Perioperative physical and nutritional therapy for tongue cancer-induced malnutrition and muscle atrophy: A case report

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ABSTRACT. Malnutrition is a common complication in patients with tongue cancer who experience dysphagia and can steadily lead to skeletal muscle atrophy. Additionally, skeletal muscle loss commonly occurs in patients after invasive surgery. Therefore, patients with tongue cancer are at high risk of skeletal muscle atrophy during the perioperative phase of treatment. Over time, physical and nutritional therapy are expected to increase skeletal muscle mass and improve nutritional status. However, immediate benefits for patients in the perioperative phase of treatment are largely unknown. This case report aimed to evaluate the combined effects of physical and nutritional therapy for a patient in the perioperative phase of treatment for tongue cancer. We describe a 48-year-old woman diagnosed with tongue cancer. Her increasing difficulty with eating and swallowing led to malnutrition. After hospital admission for oral surgery, physical and nutritional therapy were initiated. Skeletal muscle mass measured by body composition analyzer and ultrasound apparatus showed increases, whereas blood tests to indicate nutritional status showed no improvement. This case suggests that physical and nutritional therapy are effective for increasing skeletal muscle during perioperative phase treatment in malnourished patients with tongue cancer and assessment of skeletal muscle mass is a reliable method for clinical evaluation.

Key words: Skeletal Muscle, Physical therapy, Nutrition Therapy, Tongue cancer

Skeletal muscle is characterized by plasticity and responds to a variety of stressors including malnutrition, mechanical stress, and inflammatory cytokines\(^1\). Malnutrition is a common complication in patients with head and neck cancer\(^2,3\), and may lead to skeletal muscle atrophy. Highly invasive surgery also possesses a risk of skeletal muscle loss\(^4,5\). Therefore, head and neck cancer patients during the perioperative phase possess a highly risk of skeletal muscle loss. However, the chronological changes in skeletal muscle mass of perioperative head and neck cancer patients has not been reported. Skeletal muscle is essential to maintain physical performance. Low skeletal muscle mass is associated with physical dysfunction and disabilities\(^6,7\). Further, Huang showed the negative effect of surgery-induced skeletal muscle loss on postoperative muscle strength and quality of life\(^8\). Thus, preventing skeletal muscle loss in the perioperative period is a significant purpose of physical therapy.

Recent reports have shown the combined positive effects of physical and nutritional therapy in preventing skeletal muscle atrophy\(^9,10\). These studies were focused on the effects of long term intervention, 3 to 12 months, treating sarcopenia who were healthy community dwelling elderly, patients with chronic obstructive pulmonary disease and diabetic patients. However, the immediate effects of physical and nutritional therapy on perioperative phase cancer patients are largely unknown. We report the case of a malnourished patient with tongue cancer who underwent invasive oral surgery and describe the change in skeletal muscle atrophy after physical and nutritional therapy during the perioperative phase.
Table 1. Clinical course and interventions.

| Date     | Intervention                                                                 |
|----------|-------------------------------------------------------------------------------|
| HD 1     | Tracheotomy performed and nutritional support by PPN initiated.                |
| HD 7     | Physical therapy and EN initiated.                                             |
| HD 9     | Tumor ligation and primary debulking surgery performed.                       |
| HD 10    | Secondary debulking surgery performed.                                         |
| HD 36    | Physical therapy and EN interrupted, PPN resumed.                             |
| HD 37    | Oral surgery performed.                                                       |
| HD 39 (POD 2) | Revascularization performed.                        |
| HD 40 (POD 3) | Physical therapy resumed.                                |
| HD 44 (POD 7) | EN resumed.                       |

PPN: Peripheral parenteral nutrition, HD: Hospital day, EN: Enteral nutrition, POD: Post-operation day.

Diagnosis and observations on admission

The patient was diagnosed with tongue cancer (cT4aN2cM0, Stage IV) that was progressing and enlarging rapidly (Figure 1). The hypertrophied tongue tumor obstructed her trachea, making swallowing, respiration, and speech difficult. Her body weight (BW) had decreased by 8 kg in the 2-months before admission. At admission, BW was 35.9 kg and BMI was 13.5 kg/m$^2$. Laboratory tests revealed the following: Serum albumin, 2.9 g/dL; total lymphocytes, 819/μL; total cholesterol, 161 mg/dL; and C-reactive protein (CRP), 12.3 mg/dL. The patient’s controlling nutritional status (CONUT) score$^{12,13}$ was 7 points and Mini Nutritional Assessment$^8$ score$^{14}$ was 9.5 points. Furthermore, her physical function results were: walking speed, 4.56 sec/15 feet; 5 times sit-to-stand test$^{15}$ 10.0 sec; and grip strength (right/left), 19.0/19.5 kg.

Physical examination

The thickness of the right rectus femoris (RF) muscle and appendicular lean mass was measured every 7 days. Images of RF muscle were taken using ultrasound apparatus (Vivid i, GE Healthcare Japan, Tokyo, Japan) and the thickness of RF muscle was calculated from the images by image analysis software (ImageJ, NIH, Maryland, USA). The appendicular lean mass was measured by a body composition analyzer (InBody770, InBody Japan, Tokyo, Japan).

Nutritional therapy

Nutritional therapy was started by peripheral parenteral nutrition (PPN) on the day of admission. Enteral nutrition (EN) was started via an elemental diet tube on the HD 7. The first calorie target of EN was 300 kcal/day for prevention of refeeding syndrome. Based on the Harris-Benedict equation with 1.3 for the activity factor and 1.2 for the stress factor, basal expenditure was calculated to be 1802 kcal/day. The amount of EN was gradually increased up to 1800 kcal/day (45 kcal/kg/day) and 90 g/day (2.25 g/kg/day) of protein intake. After surgery, PPN was used as a...
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Table 2. Chronological change in nutritional intake.

| Date       | Parenteral Nutrition | Enteral Nutrition |
|------------|----------------------|------------------|
|            | Calorie (kcal/day)   | Protein (g/day)  | Calorie (kcal/day) | Protein (g/day) |
| HD 1       | 210                  | 15               | 0                 | 0               |
| HD 2 ~ 3   | 420                  | 30               | 0                 | 0               |
| HD 4 ~ 6   | 620                  | 30               | 0                 | 0               |
| HD 7 ~ 8   | 86                   | 0                | 300               | 15              |
| HD 9 ~ 10  | 0                    | 0                | 400               | 20              |
| HD 11 ~ 12 | 0                    | 0                | 600               | 30              |
| HD 13 ~ 14 | 0                    | 0                | 800               | 40              |
| HD 15 ~ 16 | 0                    | 0                | 1200              | 60              |
| HD 17 ~ 36 | 0                    | 0                | 1800              | 90              |
| HD 38 (POD 1) | 86              | 0                | 0                 | 0               |
| HD 39 ~ 42 (POD 2 ~ 5) | 460             | 30               | 0                 | 0               |
| HD 43 ~ 44 (POD 6 ~ 7) | 580           | 30               | 300               | 15              |
| HD 45 ~ 46 (POD 8 ~ 9) | 420            | 30               | 600               | 30              |
| HD 47 ~ 49 (POD 10 ~ 12) | 210         | 15               | 800               | 40              |
| HD 50 ~ 65 (POD 13 ~ 28) | 0             | 0                | 1800              | 90              |

Table 3. Course of physical therapy.

| Date       | Physical therapy                                                                 |
|------------|----------------------------------------------------------------------------------|
| HD 7       | Walking exercise (moderate speed and distance of perceived exertion)             |
| HD 12      | Calisthenics (SLR, hip up, squats and calf raises) 10 reps × 1 set               |
| HD 16      | Calisthenics (squats, calf raises, and step-ups) 20 reps × 2 sets                |
| HD 22      | Calisthenics (squats, single-leg calf raises, front lunges and step-ups) 20 reps × 2 sets |
| HD 36      | Physical therapy interrupted                                                     |
| HD 40 (POD 3) | Active-assist or active range of motion exercises                        |
| HD 43 (POD 6) | Manual resistance exercises                                                    |
| HD 45 (POD 8) | Sitting and standing exercises                                      |
| HD 46 (POD 9) | Walking exercise (moderate speed and distance of perceived exertion)         |
| HD 48 (POD 11) | Calisthenics (squats) 10 reps × 1 set                                  |
| HD 51 (POD 14) | Calisthenics (squats and calf raises) 20 reps × 1 set                         |
| HD 55 (POD 18) | Calisthenics (squats, calf raises and step-ups) 20 reps × 1 set               |
| HD 59 (POD 22) | Calisthenics (squats, single-leg calf raises) 20 reps × 2 sets               |

substitute for EN. On post-operation day (POD) 6, EN was resumed at 300 kcal/day (7.5 kcal/kg/day) and 15 g/d (0.35 g/kg/day) of protein. The amount of EN was increased gradually to match pre-operation amounts. The patient had no oral intake after hospital admission. The chronological changes in nutritional intake is shown in Table 2.

Physical therapy

Physical therapy began on the HD 7, 5-6 times a week for 20-minutes per session. At first, the patient walked at a moderate speed and distance of perceived exertion. On the HD 12, she started resistance training and nutritional support was increased, as described in the above section. The resistance-training program was a combination of calisthenics (squats, single-leg calf raises, front lunges and step-ups) with a maximum load of 2 sets at 20 repetitions for all exercises. After the operation, physical therapy was resumed on the bed because the patient’s neck needed to stay in a resting position. Range of motion exercise was begun with active-assist exercise and changed to active and manual resistance exercise while checking patient’s fatigue and pain. Out of bed exercises were resumed on POD 8 and resistance training was resumed on POD 12. Course of physical therapy are shown in Table 3.

Outcomes

Thickness of the RF, skeletal muscle mass and BW were showed similar chronological changes (Figure 2A-C). They were 0.94 cm, 16.9 kg and 35.9 kg, respectively, at HD 9. They increase to 1.28 cm, 18.2 kg and 38.4 kg by HD 30. They were briefly decreasing for 14 days after sur-
surgery, which decreased to 0.87 cm, 17.6 kg and 37.8 kg. They showed increases again after POD 21. They increased to 1.46 cm, 19.9 kg and 42.2 kg by POD 28.

Laboratory data is shown in the Figure 2D. Serum albumin was 2.2 g/dL at HD 7, and it slightly increased to 2.6 g/dL by day of surgery. After surgery, it decreased to 1.6 g/dL by POD 3. And then, it gradually increased to 2.6 g/dL by POD 28. CRP showed significant changes. It was 4.4 mg/dL at HD 7, and up to 7.7 mg/dL by HD 10. It decrease to 1.5 mg/dL by HD 14, and down to 0.4 md/dL by HD 17. CRP, remarkably increased after surgery, was 12.5 mg/dL at POD 2. It gradually decreased and was less than 1.0 mg/dL after POD 14. During hospitalization, CONUT score did not change remarkably and consistently showed 8 to 12 points which indicated moderate to severe malnutrition.

Discussion

In this case, we report on two important clinical aspects of muscle atrophy in a malnourished patient undergoing surgery for tongue cancer treatment. The first is the increase in skeletal muscle mass during a short period of the perioperative phase associated with a physical and nutritional therapy intervention. The second is the lack of correlation between increased in skeletal muscle mass and laboratory data for nutritional status indicators.

Skeletal muscle mass is ultimately determined by the balance between rate of protein synthesis and degradation. Malnutrition, inactivity, and invasive surgery decrease protein synthesis and increase protein degradation. Conversely, increased muscle work stimulates protein synthesis and suppresses protein degradation. Furthermore, nutrients, especially amino acids, enhance the effect of exercise-induced protein synthesis. However, temporal change in skeletal muscle mass that is influenced by various factors during a perioperative phase is poorly understood. In this case, primary factors of muscle atrophy were dysphagia-induced energy intake reduction, invasive surgery-induced inflammation and energy expenditure, as well as physical inactivity associated with bedrest. In contrast, nutritional therapy as a substitute for oral intake to satisfy the patient’s required calorie and protein intake as well as physical therapy focused on resistance training were critical factors contributing to increases in skeletal muscle mass. Consequently, the patient was able to increase skeletal muscle mass when the amount of nutrition and exercise were adequate, however, it is beyond the scope of this case report to suggest the minimum required amount of nutrition and exercise needed.

Laboratory data, especially CRP and albumin, are considered indicators of the anabolic/catabolic balance in skeletal muscle, although it was not sensitive to changes in skeletal muscle mass in this case. Systemic inflammation suppresses protein synthesis. However, mechanical stress
increases protein synthesis even in inflammatory conditions. Moreover, the half-life of albumin is 14 to 21 days. Therefore, laboratory data such as CRP and albumin, would not reflect short-term variability. We suggest assessment of skeletal muscle mass is a reliable way for clinical evaluation of anabolic/catabolic balance in skeletal muscle especially in the short-term.

The main limitation of this case report was lack of physical performance measurement at the same time of RF and skeletal muscle mass measurement. Thus, this case report could not discuss the relation between skeletal muscle mass and physical performance. Another limitation was volume of physical activities excluding physical therapy had not been recorded. There was a chance that activities of daily living affect body composition.

In conclusion, combined physical and nutritional therapy was effective in increasing skeletal muscle in the perioperative phase. Furthermore, measuring skeletal muscle mass is important for assessing the short-term variability of catabolic/anabolic state of skeletal muscle.

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