mouth. Segmental resection of the lateral portion of the mandible was performed in all patients with lower gingival carcinomas. Although the precise volume of resected tissue was not estimated in the present study, the approximate volume could be estimated by the T stage of each tumor.

From 1996 between 2001, 58 patients were subjected to oro-mandibular reconstruction with vascularized free flaps. Of these, twelve patients with upper gum, palate or cheek（not retromolar trigone）were excluded from the present study because these patients showed no swallowing dysfunction after the surgery; thirteen patients with primary and cervical lymph node recurrences were excluded because additional

surgery or radiotherapy was performed; and eight patients were excluded because six-month and/or twelve-month evaluation was not performed.

To increase the mobility of oral structures and to prevent aspiration, all patients received post-operative swallowing therapy and 16 patients also received pre-operative swallowing therapy. The swallowing therapy includes tongue range-of-motion exercises and supra or super-supraglottic swallow maneuvers [13].

Methods

The swallowing performance was assessed pre-operatively, and at 1, 6, and 12 months after surgery. All patients received the 1, 6, and 12-month post-surgical evaluation, while 20 also received a preoperative evaluation. Further, post-surgically 10 received a 24-month evaluation, 3 received a 36-month evaluation, and 2 received a 48-month evaluation. The 1-month evaluation was the first evaluation after the surgery when the patients had the tracheal tube removed and started oral food intake, and the mean numbers of days after the surgery of the 1-month evaluation was 40 days.

In modified barium swallow examination [14], patients were asked to complete two swallows each of 3cc barium liquid and a 1/2 teaspoon of barium paste (total four swallows) in a sitting position. These results were recorded on videotape and converted into digital data. Then, the oral transit time, pharyngeal transit time, and percent of the bolus swallowed were measured with Primere®（Adobe Systems Incorporated, San Jose, U.S.A.）software and the oropharyngeal swallow efficiency（OPSE）[15] was calculated. The method for calculating the oropharyngeal swallow efficiency（OPSE）was according to that reported by Logemann et al [15]. Cookies coated with barium were not used in the present study, because some patients were predicted to loose their teeth by the surgery. From the results of the preoperative mean OPSE（liquid：38.2±12,6；paste：34.0±16.2）, OPSE above 40 was considered to show an absence of dysfunction, 20-39.9 mild

dysfunction, 10-19.9 moderate dysfunction, 0-9.9 severe dysfunction. The method of nutrition, and diet level was evaluated using the Dysphagia Grading reported by Fujishima [16] in 1993. The Grading simply expresses the method of nutrition and diet level（Table 1）. The nutritional condition was evaluated using the Body Mass Index (BMI) which is commonly used to estimate nutritional conditions and calculated as body weight（kg）/ {height（m）}^{2}. The present study considered 20-25 as normal nutritional condition, above 25 as the higher nutritional condition and below 20 as the poorer nutritional condition. Post-operative pneumonia was defined as that occurring during the patient's hospitalization. New infiltration detected in chest X-rays, fever up to 37.5℃ for more than three days with an increase in C-reactive protein were defined as post-operative pneumonia. Aspiration pneumonia was diagnosed by the criterion described above with typical pulmonary infiltration detected in chest X-rays after the discharge.

To verify the reliability of the OPSE measures in the present study, ten randomly chosen data sets were reanalyzed by two of authors. The Pearson correlation coefficients of interobserver reliability were .91 for liquid and .98 for paste.

The OPSE data were analyzed statistically using repeated measures analysis of variance（ANOVA）to assess changes in the swallowing functions. Post hoc t tests were performed to isolate the source of significance with ANOVAs that had p values of less than .05 considered statistically significant.

Results

Outcome of mean oropharyngeal swallow efficiency (OPSE) measurements

The oropharyngeal swallow efficiency of both liquid and paste worsened after surgery. The mean OPSE did not differ in the 1, 6, 12, and 24-month evaluations indicating that no sufficient recovery was achieved post-surgically. However, a slight improvement was observed in liquid swallowing at the 24-month evaluation, but not in the paste swallowing（Figure 2）.

Outcome of individual oropharyngeal swallow efficiency measurements

At the final evaluation 9 of the 25 patients showed improvements, 5 showed impairment, and 11 showed unchanged functioning compared to the 1-month evaluation in liquid swallowing. Further, 6 of the 25 patients showed improvements, 6 showed impairment, and 13 showed unchanged functioning compared to the 1-month evaluation in paste swallowing. The results indicate that recovery of the post-operative swallowing function was not sufficient after more than 12 months. Aspiration was observed in 10 patients with the liquid swallowing and in 5 patients with the paste swallowing with the videofluoroscopic study 1-month post-surgically. At the final evaluation, aspiration was observed in 3 patients with the liquid swallowing and in one patient with the paste swallowing. After the 6-months evaluation, aspiration in liquid or paste swallowing was only detected in patients with severe dysfunction revealed by OPSE. (Figure 3, 4).

Course of the recovery of individual oropharyngeal swallow efficiency

Liquid OPSE was unchanged in 11 patients (44%) between the 1 and 6-month evaluations and in 19 patients (76%) between the 6 and 12-month evaluation. Only 15 patients were evaluated after more than 24 months, and 10 of these (66.7%) showed unchanged liquid OPSE, with 5 patients showing improved liquid OPSE here. Paste OPSE was unchanged in 13 patients (52%) in the 1 and 6-month evaluation and in 19

patients (76%) at 6 and 12-months. Thirteen patients (87%) showed unchanged paste OPSE after more than 24 months. These results indicate that paste OPSE changes less after more than 6 months than the liquid OPSE (Table 2).

The relationship between primary site of tumors, TN stage and OPSE outcomes

Severe dysfunction of liquid swallowing was observed only in patients with carcinomas of the tongue or the floor of the mouth. Severe dysfunction occurred in 80% of patients with carcinomas of the floor of the mouth and in 38% of patients with tongue carcinomas. No severe dysfunction was observed in patients with gingival or cheek carcinomas. Severe dysfunction for paste swallowing was also found mainly in patients with carcinomas of tongue or floor of mouth, and the occurrences were as same as the liquid swallowing. For liquid or paste swallowing, severe dysfunction was observed not only in T4 cases but also in T2 or T3 cases. Especially, patients with T2 tongue carcinomas showed higher occurrence of severe dysfunction in paste swallowing (3 out of 6) than in liquid swallowing (1 out of 6). These patients showed no dysfunction or mild dysfunction at the 1-month evaluation, but showed worsened functioning at the 6-month evaluation and the functioning had not recovered at the final evaluation. Patients with T4 carcinomas of the floor of the mouth showed severe dysfunction at the 1-month evaluation and the severe dysfunction was unchanged at the final evaluation.

Dysphagia Grading

The oral intake was difficult in six patients at the 1-month evaluation. Five patients showed improved and one patient showed worsened Dyphagia Grading at the 6-month evaluation. The Dysphagia Gradings did not change from the 6-month to the 12 or more than 24-month evaluations. Finally, 21 patients (84%) showed full oral intake of dysphagia diet, easy chewable diet, and normal foods (Figure 5). The remaining four patients need supplemental nutrition and the primary site of tumors of 3

of these was floor of the mouth. Two patients supplement the nutrition via a gastroostomy tube, one via an intermittent naso-gastric tube and the other via an intermittent oro-gastric tube. The correlation between the outcomes of the paste OPSE and Dysphagia Grading are shown in Table 5. The results indicate that both outcomes are correlate well in patients with no dysfunction, mild dysfunction, and moderate dysfunction; but, the outcomes of OPSE did not correlate with the Dysphagia Grading in patients with severe dysfunction.

Changes in Body Mass Index

Seven patients showed a poorer nutritional condition 1 month after surgery compared to that before the surgery. Three patients had recovered the nutritional condition and in two patients decreased further between 1 and 6 months after surgery. Except in one patient, the remaining 24 patients had unchanged nutritional conditions between 6 and 12 months or later, post-surgically (Figure 6). Finally, three patients (12%) did not recover the nutritional condition to that before surgery. Two of these three showed moderate dysfunction and only one patient showed severe dysfunction in liquid and paste OPSE at final evaluation. Accordingly, the severe dysfunction was not always associated with poorer nutritional conditions.

Occurrence of post-operative and aspiration pneumonia

Post-operative pneumonia occurred in 10 patients. The pneumonia occurred before the 1-month evaluation in 6 patients and after the 1-month evaluation in one patient; there was repeated post-operative pneumonia in 3 patients during the inpatient periods (before and after the 1-month evaluation). The occurrence of post-operative pneumonia was not in accordance with the level of dysfunction revealed by OPSE.

Aspiration pneumonia occurred in two patients and asphyxia in one patient between 6 and 12months after surgery. Aspiration pneumonia occurred only in patients with severe

dysfunction revealed by OPSE. None of the patients in the present study suffered from aspiration pneumonia after 12 months or later, post-surgically.

Discussions

The results of the present study indicate that oropharyngeal swallow efficiency (OPSE) in patients with oral cancer did not recover progressively between 1 and more than 12 months post-surgically, this supports the finding reported by Paulosky et al [4]. Although post-surgical OPSE may improve or worsen between 1 and 6 months, the function seems unchanged after more than 6 months, especially in paste swallowing. The post-surgical swallowing function largely depends on the motility of the remaining structure and the type of reconstruction. The functioning between 1 and 6 months may largely be influenced by xerostomia or fibrosis created by radiotherapy [8-11], post-surgical scar formation, and atrophic changes of the free flaps, and in this period, patients were trying to control the new oropharyngeal structure. Because these influences may reduce or become stable after 6 months [9], the swallowing function more than 6 months post-surgically would be unchanged compared to that at 6 months. Of course, we take it for granted that the duration might vary due to preoperative and postoperative radiotherapy and / or chemotherapy. The tendency is more obvious in paste swallowing than in liquid swallowing. Further, liquid OPSE appears to improve more than 12 months post-surgically. These may be explained by the necessity of greater tongue pressure in paste swallowing than with liquids and liquids tend to move more rapidly with gravity alone [3]. It is also possible that the improvement in liquid OPSE is because the pharyngeal motility was well maintained in oral cancer patients, and these patients may be accustomed to the manner or posture for liquid swallowing.

Severe dysfunction revealed by OPSE was observed mainly in patients with carcinomas of the tongue or floor of the mouth and not with carcinomas of the lower gum or cheek. Further, patients with mild dysfunction at the 1-month evaluation could deteriorate to severe dysfunction at the 6-month evaluation and this degree of

dysfunction continued until after the 12-month evaluation. These cases were two patients with tongue carcinomas and one patient with a carcinoma of the floor of the mouth. The tumor size of these patients was T2 and all were reconstructed with forearm flaps. Videofluoroscopic examination showed an extension in the distance from the base of the tongue to the posterior pharyngeal wall and tying down of the tongue, results in swallowing discordance. Therefore, to afford appropriate medical intervention, careful follow-up is needed even for the mild dysfunction groups, as determined at the 1-month evaluation, especially for patients with carcinomas of the tongue or floor of the mouth.

The surgical extent of the carcinoma of the floor of the mouth often includes anterior tongue, anterior mandible, and a large portion of the Mm. Suprahyoideus. This accounts for the post-surgical severe swallowing dysfunction for T4 carcinomas of the floor of the mouth. Because these patients did not show improvement in the swallowing function at the final evaluation, alternative nutrition such as gastroostomy feeding [17] should be instituted as early as possible post-surgically to maintain a good nutritional condition.

Both the Dysphagia grading and Body mass index showed some improvement or worsening between 1 and 6 months post-surgically, and they did not change after more than 6 months post-surgically. These findings showed similar tendency as of the results of the OPSE in the present study. Finally, 21 patients achieved full oral intake and only three patients showed poorer nutritional condition compared to the situation before surgery, and aspiration pneumonia was not occurring after more than 12 months. From these results, as also reported by Stacher et al [5], patients in the present study had relatively stable medical status with functional swallowing.

The outcome of the severe dysfunction revealed by OPSE did not correlate well with the Dysphagia grading (method of nutrition and diet level). A possible reason

for this discrepancy is that these patients are thought to be able to feed orally, spending more time and adjusting the diet or swallowing posture to overcome the disadvantages shown by the videofluoroscopic evaluation. The contrivance and effort performed by the post-surgical oral cancer patients may also be related to the discrepancies between swallowing perceptions and functioning for the group [18]. Because the post-surgical swallowing function does not recover to the level before surgery, the goals of the functional recovery should be set to maintain good medical status and to avoid aspiration pneumonia. Therefore, evaluations of the post-surgical swallowing function are recommended to include the nutritional condition, method of nutrition, diet type, and occurrence of pneumonia with OPSE. Further investigation is needed concerning the discrepancy between the outcome of the OPSE and medical status in the post-surgical oral cancer patients.

The swallowing function is known to deteriorate with age even in healthy persons [19]. Although the present study shows the outcomes of post-surgical swallowing function at more than 24-months in 15 patients, the long-term results of the post-surgical swallowing function are not well documented. Further investigation needs to focus on also this issue.

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Legends

Table 1. no legend

Table 2. no legend

Table 3. no legend

Figure 1. Details of the oral cancers and treatments of the patients in the study here

FA: radial forearm flap, RA: rectus abdominis flap, ALT: anterior lateral thigh flap, Fi: fibula osteocutaneous flap, P: titanium plate, RND: radical neck dissection, mRND: modified radical neck dissection, SOHND: supraomohyoid neck dissection

Figure 2. Outcomess of mean oropharyngeal swallow efficiency

Mean oropharyngeal swallow efficiency (both liquid and paste) at 1, 6, 12, and more than 24 months were significantly lower than before surgery. ＊: $p < .0001$, †: $p < .02$

Mean oropharyngeal swallow efficiency (only in liquid) at more than 24 months was significantly higher than at 1, 6, and 12 months after surgery. ††: $p < .04$

Figure 3. Outcomes of individual oropharyngeal swallow efficiency (liquid).

The numbers in brackets show the number of patients who aspirated during the videofluoroscopic examination. Heavy arrows show improvement, fine arrows show unchanged, and chained arrows show worsened oropharyngeal swallow efficiency. The number near each arrow shows the number of cases.

Figure 4. Outcomes of individual oropharyngeal swallow efficiency (paste).

The numbers in brackets show the number of patients who aspirated during the videofluoroscopic examination. Heavy arrows show improvement, fine arrows show unchanged, and chained arrows show worsened oropharyngeal swallow efficiency. The number near each arrow shows the number of cases.

Figure 5. Outcomes of individual Dysphagia Gradings

Heavy arrows show improvement, fine arrows show unchanged, and chained arrows

show worsened Dysphagia Grading. The number near each arrow shows the number of cases.

Figure 6. Outcomes of individual Body Mass Index

Heavy arrows show improvement, fine arrows show unchanged, and chained arrows show worsened nutritional conditions. The number near each arrow shows the number of cases.

Table 1. Dysphagia Grading (Fujishima, 1993)

Method of nutrition		Diet level	
I	Severe Dysphagia	1	Therapy, no indication
	Alternative nutrition	2	Indirect therapy
		3	Direct and indirect therapy
II	Moderate Dysphagia	4	Minimal intake for oral satisfaction
	Oral intake with	5	Meals, once or twice a day
	supplemental nutrition	6	Meals, three times a day
III	Mild Dysphagia	7	Dysphagia
	Full oral intake	8	Easy chewable diet
		9	Normal food with observation
IV	Normal	10	Normal swallowing ability

Table 2. Course of recovery of individual oropharyngeal swallow efficiencies

	between 1 and 6 months	between 6 and 12 months	after more than 12months
liquid			
improved	7	4	5
worsened	7	2	0
unchanged	11 (44%)	19 (76%)	10 (67%)
paste			
improved	6	3	1
worsened	6	3	1
unchanged	13 (52%)	19 (76%)	13 (87%)

Table 3. Relationship between outcomes of oropharyngeal swallow efficiency (liquid) and the Dysphagia grading (number of cases) at final evaluation

	II- 4	II- 5	II- 6	III- 7	III- 8	III- 9
no dysfunction	0	0	0	0	1	2
mild dysfunction	0	0	0	1	0	5
moderate dysfunction	0	0	0	0	5	0
severe dysfunction	1	3	0	2	5	0

Tongue : 13

Hemiglossectomy: 9

FA: 7

RA: 1

ALT: 1

RND: 2 mRND: 4

mRND+SOHND: 1

mRND bds: 2

Subtotalglossectomy: 4

RA: 2

ALT: 2

mRND: 1

mRND bds: 1

SOHND bds: 1

SOHND+RND: 1

Floor of the mouth : 5

FA: 1

RA: 1

RA+P: 3

mRND: 1

SOHND bds: 1

mRND+SOHND: 1

SOHND+RND: 2

Lower gingiva and alveolus : 4

RA+P: 3

Fi: 1

RND: 2

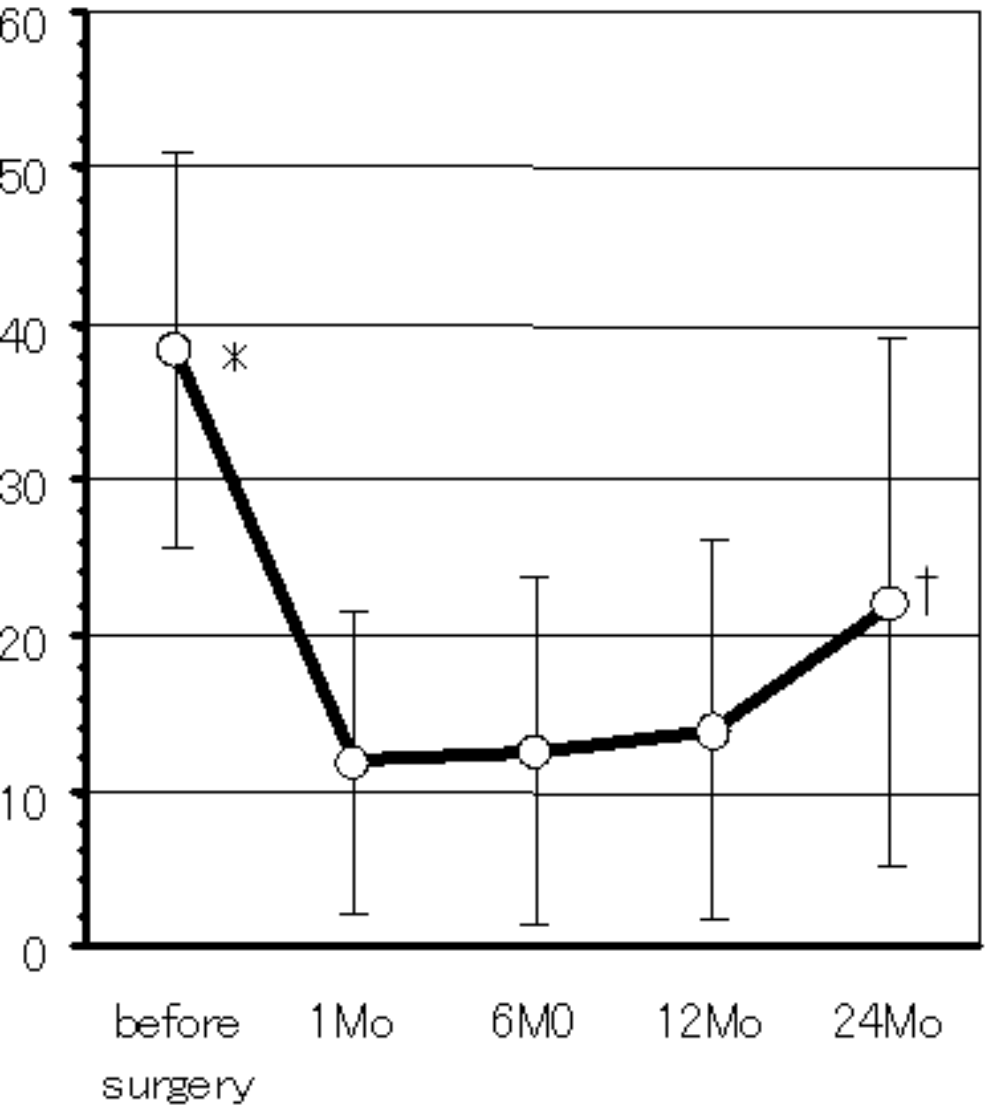
SOHND: 2

Cheek : 3

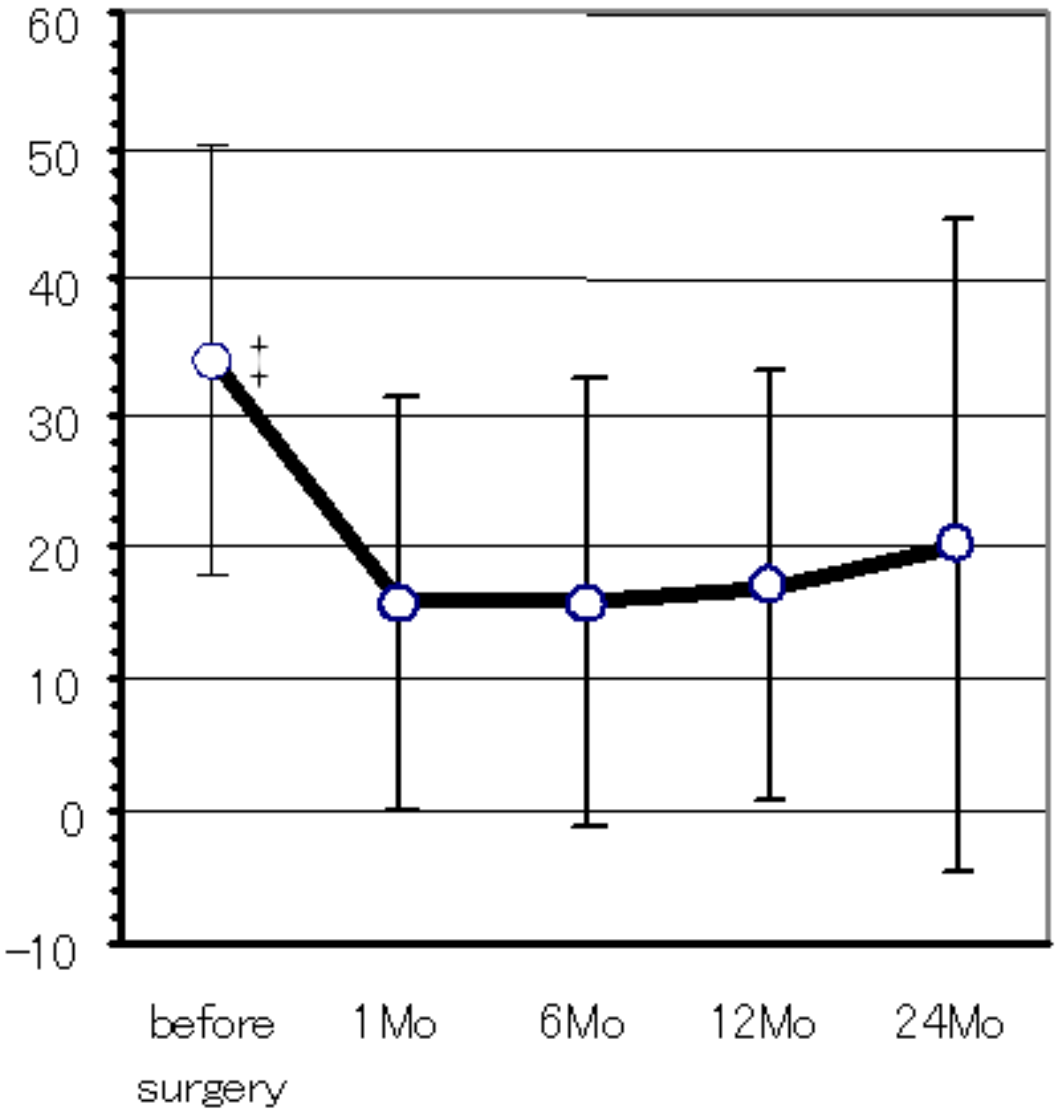
RA: 3

mRND: 1

SOHND: 2



liquid



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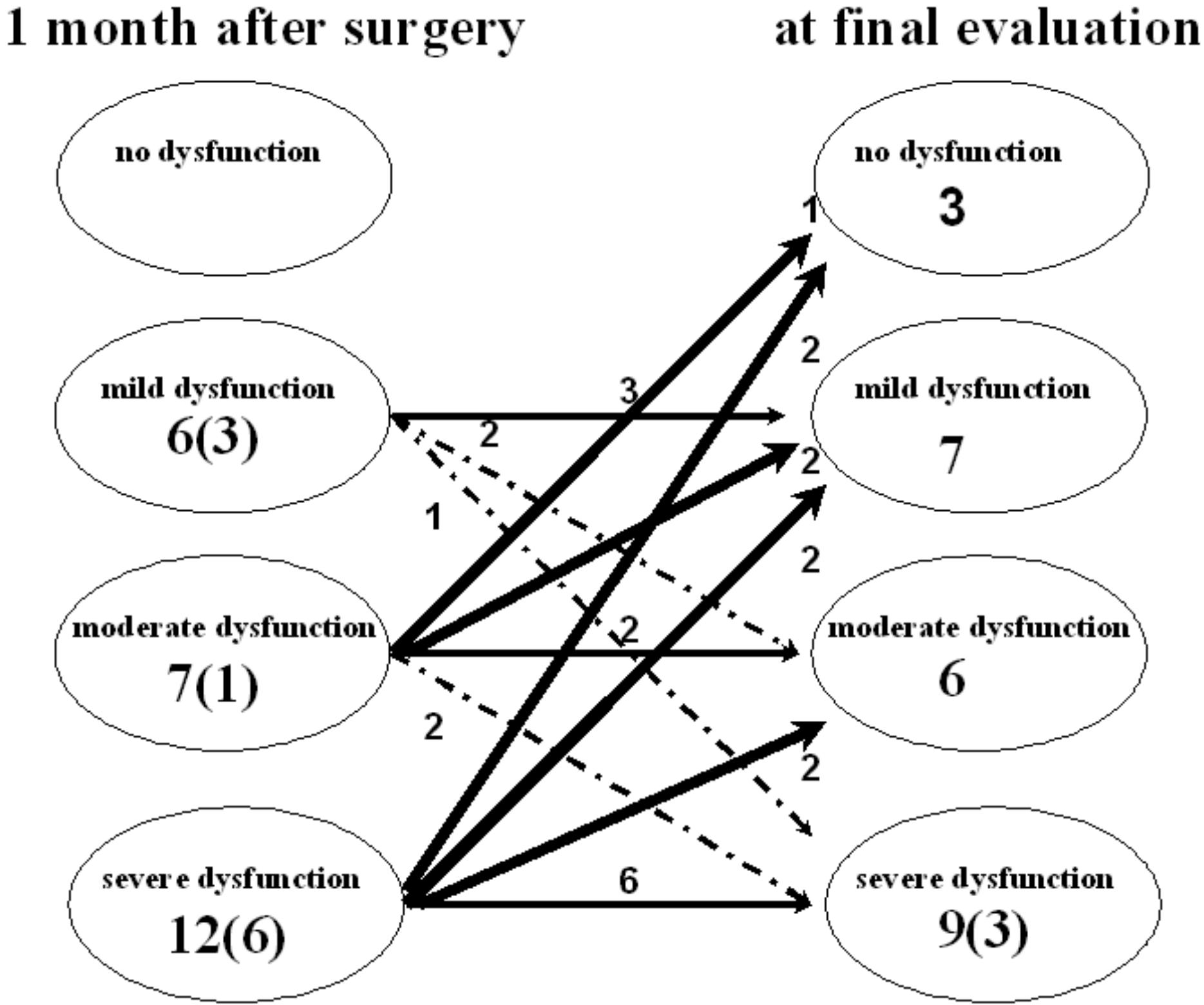
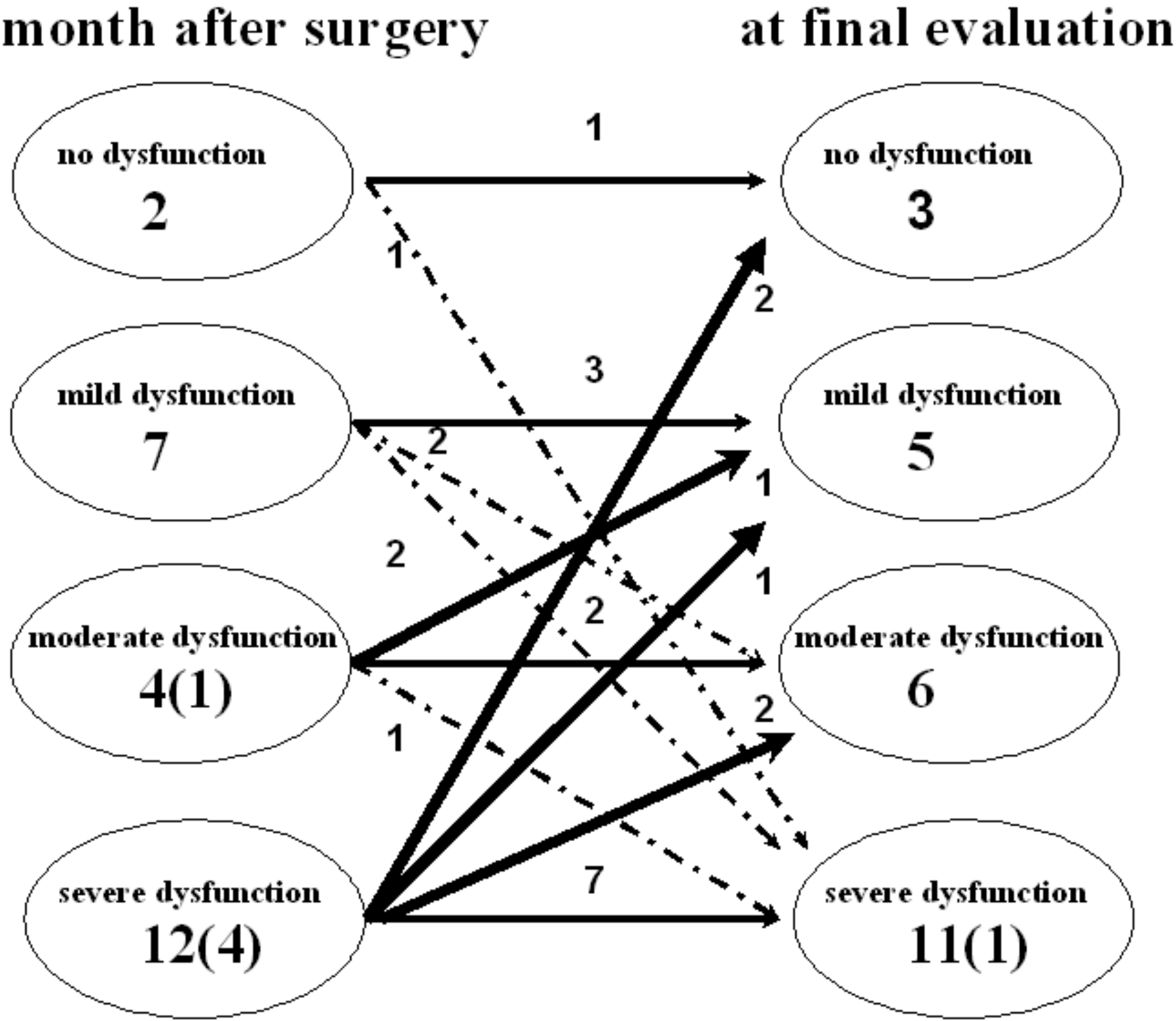
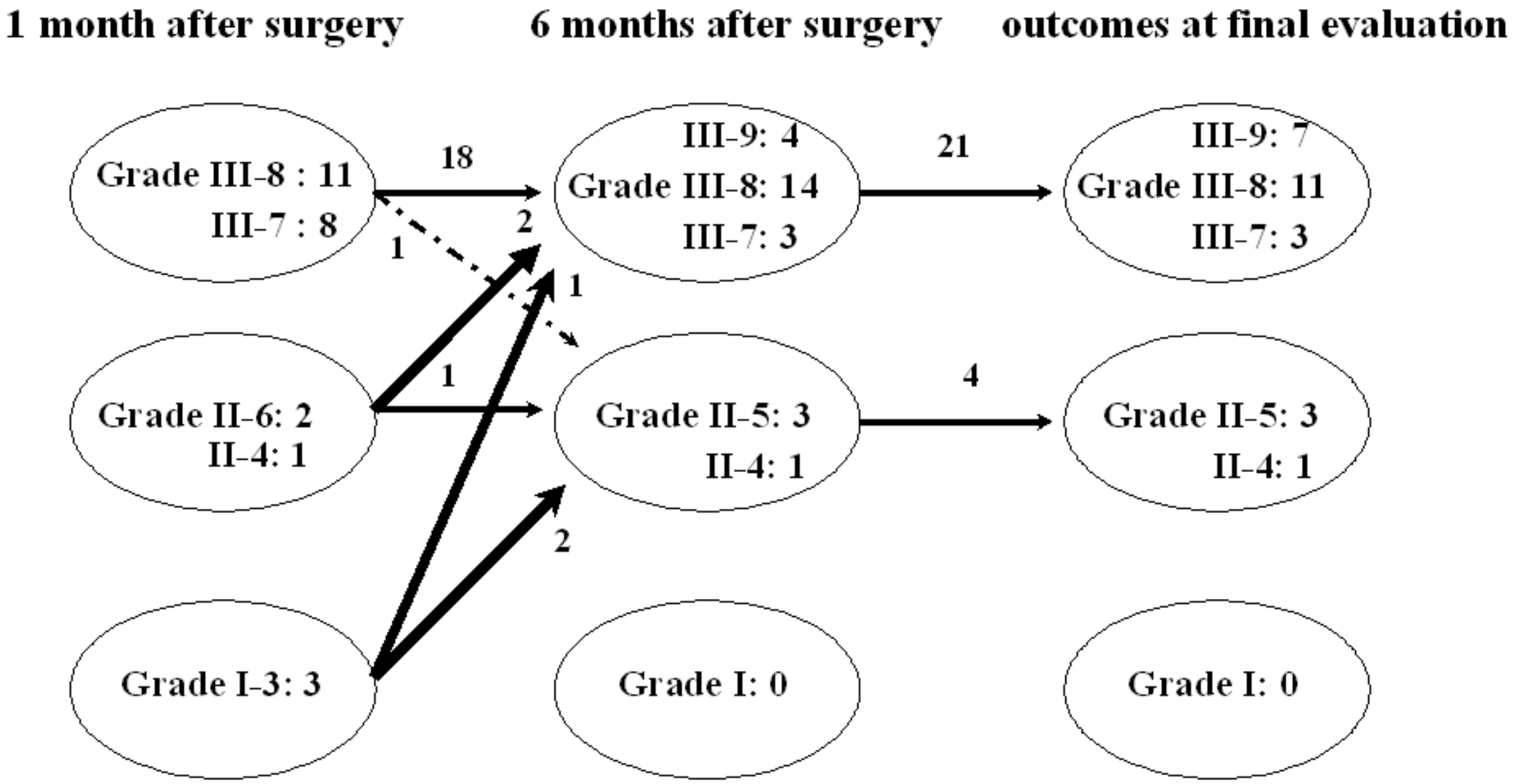
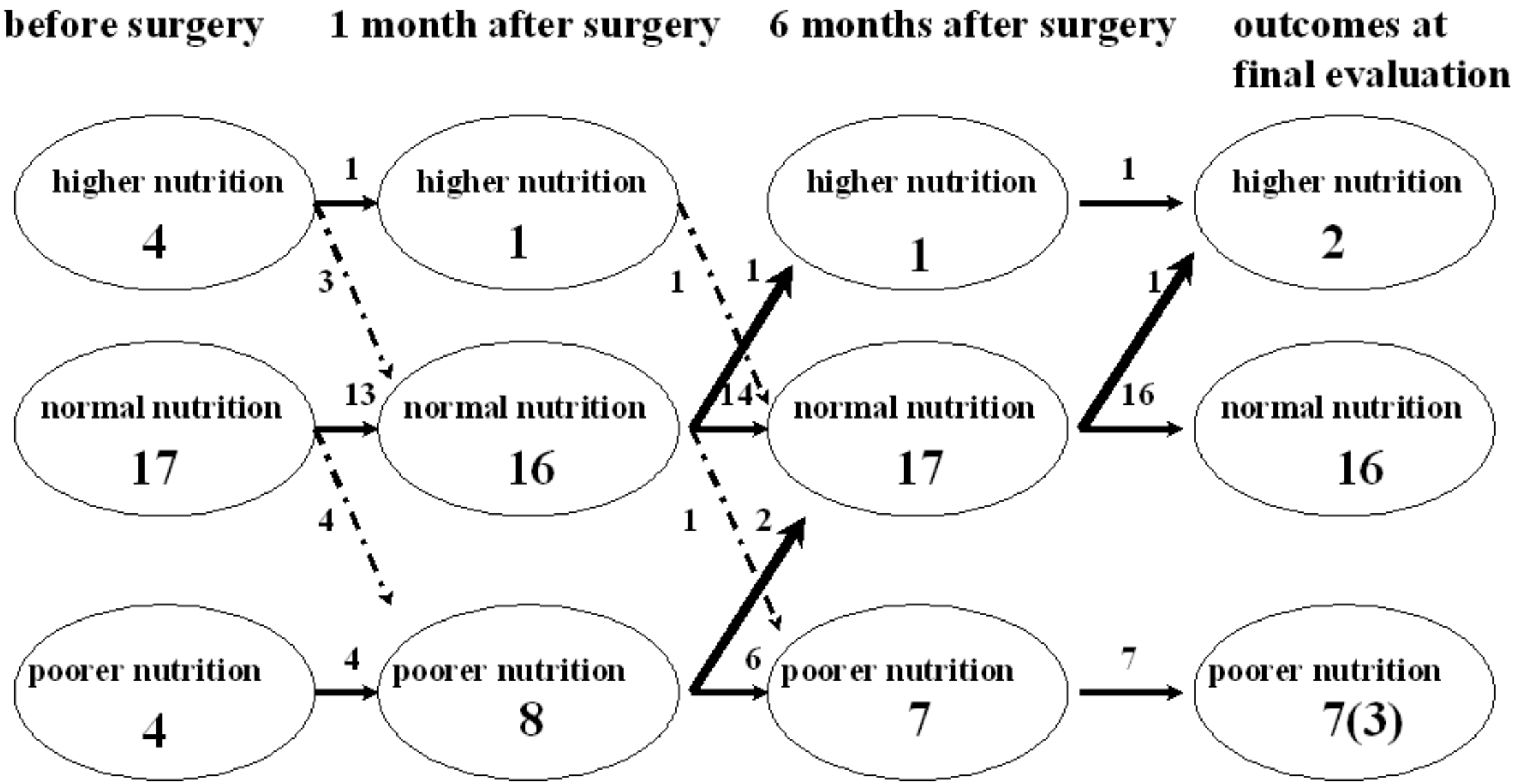

1 month after surgery
at final evaluation
no dysfunction
mild dysfunction
6(3)
moderate dysfunction
7(1)
severe dysfunction
12(6)
no dysfunction
3
mild dysfunction
7
moderate dysfunction
6
severe dysfunction
9(3)
1
2
3
2
1
2
2
2
2
2
6


1 month after surgery
at final evaluation
no dysfunction
2
mild dysfunction
7
moderate dysfunction
4(1)
severe dysfunction
12(4)
no dysfunction
3
mild dysfunction
5
moderate dysfunction
6
severe dysfunction
11(1)
1
1
2
3
2
1
2
1
2
2
1
7


1 month after surgery
6 months after surgery
outcomes at final evaluation
Grade III-8 : 11
III-7 : 8
Grade II-6: 2
II-4: 1
Grade I-3: 3
III-9: 4
Grade III-8: 14
III-7: 3
Grade II-5: 3
II-4: 1
Grade I: 0
III-9: 7
Grade III-8: 11
III-7: 3
Grade II-5: 3
II-4: 1
Grade I: 0
18
21
4
1
2
1
1
2


before surgery
1 month after surgery
6 months after surgery
outcomes at final evaluation
higher nutrition 4
normal nutrition 17
poorer nutrition 4
higher nutrition 1
normal nutrition 16
poorer nutrition 8
higher nutrition 1
normal nutrition 17
poorer nutrition 7
higher nutrition 2
normal nutrition 16
poorer nutrition 7(3)
1
3
13
4
4
1
1
14
1
2
6
1
1
16
7