この症例に対し iPad を使用したコミュニケーション方法の確立およびソーシャルネットワークの利用方法を検討した。

	入院時	介入7カ月	介入11カ月	介入15カ月後～現在
BI	25	20	20	20
FIM	63	53	51	28～51
コミュニケーションの状態	言語にて可能	構音障害が強くなり会話困難になる	会話が難しい状態が多くなる	閉眼して反応が見られない時期が多くなる
治療	ステロイドパルス 免疫グロブリン大量療法 血漿交換療法		免疫吸着療法 リツキシマブ	
作業療法	座位訓練 ROM訓練 食事動作訓練	座位訓練、ROM訓練 レッツチャット導入 環境調整（ナースコール）	ROM訓練 Will（TVゲーム）を右手で行う 外出訓練	ROM訓練 Will（TVゲーム）を右手で行う

表 1　症例経過

【倫理的配慮】

症例及び家族に対し口頭にて発表の同意を得た。

【結果】

症例に対し、当初はレッツチャットを使用してコミュニケーションをとっていた。レッツチャットではポイントタッチスイッチ使用し、頸部回旋運動により頬をスイッチに接触させることで、操作が実現した。主に看護師や医師などの医療者とのコミュニケーションに使用されていた。しかしレッツチャットでは本人、家族が希望しているソーシャルネットワークが出来ない。そこでポイントタッチスイッチを、なんでもワイヤレス（テクノツール）（図 2）に接続し、iPad へは Bluetooth 接続を行うことで iPad の操作を可能にした。使用方法は、伝の心などと同様で画面上に枠が現れてその枠が経時的に移動する。枠が目的箇所に移動した時にスイッチを押すと選択される。本症例のコミュニケーションはこの方法を用いて iPad の「メモ」機能で図った。日記を書くこと、LINE や Facebook、アプリケーション（以下アプリ）を使ったゲームなどを行えるようになり以前と比べ操作時間の延長がみられた。病棟では常に本人が使えるように設定してあるが、本人が寝ている時など使用しない時は、iPad を外して家族が使用している。

本人の満足度は Numerical Rating Scale（NRS）（図 3）でレッツチャット使用時が 2、iPad 使用時が 7 であった。

<u>iPad となんでもワイヤレス装着</u>

<u>スイッチ接続の手順</u>

①ポイントタッチスイッチのコードを何でもワイヤレスのコネクターに差し込む

②iPad の設定で Bluetooth をオンにする

③なんでもワイヤレスを起動させ、iPad との接続を確認する

④iPad の設定から一般を選択

⑤一般の中の「アクセシビリティ」を選択

⑥アクセシビリティの中の「スイッチコントロール」を選択する

⑦スイッチコントロールの中の「スイッチ」を選択し、その中の「新しいスイッチを追加」を選択

⑧ソースの外部を選択すると「外部スイッチをアクティベートしてください」と表記される

⑨接続しているスイッチのボタンを押すとスイッチ名を記入する画面が現れる
⑩スイッチ名を記入し、スイッチコントロールをオンにする
⑪画面上に枠が現れ、スイッチ操作可能になる
⑫枠の動く時間や枠の大きさなどの細かな設定はスイッチコントロールの画面で設定が可能

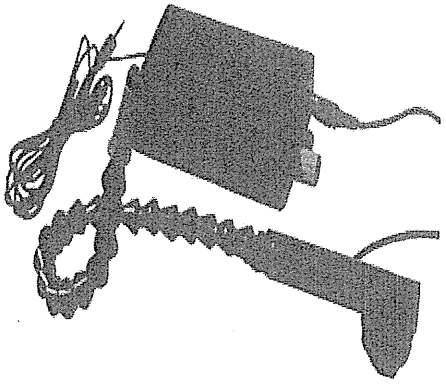

図1 ポイントタッチスイッチ（パシフィックサプライ）

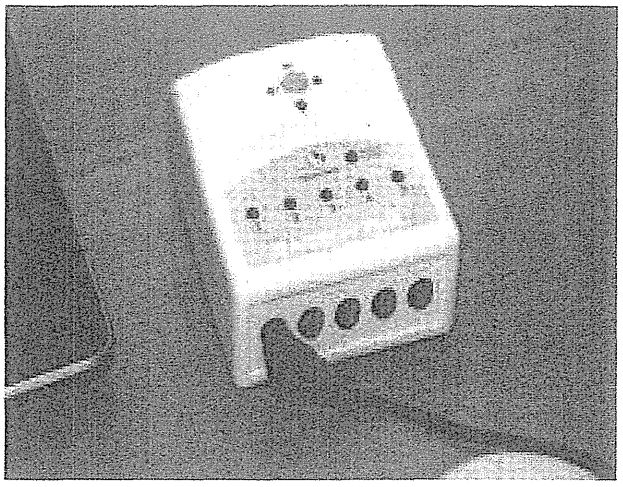

図2 なんでもワイヤレス（テクノツール）

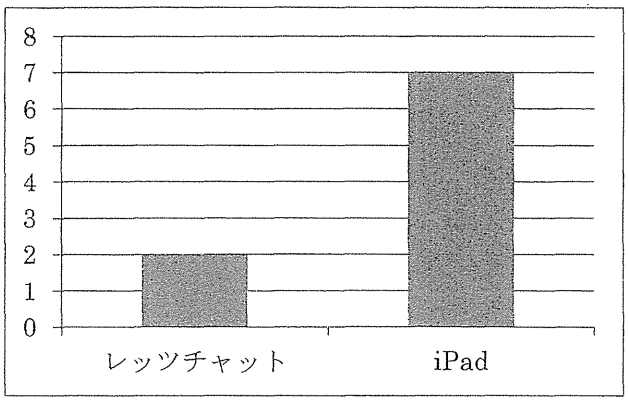

図3 本人の満足度 Numerical Rating Scale

機器名	価格（円）	入力方法	利点
ボイスキャリーペチャラ	98,800	キーボード	・会話にのみ使用し操作が簡単 ・持ち運びしやすい
レッツチャット	168,000	スイッチ	・会話にのみ使用し操作が簡単 ・持ち運びしやすい
伝の心	450,000	スイッチ	・メールやゲームなどのパソコンが操作出来る ・日本では最も一般的に使われている
tobii P-10	1,390,000	視線	・視線入力でメールやパソコンが出来る ・視線入力で身体の動きがなくても使用出来る
iPad	53,800～	スイッチ	・様々なアプリを使用出来る ・持ち運びが容易 ・患者が使用しないときは他の者が普通に使用出来る

表2 各コミュニケーションエイドの特徴

【考察】

作業療法の中でも神経難病患者などのコミュニケーション手段として従来の方法と合わせて、徐々にITの活用が広まってきている。また「重度障害者用意思伝達装置」導入ガイドライン検討委員会[1]が平成21年度障害者保健福祉推進事業でまとめた報告では、利用者のニーズとしてはやりとりとメールが高く、次いでインターネットであったように、メールやインターネットへの希望は高くなっている。

各機器の特徴は表2に示している通りであるが、ボイスキャリーペチャラは会話のみに特化しており、インターネットなどは難しい。操作は上肢の保持機能がある程度維持なければ使用する事が出来ない。レッツチャットも会話のみに特化しており、インターネットなどは難しい。しかし、どのようなスイッチでも接続が可能。伝の心は比較的コミュニケーションツールとして使用頻度が高く、インターネットなども出来る。日本では使用者の50%を越える最も使用頻度の高いコミュニケーションエイドである。環境制御の機能（エアコンを操作する、テレビのチャンネルを変える、電灯をつけるなど）の操作が可能。しかし、LINEは出来ない。tobii P-10は視線入力でコミュニケーションが図れ、インターネットやパソコンの周辺機器の操作や環境制御の機能も可能。しかしながら非常に高価でありLINEを行う事は出来ない。今回の症例は若年であり、LINEやFacebookを日常的に使用していた。その為、家族や友人とのコミュニケーションツールがLINEであり、そのLINEが出来る事が最大の目的であった為、スマートフォンや本人の持っていたiPadを使用することにした。しかしながらスマートフォンでは画面が小さくより大きいiPadを使用することにした。iPadへの接続は前述したように行うことで比較的容易に行うことが出来た。また今回使用した機能はiPadやiPhoneに標準装備されている機能であるため、「なんでもワイヤレス」があれば、誰でも利用が可能である。iPadの利点は薄く持ち運びが便利であり、「トーキングエイド」など多様な福祉系アプリが開発されているため様々な場面での利用価値が高いことである。また、ゲームや教養などのアプリなどがあり患者の余暇時間の充足を担うことが出来る。環境制御の機能も専用の機器とアプリをダウンロードする事で使用が可能である。また患者が使用しない時は、他の者が使うことが出来るため有効活用が出来る。

今回の症例を通して、コミュニケーションをとる為の手段を試行錯誤し、インターネットから情報を収集[2][3]し、患者が必要としているソーシャルネットワークの方法を知る事が出来た。

中邑[4]によればiPadやiPhoneなどの機器は我々の身の回りにあるテクノロジーでメリットは家電量販店で手に出来る、生活のなかで親しんでいるため導入にあたってリテラシーの心配がない等あるがその一方で専門家がこのようなテクノロジーを使って支援するという視点が少なく、またその活用についてアドバイスを受けにくい。また日常生活用具給付制度や補装具費給付制度の対象になりにくい等の問題があると述べている。

このような現状を変える事が出来るのは、コミュニケーションエイドに関しての仕事をしている作業療法士ではないかと考える。

現代社会ではソーシャルネットワークが生活の重要な一部となっている。今回の症例も外部と結びつく事で笑顔が増えiPad使用満足度の向上につながったと考える。また患者の笑顔から、コミュニケーションが必要なのは患者と医療者間だけではなく、患者とそれを取り巻く周りの家族や友人も重要である事に気づくことができた。

このことから社会との結びつきを維持する為の手段としてiPadは有用なツールであると考える。ALSなどの神経疾患に対しても今後有効なツールになると考え利用価値は高まっていると思われる。そのため作業療法士としてITの有効活用方法を熟知しておくことが必要だと思われる。また近年のITの流れは速く常に最新の情報を取り入れられるようにしておく必要があると考える。

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P268-Rf

発達性読み書き障害児に対する視覚認知機能を必要とした課題の試み
Approach using visual recognition for a child with developmental dyslexia

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Key words: 視覚認知機能，学習障害，(視覚情報処理過程)

【はじめに】発達性読み書き障害(以下DD)とは，全般的な知的側面や音声言語の発達に遅れがなく，心理的あるいは社会的要因がないにもかかわらず，読み書きのみに特異的な障害を示す症状である．今回，読み書きの難しさを主訴に作業療法が開始となった1症例に対して，視覚認知機能を必要とする介入を行い，音読と書取に改善が認められ，本症例，保護者の同意を得たので報告する．

【対象と方法】右利きの男児，12歳，小学校通常級6年生．周産期・乳児期では特記事項なし．2年生頃より学校から読み書きの難しさを指摘されていた．10歳時，入眠中に全身けいれんがあり他院小児科を受診．脳波では左頭頂葉から後頭葉優位に高振幅の棘波・棘徐波があり，デパケンを開始．その後再燃なく，読み書きの困難さから当院小児科を紹介受診．WISC-ⅢはVIQ96，PIQ93，FIQ94，群指数では処理速度75と落ち込みがみられた．眼科所見では異常なし．11歳4ヶ月時に作業療法を開始した．開始時評価として，ADL自立，集団適応やコミュニケーション良好．漢字は苦手で，学校の漢字テストでは100点中2点(50問中1問正答)だった．小学生の読み書きスクリーニング検査(以下STRAW)では，音読はカタカナ1文字，ひらがな，カタカナ，漢字単語で同学年健常児平均の-2SD以下を示した．書取はひらがな単語で-1SD～0，カタカナ単語で-2SD～-1SD，漢字単語で-2SD以下を示した．K-ABC心理・教育アセスメントバッテリーでは，絵の統合・算数・文の理解は平均値以上を示し，手の動作・語の配列・ことばの読みは平均値以下を示した．コース立方体組合せテストではIQ165，複雑な図形では見本の絵柄を2分割して組み立てている，とのこと．臨床観察では利き目は右．眼球運動は左方向への追視時・サッカードに頚部左回旋運動あり，輻輳は可能であったが運動時に連合反応(表情の歪み)がみられた．視写は全般的に，聴写は文字の想起に，音読は改行時に時間を要した．検査中の様子は協力的で，文字の読み書きを含む課題ではあくびや頭を抱える様子が頻回であった．本症例は視覚情報処理過程において，高次の処理機能とされる視覚認知機能が良好であったため，能動的に取り組める探索・模倣・構成課題を導入した．介入期間は2012年5月から11月までの計10回，1回約60分を，文字(ひらがな・カタカナ)の間違い探し，写真で示した見本と同様にペグを挿す課題，2分割した漢字を組み合わせる漢字パズルを中心に実施した．介入で使用した漢字は小学校2年生で習得する漢字160字のうち，文字を水平あるいは垂直に2分割にできる80字とした．

【結果】STRAWでは，音読はひらがな，カタカナ1文字，ひらがな，カタカナ単語いずれも全問正答し，漢字単語で同学年健常児平均の-1SD以上を示した．書取はひらがなで全問正答し，カタカナの1文字，単語で-1SD以上，漢字単語で-2SD～-1SDを示した．眼球運動では追視・サッカード・輻輳いずれも運動時に開口はみられたが，頚部回旋運動はみられなかった．視写・聴写・音読の所要時間に介入前との変化はなかったが，視写・聴写ともに誤答数は減少し，聴写においては使用する漢字数が1→8と増加した．学校の漢字テストでは100点中94点(50問中47問正答)と報告があった．

【考察】視覚性記憶機能や視覚認知機能に障害のあるDD児における漢字書字指導として，聴覚法が有用とする報告がある中，本症例の視覚情報処理過程に着目し，トップダウン処理によって視覚認知機能を必要とする介入を図ることにより，視機能や視覚探索の他，音読，書取において介入前よりも改善が認められた．

Case Report

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The effect of anti-gravity treadmill training for prosthetic rehabilitation of a case with below-knee amputation

Yukio Mikami, Kouki Fukuhara, Toshihiro Kawae, Hiroaki Kimura and Mitsuo Ochi

Abstract

Background: The aim of this case study was to verify the efficacy and safety of anti-gravity treadmill training for prosthetic rehabilitation following below-knee amputation.

Case description and methods: The patient underwent left below-knee amputation as a result of diabetic foot gangrene. Since his physical strength and vitality had declined during the perioperative period, anti-gravity treadmill training was introduced for his outpatient prosthetic rehabilitation.

Findings and outcomes: Stable prosthetic gait exercise could be carried out under guidance on the anti-gravity treadmill, quickly resulting in improved gait. Furthermore, the patient's self-efficacy and exercise tolerance were elevated after the period of anti-gravity treadmill training. At the final evaluation following 6 weeks of rehabilitation with the anti-gravity treadmill, he had acquired prosthetic gait with the assistance of a T-cane.

Conclusion: The anti-gravity treadmill was found to be a useful instrument for prosthetic rehabilitation following below-knee amputation.

Clinical relevance

Anti-gravity treadmill training has the potential to support the prosthetic rehabilitation of below-knee amputees, especially for patients whose physical strength and vitality are decreased.

Keywords

Anti-gravity treadmill, prosthetic rehabilitation, below-knee amputation

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Background

Recently, the main causes of amputation of the lower limbs have changed from traffic accidents and tumors to peripheral arterial disease, and the incidence of lower extremity amputation has increased.[1] Most patients with peripheral arterial disease have difficulties in walking and do not have the habit of taking regular exercise because of symptoms including pain and paralysis.[2] Therefore, the physical strength and vitality of patients tend to decrease during the perioperative period, and most patients cannot participate positively in prosthetic rehabilitation; it is therefore difficult for them to attain appropriate prosthetic gait.

The anti-gravity treadmill, consisting of a treadmill enclosed within an airtight chamber, applies air pressure to a patient's lower body to alter body weight support and can decrease the load on lower extremities and cardiovascular function.[3] Furthermore, on the current commercially available anti-gravity treadmill (AlterG™, Fremont, CA, USA), the risk of falling is negligible because in addition to the presence of a handgrip, patients wear shorts specially designed for the treadmill which are attached to the

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treadmill air chamber. Therefore, our hypothesis was that the anti-gravity treadmill could be a useful instrument for prosthetic rehabilitation of below-knee amputees, especially for those patients with reduced physical strength and vitality. However, so far, there have been no reported investigations of the efficacy of anti-gravity treadmills for prosthetic rehabilitation.

The purpose of this case study was therefore to verify the safety and effectiveness of anti-gravity treadmill training for prosthetic rehabilitation of a below-knee amputee.

Case description and methods

A 66-year-old male subject (weight = 81 kg, height = 168 cm) underwent left below-knee amputation because of diabetic foot gangrene. Following amputation, necrosis of the stump of the left lower leg occurred and additional debridement of the stump was performed. Treatment of the wound and servicing of the removable rigid dressing were started the day following the debridement. However, it took 5 weeks for the wound to heal and to attach the lower extremity pressure-cast prosthesis (ICECAST Anatomy; Össur, Reykjavik, Iceland).[4] Although resistance muscular strength training and endurance training were continued in the interim, his physical strength and vitality decreased. After attaching the lower extremity prosthesis, standing-position training, balance training, and walk training with a parallel bar were performed, but the patient could not acquire the necessary prosthetic gait ability because he was exhausted by the rehabilitation and required crutches and assistance in walking at the time of discharge. Since his decreased physical strength and vitality were considered to be inhibitors of his gait exercise, anti-gravity treadmill training was introduced for his outpatient prosthetic rehabilitation.

The outpatient rehabilitation was conducted for 20–40 min three times a week, beginning with stretch exercises followed by the anti-gravity treadmill (AlterG M320; AlterG™) training (Figure 1). Regarding the treadmill setting, body weight support, walking speed, and exercise time were adjusted with the ratings of perceived exertion using Borg's scale of 10–13 points for walking and cardiopulmonary effort. Borg's[5] scale is an index to measure the rating of perceived exertion: 10 points indicates "fairly light" and 13 points indicates "somewhat hard." The incline of the treadmill was not changed. During anti-gravity treadmill training, guidance in the correct prosthetic gait was also carried out. After treadmill training, resistance muscle strengthening exercises (especially for the diseased limb) and free walk training on the floor were briefly performed. During the study period, body weight support, treadmill speed, and exercise time on the treadmill were adjusted according to the Borg ratings of perceived exertion.

The General Self-Efficacy Scale was used to assess optimistic self-efficacy to cope with a variety of difficult demands at each important step in the study period.[6]

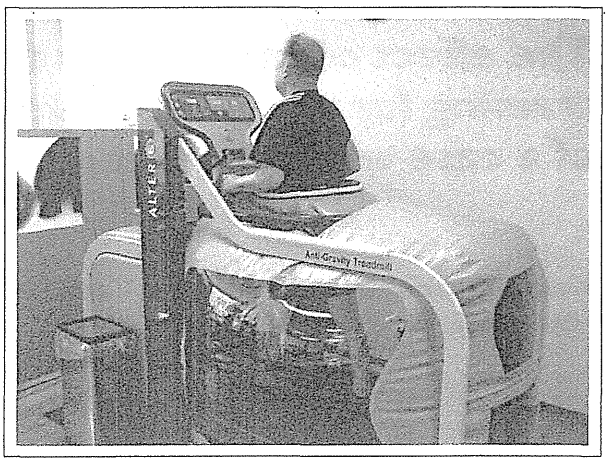

Figure 1. Patient training on the anti-gravity treadmill.
The patient is wearing shorts specially designed for the anti-gravity treadmill and is walking with a left lower extremity prosthesis. On the anti-gravity treadmill, the risk of falling is negligible and gait is stable.

At 1 week (initial examination) and 6 weeks after (final examination) the introduction of treadmill training, the performance of walking on the floor including a 6-min walking distance was evaluated.

At the initial and final examination of the study, pulmonary gas exchange was also measured breath-by-breath with a mobile aero monitor (AE-100i; MINATO Medical Science, Tokyo, Japan) during the anti-gravity treadmill training at 40% of body weight support and a speed of 1.25 m/s for 8 min. The oxygen consumption rate (VO_2) was recorded throughout the tests.

Ethical consideration and informed consent

The subject and his wife were informed about the parameters of the study and consented to a series of investigations. A signed statement of consent was obtained from the couple for permission to use the photographs and laboratory data. The Hiroshima University Ethics Committee suggested to obtain a signed statement of consent for a case study.

Findings and outcomes

During the study period, no falling occurred, there were no apparent problems with using the lower extremity prosthesis, and the prosthetic gait exercises were accomplished stably and successfully.

The General Self-Efficacy Scale was 27 before the first operation and 26 at discharge, where it remained until the introduction of the anti-gravity treadmill training. However, it rose to 33 just after the introduction of anti-gravity treadmill training and remained at 33 through to the final evaluation.

Table 1 shows the progress of the anti-gravity treadmill training. At the beginning, the patient exercised with

Table 1. Exercise intensity on the anti-gravity treadmill.

Session	BWS (% BW)	Speed (m/s)	Duration (min)
1	40	0.56–0.83	10
2	30	1.11	20
3	15	0.83	20
4	30	1.39	20
5	15–25	1.11	30
6	0–15	0.97–1.11	30–40

BW: body weight; BWS: body weight support.

Figure 2. Gait 1 week (initial) and 6 weeks (final) after introduction to anti-gravity treadmill training: (a) initial—the patient tried to walk with crutches but gait was unstable and he required the assistance of his wife; and (b) final—gait was stable and the patient could walk with a T-cane without assistance.

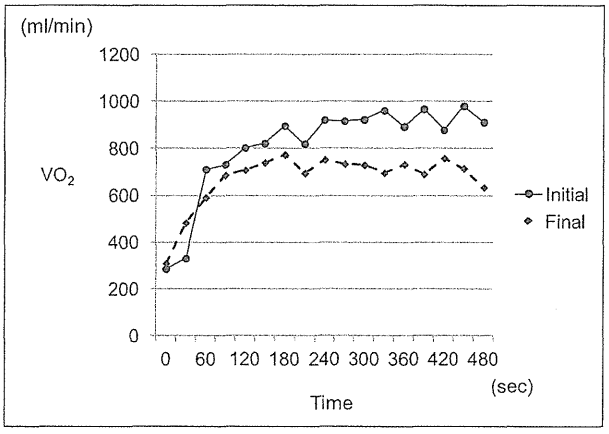

Figure 3. Oxygen consumption rate (VO_2) during anti-gravity treadmill training.
The oxygen consumption rate reached a plateau about 3 min after the start of the training. After reaching the plateau, VO_2 at the final examination was lower than that at the initial examination, confirming that motion efficiency improved after the anti-gravity treadmill training.

30%–40% of body weight support and at a speed of 0.56–0.83 m/s for 10 min. However, at the final evaluation, he could exercise with only 0%–15% of body weight support and at a speed of 0.97–1.11 m/s for 30–40 min.

Before the introduction of the anti-gravity treadmill training, he required crutches and assistance when walking. However, at the final evaluation, he had fully acquired the ability for prosthetic gait with the aid of a T-cane and no longer required assistance (Figure 2). At the initial examination of the study, the 6-min walking distance with crutches and assistance was 230 m (mean velocity 0.64 m/s). However, at the final evaluation of the study, the walking distance with a T-cane was 331 m (mean velocity of 0.92 m/s). The points on Borg's scale after the 6-min walking at the initial examination were 13: the same as at the final examination, although the walking distance at the final examination was longer than that at the initial evaluation.

The oxygen consumption rate reached a plateau about 3 min after the start of the anti-gravity treadmill training. After reaching this plateau, the VO_2 at the final evaluation was lower than that at the initial examination for the same treadmill conditions (Figure 3).

Discussion

In space, the lack of gravity can cause bone loss and muscle atrophy; contrarily, on Earth, gravity can cause musculoskeletal disease.[7] From these points of view, the anti-gravity treadmill, which can provide body weight support by as much as 80%, has been developed. Patil et al.[8] measured the knee forces of patients who had undergone total knee arthroplasty on an anti-gravity treadmill and reported that it enabled them to control and decrease forces on the knee. Regarding cardiopulmonary function, Hoffman and Donaghe[9] showed that VO_2 and heart rate for the same treadmill speed are reduced with increase in body weight support.

After the anti-gravity treadmill was developed, a number of clinical and basic studies have been performed to assess its effectiveness for patients with lower extremity arthritis and other disorders that interfere with the ability to walk, and some favorable data have been published.[10,11] However, to date, there appear to have been no reports of its efficacy for the lower limb amputees.

Concerning below-knee amputees, standing-position training, balance training, and walk training are the generally

recommended methods for prosthetic rehabilitation. After achieving prosthetic gait ability using parallel bars, prosthetic gait is typically practiced away from the parallel bar. However, since prosthetic gait requires more physical strength than normal walking, some aged patients cannot acquire practical prosthetic gait.[12]

In this study, the eyesight of the patient was poor and he underwent hemodialysis because of diabetic complications, so he was not in the habit of taking regular exercise. Furthermore, the physical and mental activities of the patient were decreased because he could not walk for long distances during the perioperative period. Therefore, the patient could not acquire practical prosthetic gait ability until discharge because he felt exhausted during rehabilitation, and it was considered difficult to elevate his physical and mental activities to develop prosthetic gait. Therefore, the anti-gravity treadmill training was introduced as a way of reducing the load on the lower extremity and cardiopulmonary function, with little risk of falling.

Adjustments can be made to the anti-gravity treadmill for percent body weight support, walking speed, and effort required by changing the incline of the treadmill. However, Finch et al.[13] reported that the percentage of total double-limb support time was decreased by introducing the support of 50% of body weight, and Mercer et al.[14] showed that the muscle activity of the lower extremity was decreased by body weight reduction. These findings imply that the prosthesis should bear a certain minimum load to ensure successful prosthetic rehabilitation. Therefore, in this study, treadmill training commenced at 40% of body weight support. Initial treadmill speed was 0.56–0.83 m/s and exercise time was 10 min, values were estimated based on Borg's scale for walking and cardiopulmonary effort. The incline of the treadmill was not changed, in order to reduce extra burden on the prosthetic gait. Providing gait guidance was straightforward because of the transparency of the supporting air chamber. On the treadmill, the kick-off of the legs was easy, however, careful guidance for the forward swing of the legs was important to obtain stable gait. Since patients cannot see their legs on the current commercially available anti-gravity treadmill, some minor changes, such as mounting a lower leg monitor, were considered necessary. In this study, the treadmill reaction forces, velocity, and duration of the exercise were gradually increased because prosthetic gait ability and physical strength steadily improved.

As mentioned earlier, the mental activity of the patient was reduced because of the long period experiencing difficulty in walking because of his diabetic complications. Although his self-efficacy was temporarily elevated at the introduction of prosthetic rehabilitation, it remained low until the introduction of anti-gravity treadmill training. Since he could walk comfortably, faster, and longer on the anti-gravity treadmill, his self-efficacy was markedly improved just after he began the treadmill training. This unexpected benefit was not anticipated before the introduction of treadmill training. Since his self-efficacy was markedly elevated, he quickly developed a positive attitude to participating in the training and his gait was quickly and smoothly stabilized.

Cardiopulmonary function measured as oxygen consumption rate at the final evaluation was lower than that at the initial examination, demonstrating improvement in motion efficiency following anti-gravity treadmill training. In the 6-min walking distance test, the Borg rating of perceived exertion at the initial examination was the same as that at the final examination.[15] However, since the walking distance at the final evaluation was longer than that initially, this result, too, might suggest an improvement in motion efficiency after anti-gravity treadmill training.

In this study, the walking training on the floor was briefly performed after the treadmill training. With the stabilization of gait on the treadmill, the gait on the floor was also stabilized and walking speed was elevated as well. Together with the elevation of his physical strength and vitality, the patient was finally able to walk with a T-cane.

Conclusion

A case of below-knee amputation caused by diabetic gangrene was reported, where prosthetic rehabilitation using an anti-gravity treadmill was shown to be successful and efficient. Stable walking exercises could be performed with little risk of falling. After training, the self-efficacy and exercise tolerance were clearly elevated and the patient progressed quickly and efficiently to acquire the ability of prosthetic gait with the aid of a T-cane. The anti-gravity treadmill is therefore recommended as a useful instrument for prosthetic rehabilitation for below-knee amputees.

Author contribution

All authors contributed equally in the preparation of this article.

Conflict of interest

The authors declare that there is no conflict of interest.

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Original Article

Immediate effect of passive and active stretching on hamstrings flexibility: a single-blinded randomized control trial

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Abstract. [Purpose] This study compared the efficacy of passive and active stretching techniques on hamstring flexibility. [Subjects] Fifty-four healthy young subjects were randomly assigned to one of three groups (2 treatment groups and 1 control group). [Methods] Subjects in the passive stretching group had their knees extended by an examiner while lying supine 90° of hip flexion. In the same position, subjects in the active stretching group extended their knees. The groups performed 3 sets of the assigned stretch, with each stretch held for 10 seconds at the point where tightness in the hamstring muscles was felt. Subjects in the control group did not perform stretching. Before and immediately after stretching, hamstring flexibility was assessed by a blinded assessor, using the active knee-extension test. [Results] After stretching, there was a significant improvement in the hamstring flexibilities of the active and passive stretching groups compared with the control group. Furthermore, the passive stretching group showed significantly greater improvement in hamstring flexibility than the active stretching group. [Conclusion] Improvement in hamstring flexibility measured by the active knee-extension test was achieved by both stretching techniques; however, passive stretching was more effective than active stretching at achieving an immediate increase in hamstring flexibility.

Key words: Hamstring flexibility, Active stretching, Passive stretching

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INTRODUCTION

The tightness of hamstring muscles is one of the main factors hindering performance in daily and sporting activities. Reduction in the flexibility of the hamstrings has been reported to be associated with the occurrence of back pain in adolescents and adults in cross-sectional studies[1, 2)]. Furthermore, reduction in the flexibility of the hamstrings has been reported to increase the risk of damage to the musculoskeletal system[3, 4)]. Thus, flexibility of the hamstrings is important for general health and physical fitness[5, 6)].

Several studies have indicated that flexibility of the hamstrings is improved by stretching[7–11)]. Indeed, many stretching techniques are used in clinical practice, including ballistic stretching, static stretching, and proprioceptive neuromuscular facilitation techniques. Among the stretching methods, passive and active stretching techniques are easy to implement and are useful as home exercises. Active stretching increases the flexibility of tight muscles while concomitantly improving the function of antagonistic muscles[12)]. In contrast, passive stretching is characterized by the addition of stretch stimulation on muscle contraction independent of the subject[13)]. Murphy detailed a new active stretching technique called the dynamic range of motion (DROM)[14)]. This method is as an alternative to static stretching. During DROM, a contraction by the antagonist muscle causes the joint crossed by the agonist muscle to move through the full ROM at a controlled, slow tempo[14)]. DROM is a technique that takes advantage of reciprocal innervation. However, Bandy et al. reported that passive stretching is more effective than DROM[15)], but their study had different stretching conditions, such as different stretch elongation times, and

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Table 1. Characteristics of the subjects in each group

Characteristics	Active stretching group (n=18)	Passive stretching group (n=18)	Control group (n=18)
Age (years)	20.1 ± 1.2	20.3 ± 1.0	20.5 ± 1.2
Weight (kg)	61.5 ± 8.3	59.9 ± 8.2	57.4 ± 6.6
Height (cm)	167.1 ± 8.3	164.6 ± 8.2	158.8 ± 6.6

mean ± SD

was not an accurate comparison of the stretching techniques. To our knowledge, no studies have compared active and passive stretching techniques using the same method for the hamstring muscles. Thus, the purpose of this study was to compare the effect of passive and active stretching techniques using the same method on the flexibility of the hamstring muscles.

SUBJECTS AND METHODS

Subjects

A total of 54 healthy young subjects were randomly allocated among three groups: an active stretching group, a passive stretching group, and the control group. The subjects were paired according to gender (9 males and 9 females for each group). The inclusion criteria were as follows: limited hamstring flexibility, operationally defined as 70° by the active knee-extension test (AKET) conducted at 90° of hip flexion in the supine position[11]; no participation in strengthening or stretching programs for at least 1 year; and the absence of injury to the lower extremities. Institutional review board approval was obtained before recruitment of subjects. All subjects signed an informed consent form agreeing to participate in the study. This research was approved by Saitama Prefectural University's Committee of Ethics in Research (No 22705).

Methods

Hamstring flexibility was measured before the intervention. Hamstring flexibility was measured using the AKET, which has high reliability[16–18]. Subjects were positioned supine with their right hip and knee flexed at 90°, and their lumbar lordosis was supported with a lumbar roll. From that position, extension of the knee was performed. The knee was extended to the point of mild resistance or just below the threshold of myoclonus, as described by Gajdosik[16]. The same-blinded assessor measured the knee angle (degrees from full extension) in all three sessions using an inclinometer. Subjects in the passive stretching group had their knee extended by one examiner while lying supine with 90° of hip flexion. In the same position, subjects in the active stretching group extended their own knee. Stretches were performed times in 3 sets of the assigned stretch. Each stretch was held for 10 seconds at the point where tightness in the hamstring muscles was felt, and then the leg was slowly lowered (over 10 seconds). Stretches at maximum knee extension elicited a "strong but tolerable feeling of muscular tightness" in the back of subjects' legs[19]. Subjects in the control group did not perform stretching.

Means and standard deviations (SD) of the pre-intervention and post-intervention AKET measurements were calculated for each group. In addition, the mean difference between pre-intervention and post-intervention AKET measurements was also calculated.

The pre-intervention and post-intervention AKET angles of the control group were used to assess the reliability of the measurement using the intraclass correlation coefficient, ICC (1,1). One-way analysis of variance (ANOVA) was used to test for significant differences between groups in the dependent variables: characteristics of each group (differences in age, height, and weight), pre-intervention AKET angle, and flexibility change (difference between post- and pre-interventions). The data were analyzed using one-way ANOVA with the Tukey-Kramer test for multiple comparisons. The level of significance was chosen as $p=0.05$. Statistical analyses were performed using SPSS version 15.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

The characteristics of each group were not significantly different (Table 1). The mean values of degree of knee extension of the pre-intervention and post-intervention measurements of the control group were 44.2 ± 5.1° and 45.1 ± 3.7°, respectively. The ICC (1,1) value calculated for the pre-intervention and post-intervention knee extension of the control group was 0.97.

Table 2 shows the means of the pre-intervention and post-intervention measurements and the flexibility change each group. The pre-intervention AKET angle was not significantly different between the groups ($p=0.57$). A comparison of each group showed a significant difference between the groups' flexibility changes ($p=0.01$). Specifically, the passive stretching group showed a greater gain in flexibility than the control group.

DISCUSSION

The present study compared passive and active stretching techniques for hamstring flexibility. The results of this study demonstrate that both active and passive stretching were effective at improving hamstring flexibility compared with the control group. In addition, the passive stretching group showed a significant improvement in flexibility compared with the active stretching group.

Winter et al. reported that passive stretching is characterized by the external addition of stretch stimulation on muscle contraction, while active stretching is characterized by a reciprocal innervation mechanism used to relax antagonist muscle contraction[13]. Reciprocal inhibition adjusts the

Table 2. Active knee extension angles in each group before and after stretching

	Active stretching group	Passive stretching group	Control group
Pre-intervention	45.9 ± 8.9°	40.6 ± 16.1°	44.2 ± 5.1°
Post-intervention	52.9 ± 8.9°	56.4 ± 15.8°	45.1 ± 3.7°
Flexibility change	7.0° #	15.8° * #	0.9°

mean ± SD
*significant difference between the active and passive stretching groups. #significant difference from the control group.
Flexibility change: difference between pre intervention and post intervention

contraction of agonist and antagonist muscles to facilitate various movements. In this study, the subjects in the active stretching group performed stretches using this mechanism. However, the improvement in hamstring flexibility in the active stretching group was less than that of the passive stretching group. The reason for this difference may be the posture of the active stretching group during the stretch. When holding the stretch position the excitatory spinal motor neurons overcome γ inhibitory neuron impulses[20]. In this study, the final knee extension position was held for 10 seconds by subjects in the active stretching group. Consequently, there was a simultaneous contraction of agonist and antagonist muscles without antagonist suppression of the γ impulses. Therefore, the active stretching group did not experience antagonist muscle relaxation, suggesting that there is a difference in the degree of stretch stimulation between the active and passive stretching groups.

A recent study reported that passive stretching is harmful for movement performance[21]. Simic et al. reported that the results of a meta-analysis of 104 studies showed passive stretching before exercise results in a reduction of maximum muscle strength[21]. In contrast, active stretching has been reported to improve movement performance. Yamaguchi et al. reported that muscle strength was improved by an average of 13.3% after stretching[22]. In addition, Faigenbaum et al. compared motor function after different stretching techniques, and showed that active stretching improves motor function[23]. Thus, the effect of passive stretching and active stretching should be considered together with when the stretching occurs, e.g. before and after exercise, as this could influence the effect. The results of the current study show that passive stretching was useful for increasing the flexibility of the hamstring muscles. Previous studies reported improvements in flexibility were elicited by passive stretching conducted for patients with contracture and limited flexibility[8, 13]. However, passive stretching before exercise is not recommended according to another study[21]. Thus, passive stretching should be recommended for use when improvement in flexibility is required, for example, when there are post-exercise and range of motion restrictions, and particularly for bedridden patients, passive stretching may become one of the choices of the therapy.

The subjects of this study were young people. This study did not investigate the effects of stretching on elderly people, and only focused on immediate effects. Further studies are required. Specifically, studies using long-term interventions with greater numbers of subjects including the elderly, and comparison of time and frequency of active and passive stretching are required. In addition, it is possible to evaluate the effect of stretching on exercise performance, not only flexibility.

In conclusion, we investigated the effect of passive and active stretching techniques on hamstring flexibility. The results of this study suggest that improvement in hamstring flexibility can be obtained by both stretching techniques. However, passive stretching may elicit greater improvements in hamstring flexibility than active stretching.

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春季学術大会論文

視覚障がい者 Web Accessibility に配慮した病院 Webpage 標準仕様書の必要性

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春季学術大会論文

視覚障がい者 Web Accessibility に配慮した病院 Webpage 標準仕様書の必要性

田中　武志[*1]　津久間秀彦[*1]　池内　実[*1]

［背景・目的］視覚障がい者にとって Web は利用頻度の高い情報メディアであり，特にスクリーンリーダを用いた閲覧が多くなされる．しかし，多くの公共機関や医療機関の Webpage では十分な対応が為されていないのが現状であり，改善のためにはコンテンツの情報も含めて整理する必要がある．［方法］2015 年 1 月に国立大学病院の 47 の Website の Top-page について，1) Accessibility 評価によるサイトの分類，および 2) Webpage 上の情報項目とその出現順序，について調査した．［結果］1) 視覚障がいに対応する機能を持つものの，スクリーンリーダが読み上げるコメント等の不備によって JIS 規格を十分に満たさない Website が多く，全体として対応が不十分であること，および 2) ほとんどすべての病院において患者の受診に必要と思われる情報は提示され，提示順序も比較的上位にあるものの，病院ごとの差が非常に大きいこと，が判明した．［考察］JIS に則ってコメントと情報項目を整理し標準化することで，病院 Website を視覚障がい者がより利用しやすくする環境を整備できるものと考える．

キーワード：Web Accessibility，視覚障がい者，HTML, JIS X8341-3:2010

The Necessity of the Standard Specifications of Hospital Webpage that Guarantees Web Accessibility of Visually Impaired Person: Tanaka T[*1], Tsukuma H[*1], Ikeuchi M[*1]

The world-wide-web (WWW) is an important information media for a visually impaired person in Japan. Although there is lot of variations of their settings to use WWW, most of them use a screen reader. However, most webpages of public institutions in Japan are not coded as taking into account of a screen reader user, and their web accessibilities are not enough to pass JIS X 8341-3. The authors reviewed the top-pages of 47 national university hospital websites from viewpoint of web accessibility, in January, 2015, and found that; 1) as same as other public institutions, many websites did not pass JIS X 8341-3, of which the result did not show remarkable improvement from the reviews in 2014; and that 2) although most of information items on their webpages which patients need to access medical services in general were found near to the top of webpage, there were so many variations of ways to show these items: Such a

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variation may prevent a visually impaired person's access to the information due to difficulty of understanding the structure of the webpage. These problems shows the necessity of the standard specifications of hospital webpage for visually impaired persons.

Key words: Web accessibility, Visually impaired person, HTML, JIS X8341-3:2010

1. はじめに

国連の障害者権利条約を受けて，2011 年にわが国の障害者基本法は改正され，社会的障壁の除去の実施について『必要かつ合理的な配慮』が法的に求められるようになった．日本では高齢者・障がい者のインターネット利用率は高く，障がい者のケアや QOL を守るための重要な社会資源である医療機関 Webpage への合理的配慮の実施が早急に求められている．

Web へのアクセスが最も困難な視覚障がい者にとっても Web は欠かせない情報メディアである．視覚障がい者はその症状が多彩であるが故に Web の利用形態も非常に多様であるが，全盲者においてもロービジョン・弱視者においてもスクリーンリーダ（音声読み上げソフトウェア）の使用率が高いことは共通している[1]．

しかしその一方で，多くの視覚障がい者は Webpage の理解や操作に日々困難を感じている[1]．特に公的機関の Webpage の多くは，技術的理解・知識および予算・人手の不足などにより Accessibility に問題を多く抱えている現状がある[2]．公共機関であり，かつ多数の障害者が通院する地域の基幹病院である国立大学病院においても，その Webpage の多くが同様の問題を抱えており[3~5]，特に音声読み上げソフトウェアの動作に直接関係する HTML の記載方法や構成に問題があることが判明している[3,5]．

またスクリーンリーダは Webpage の情報をシーケンシャルに読み上げていくため，一般的な Web Browser による閲覧と比べて情報の一覧性に著しく欠ける．したがって，視覚障がい者の Web Accessibility を確保するためには，正しい HTML の記述に加えて，わかりやすいコンテンツの提示順序・方法についても考慮する必要がある．しかし Web Accessibility に関する JIS X 8341-3 の大部分は技術面と一般的な記載方法の規程であり[6]，Webpage の内容にはほとんど触れておらず，どの情報をどのように提示するかは Webpage の制作者に任されている．そのため Web の利用者は異なる Website にアクセスする度に異なるパターンで情報を受け取ることになっているのが現状であり，「音声読み上げソフトを使っても，ほとんどのホームページが理解しにくい．読み上げやすい画面にするために，ある程度統一するような規則でもできれば良いと思う」[1]という不満も聞かれる．

しかし，もしも各病院の Website の入り口である Top-page の仕様を内容まで含めて標準化することが可能であれば，患者がどの病院の Website にアクセスしても迷わず求める情報を探すことができるようになり，多くの病院 Website の Accessibility 向上が期待される．

本論文では，技術的な課題に絞った文献[5]の調査からさらにコンテンツに立ち入って病院 Website の視覚障がい者 Web Accessibility 対応状況を調査し，国立大学病院のみならず，すべての病院の Webpage を対象とした標準仕様の必要性について考察する．

2. 方　法

2014 年 9 月に下記 1)，2015 年 1 月に国立大学病院の 47 Website（歯科病院 2, 分院 3 を含む）の Top-page を対象に 1) と 2) の調査を行った．

1) Accessibility 評価による Website の分類

以下の 2 点，A) Webpage の知覚可能性，理解可能性，操作可能性，頑強性の 4 つの視点[7]から全盲者を想定したスクリーンリーダへの対応

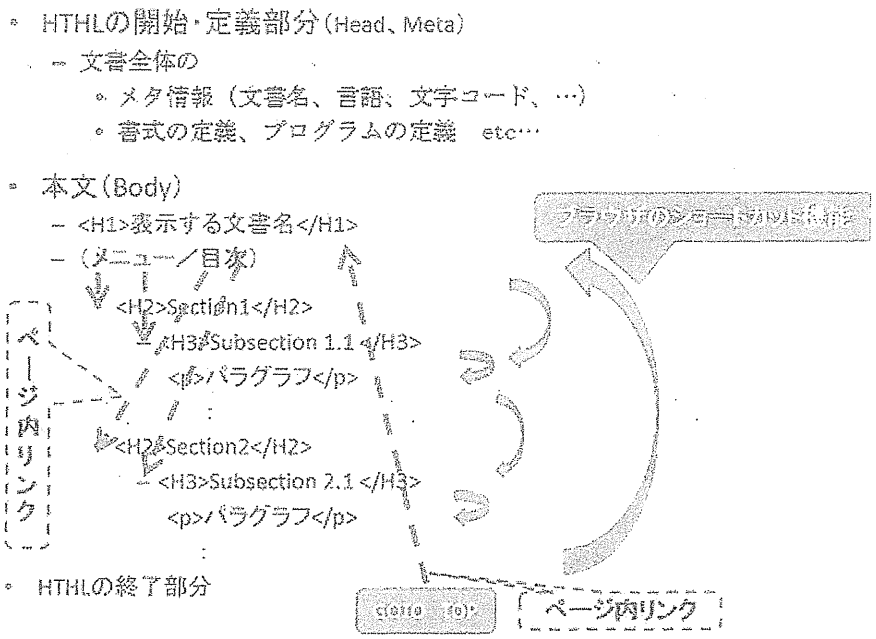

図1　HTML 文書の構造と Browser のショートカット機能

（以下，全盲対応），および B）ロービジョン・弱視者を想定した配色や文字サイズの対応（以下，弱視対応）について，JIS 規格に準拠した Web Accessibility 評価ツール miChecker[8] を用いて各サイトを 4 段階（星なし～星 3 つ）で評価し，4×4＝16 のクラスタに分類した．ただし，2014 年 9 月の調査は miCheker の Ver. 1.0，2015 年 1 月の調査では同 Ver. 1.2 を用いている．

2）情報項目の出現順序

スクリーンリーダが，Webpage のランドマーク（タグによる見出しなど）へのショートカットや Webpage 内リンクに対応していると仮定し（図 1），患者が受診をする際に必要な情報（あるいはその情報の載ったページへのリンク）に辿り着くまでに何秒掛かるかを，miChecker を用いて計測（図 2）し，どのような情報項目が優先して提示される傾向があるのか，について調べた．

3．結　果

1）Accessibility 評価による Website の分類

2015 年 1 月の結果を図 3 に示す．評価の概要の平均は，音声対応が星 1.17 個，弱視対応が星 1.23 個であり，miChecker（Ver. 1.0）を用いた 2014 年 1 月（音声対応が星 1.32 個，弱視対応が星 1.19 個）[5] と 9 月（音声対応が星 1.23 個，弱視対応が星 1.17 個）の調査と比べて，個別の変化はあるものの，全体としての大きな向上は見られない．

miChecker に問題として挙げられている項目を調べると，過去の調査[3,5] と同様に，知覚可能性の問題，特に画像情報に対する不適切なコメントが目立つ．

2）情報項目の出現順序

出現時間を平均し，出現順序の早い順に情報項目を並べた結果が表 1 である．

ほとんどの Webpage では病院名が最初に読み上げられるが，病院名が読み上げられる前に他の項目（検索ウィンドウやフォントサイズの切り替えボタンあるいは大学 Website へのリンクなど）が読み上げられるケースや，コメント記載が適切でないため病院名がわかるまで時間が掛かるケースなど，理解可能性の問題があると思われる Website がいくつか存在する．

2 番目から 4 番目には利用者の Usability に関する項目が並ぶ．2 番目の情報項目には，Webpage のベースとなる言語（日本語とその他の言

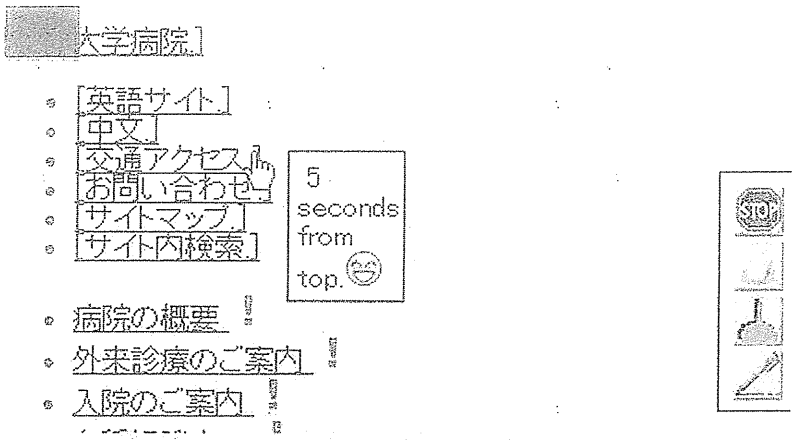

図 2　miChecker による到達時間の計測
マウスポインタの箇所に到達するまでの時間が表示される.

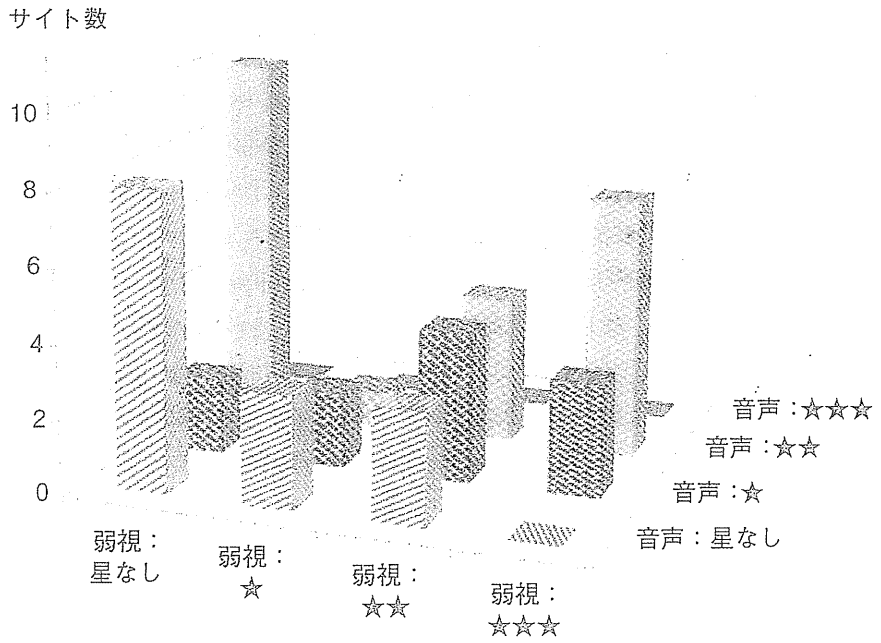

図 3　miChecker によるサイトの分類（2015 年 1 月）
右上に行くほど高評価となる.

語，特に英語など）のページへのリンクがきている．3 番目にはページ内検索のウィンドウが来ており，79%（37/47）の Website が採用している．しかしながら 2 つの Website ではスクリーンリーダ用のコメントが付いておらず，4 つの Website はスクリプトのみでスクリーンリーダが認識しない仕様になっていた．4 番目にはロービジョン・弱視者対応用のフォントサイズや配色の変更ボタンがきており，これも 79%の Website が採用しているが，前項目と同様にコメントの不備が 8 つの Website で，スクリーンリーダに表示されない仕様が 1 つの Website で，それぞれ見られた．

5 番目から 8 番目には，診療（外来・入院）案内，施設案内，交通・アクセス，診療科・部門の案内，などの患者の受診のために必要と思われる情報項目が，9 番目と 10 番目には，患者紹介窓口などの連携医療機関向け窓口，病院のニュース（お知らせ），などの医療機関側にとって必要な情

表1　情報項目の出現順序（上位10項目）

出現順序	項　　目	平均出現時間（秒）	出現サイト数
1	病院名	1.5(SD=5.3)	47
2	言語切り替え	12(SD=10)	28
3	サイト内検索	13(SD=19)	37
4	フォントサイズ等変更	14(SD=10)	37
5	診療案内（外来・入院）	20(SD=17)	47
6	施設概要	24(SD=11)	47
7	交通・アクセス	29(SD=33)	47
8	診療科・部門	30(SD=34)	47
9	紹介・医療機関向け	34(SD=25)	47
10	ニュース・お知らせ	36(SD=37)	47

報が並んだ．これらの情報項目はすべてのWebsiteで確認されたものの，Webpageごとにこれらの情報項目の定義の違い（外来診療と入院診療の情報が最初から分かれている/共通の項目になっている，など）や名称・用語の違い（交通アクセス/交通案内/交通のご案内，など）が少なからずある．

全般的に，ほとんどの項目について平均出現時間とその標準偏差（SD）が同程度，あるいはそれ以上の時間であり，実際のWebpage閲覧時の出現順序は表1のものと比べてかなりのバリエーションがある．

4. 考　察

1) Web Accessibility と Usability

Web Accessibilityに配慮した機能を持ったサイトが多くなってきた一方で，未だにその意義と意味が十分に理解されておらず，結果としてHTML文書の意味を踏まえた適切なコメント・meta情報の付与が十分に為されていない現状がある．例えばあるWebsiteでは，明らかにスクリーンリーダによる読み上げを意識したページ内リンク（スキップリンク）を備えながらも，多くの画像情報に「画像です」という利用者には意味のないコメントが付けられていることによりmiChecker による評価は低くなっている．Web Accessibility に配慮しつつ適切な Usability を得るためには，利用者の操作方法と技術的な問題の両方を考慮しながら適切なコメント・meta 情報を付けていかねばならない．以下，コメント・meta 情報の付け方と Usability に関係する項目について議論する．

(1) 言語の切替

Web Accessibility を考慮する際，Webpage 内の meta 情報の中でも言語の指定は最も重要な情報の一つである．なぜなら，スクリーンリーダの音声ライブラリは読み上げる言語によって異なるからである．したがって，日本語 Webpage から英語 Webpage への（あるいはその逆の）リンクはできるだけページのトップに近い箇所に置くべきである．また病院によっては日本語 Webpage 以外の需要はほとんどない場合もあるかもしれない．しかし国際化が進む日本の社会の中では，少なくとも地域の二次医療機関以上のレベルの病院の Top-page は日本在住の外国人に対する配慮が求められる可能性があり，考慮が必要であろう．

(2) サイト内検索

視覚障がい者の Webpage の操作に関しては基本的にキーボード入力が想定されており，Webpage のすべての箇所にキーボード操作で到達できることが必須条件である．

現状，Google や Yahoo などの大手 Web 検索サイトも Webpage 全文検索ソフトウェアも，視覚障がい者にとって使いやすいものとはいえない状況である[1]．ものの，検索が容易になれば，キーボードを操作してメニューを総ざらいするよりも少ない手順で求める情報に到達できるであろう．

十分使いやすければ，表1の出現順序と同様に，検索機能は比較的上位に来るのが妥当と思われる．

(3) フォント・配色の表示変更

フォント・配色の表示変更は Web Accessibility 確保のための必須機能ではない．そもそも全盲者には意味のない機能ではあるが，ロービジョン・弱視者にとっても必須の機能とはいえない．