6時間後以降は湿度90%での値に変化はほとんどみられず，他の条件よりも有意に高い値を維持していた．1時間後の値と比較すると，2時間後以降は有意に低い値であった．WKでは，湿度30%と60%での値と比べると湿度90%の値が多くの時点で有意に高かった．また，湿度30%の場合は4時間後以降，他の条件では3時間後以降に1時間後の値と比べて有意に低くなった．MGでは，湿度90%での値は他の条件よりも有意に高い値を維持し，30%では低い値を示した．1時間後の値との比較では，湿度60%での4時間後の値を除き，すべての条件で1時間後の値よりも有意に低くなった．

考　　察

口腔乾燥への対策として，現在の臨床場面では局部の加湿ならびに保湿が行われることが多い[19]．これまでにも多くの洗口液や保湿剤が使用され，湿潤作用や保湿作用をもつ成分はグリセリンやソルビトール，ヒアルロン酸ナトリウム，キシリトールなど多岐にわたる[20]．これらは現在も口腔粘膜用の保湿剤に配合されているものも多いが，利点だけでなく欠点も報告されている．グリセリンは適量よりも多量に使用した場合，その吸湿性のために皮膚や粘膜から水分を吸収してしまう恐れがある[21]．また，口腔ケア手法や頻度によっては口腔保湿剤が乾燥し，粘膜に強固に付着する例もあり，使用法や成分に留意する必要がある[12,13]．これらに関し，口腔乾燥を伴う患者への口腔ケア方法についての推奨される手順などが拡がっているものの，口腔保湿剤の経時的変化や評価は定まっていない．本研究の結果では，5種類の市販されている口腔保湿剤すべてで曳糸性や流動性が数時間以内に著明に変化し，湿度が低い環境では2時間後ですでに大きな変化を示したものもみられた．

曳糸性試験では，湿度30%の条件下のRCとOB，湿度30%と60%のAG，すべての湿度条件下のMGで試料が徐々にゼリー状から固形に変化する様子がみられた．RCではエタノールが主成分として含まれており，揮発性のため水分を吸収しながら蒸発する．また，ゲル状の手指消毒剤に関する研究では，消毒剤塗布後数分でエタノールが揮発・蒸発することが報告されているため，この作用によって試料の固形化が進んだものと考えられる[18,22]．また，水添デンプン，カルボキシメチルセルロースナトリウム，グリセリン，ポリメタクリル酸グリセリルについては湿潤作用や水分保持作用があるとされる．これらの成分が経時的にどのように水分を失うかについては報告がないものの，湿度が100%未満の条件下では水分の蒸発が生じるものと推察される．水分の蒸発は気温や湿度，風速などに影響を受け，湿度90%と比較すると水分の蒸発量は湿度60%では約2.5倍，湿度30%では約5倍に達するとされる[23]．これらによって口腔保湿剤から水分が蒸発し，試料が固形へと変化したものと推察される．曳糸性試験では，実験途中でほぼ完全に固形となった試料では測定値が変化せず，ゼリー状の形態を保持した試料では測定値が高くなった．これは試料の粘性が高まった結果と考えられ，本研究の測定方法によって経時的な試料の粘性が計測できるものと考えられる．一方で，曳糸性試験では粘弾性や弾性の影響が関連すること，完全な固形となった試料では測定が困難であることについては今後の検討が必要と考えられる．

流動性試験においては湿度90%の条件よりも60%あるいは30%の条件で流動性が低下することがみられ，湿度30%でのOBとMGでは3〜4時間後に流動性が全くなくなった．これらの試料では，各条件に保管前の状態で平面での流動性が約1 mmと低く，経時的な水分の喪失が流動性に与えた影響よりも，試料が本来有する性状であると考えられる．実際の口腔清掃に際しては，本研究の計測にて行ったように口腔保湿剤を積層せず，粘膜面に薄く延ばすように塗布することが推奨されている[20]．また，長時間にわたり乾燥部位に留置できること，咽頭部に容易に流入しないことも口腔保湿剤に必要な性状とされるため，短時間内であれば口腔保湿剤の流動性は必ずしも高い必要はないと考えられる．斜面での流動性試験では，多くの試料で1時間後の計測値と比較してそれ以降の計測値は有意に低下していた．特に保管前の流動性が高かったRCやAG，WKでは流動性の低下が著しく，RCでは6時間後，AGでは3時間後，WKでは2〜3時間後に流動性の数値は半減した．これは，斜面における口腔保湿剤の流動性が一定時間保持されるということであり，塗布した面から口腔保湿剤が拡大する可能性があることを示している．一方で，流動性は湿度が低い状況であるほど早期に減少しており，湿度が低い状態では粘膜保湿剤が短時間で流動性を失うと考えられる．前述のように実際の保湿剤は薄く塗布することが推奨されているため，適切な使用法では本研究でみられた流動性は生じないと考えられるが，不適切な使用法である場合には保湿剤の奥舌や咽頭部への流入の可能性も考えられる．保湿剤の使用例では，重度の口腔乾燥を改善するために使用した保湿剤が徐々に乾燥し，塗布後数時間で膜状に固着する様子も報告されている[7]．この保湿剤の変化は本研究における試料の曳糸性や流動性が低下した状態と類似しており，乾燥状態に置かれた保湿剤の性状変化によるものと考えられるが，本研究の結果では湿度が90%，すなわち口腔内に口腔乾燥状態がみられなかった高齢者を想定した状況でも曳糸性や流動

性の低下は生じることが示された．このことは，口腔乾燥の程度にかかわらず保湿剤の性状は経時的に変化することを念頭において，保湿剤を使用した口腔衛生管理を行う必要性を示唆するものと考えられる．

本研究で使用したアクリル板は食物の流動性試験や義歯用粘膜調整剤の粘弾性変化の測定などに使用されるものの，表面性状は口腔粘膜と異なっている点を考慮する必要がある[24,25]．また，曳糸性での変化と流動性の変化との間にも明確な関連はみられなかった．保湿剤の物性に関する他の報告でも曳糸性と粘度との間に関連はみられず，含有成分やその割合に大きな影響を受けることが示唆されている[14]．食品の物性においても，流動性などの特性は高分子タンパクなどの構造，含まれる水分の動態など多くの要素の影響を受けるとされる[26]．本研究の試料にも分子量10万以上のヒアルロン酸ナトリウムやポリメタクリル酸グリセリルなどが含まれる．また，グリセリンは食品の流動性の調整に使用されることがあり，その濃度などは粘膜保湿剤の流動性にも大きく影響を与えると考えられる．このため，本研究で使用した流動性試験の結果がどのような因子に影響を受けるかを詳細に検討するとともに，計測場面の改善などが必要と考えられる．また，保湿剤の曳糸性や流動性は低い湿度条件で早期に低下する傾向が示されているものの，口腔粘膜上にみられる口腔乾燥度と口腔内の湿度が常に相関するとはいえず，湿度設定のみで口腔乾燥状態の程度を再現できるとは考えにくい．特に，開口状態や口呼吸は口腔内の湿度に大きく影響するとされるため，口腔乾燥状態の再現法については今後の改善が必要であると考えられる[27]．

以上から，口腔粘膜に使用される保湿剤は時間の推移によって曳糸性が増加し固形状の形態となること，流動性が低下するとともに，特に湿度が低下した乾燥状態においてはその変化が短時間のうちに生じる可能性が示唆された．このため，口腔乾燥患者に保湿剤を使用する際は保湿剤の物性が経時的に変化することに留意し，口腔清掃時には以前に塗布された保湿剤を確実に除去することが必要であると考えられた．

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An Experimental Study on the Relationship between Temporal Changes on the Physical Properties of Oral Moisturizing Gel and Humidity

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The aim of this study was to establish an oral health care method for oral dryness, hence, the relationship between temporal changes of oral moisturizing gel and humidity was examined.

The specimens were five kinds of commercially available oral moisturizing gels and these were stored at 37°C and 30% humidity. The spinnability and fluidity of the gels were then measured at 1, 2, 3, 4, 6, 8 and 12 hours later. Similarly, samples stored at 60% or 90% humidity were measured. The spinnability was measured by a spinnability tester and fluidity was measured with 3 g of each sample on a plane surface and on a sloping acrylic plate.

In the spinnability test, all the specimens showed significantly higher values after 2 hours than the original specimens at 30% humidity.

In the fluidity test on a plane surface, all the specimens at 30% and 60% humidity showed significantly lower values after 4 hours than the original sample, and the fluidity test on a slope showed similar tendencies except for one specimen.

These findings suggest that the spinnability of oral moisturizing gels can be increased and the physical properties are changed to solid form over time, and the fluidity decreases especially quickly at low humidity.

小児の嚥下障害とリハビリテーション*

keywords：嚥下障害、小児

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小児の嚥下障害は、代謝の維持とともに発育を考慮した栄養管理が必要とされ、経口からの栄養摂取が困難なために長期に経管に頼らざるを得ない場合が多い。

小児の嚥下障害の主訴は様々だが、特徴的には出生直後からの吸啜機能不全で哺乳障害の既往が多いことにある。哺乳障害により経管栄養となり、その後は嚥下障害により経口からの摂取が進まず、多くは継続して経鼻経管や胃ろうによる栄養摂取が主となっている。

小児の嚥下障害に対するリハビリテーションの特徴は、原疾患の特徴に加えて、口腔・咽喉頭領域の形態的な成長を考慮したリハビリテーションの対応を常に必要とするところにある。また、経口摂取経験が極端に少ない場合には、口腔・咽頭・喉頭部の協調運動を学ぶことができずに嚥下障害が重度となっている場合も多い。随意的な嚥下機能獲得後に嚥下障害となった成人とは異なった対応が必要とされ、その対応には発達面からの注意が必要である。

【はじめに】

嚥下障害のある小児は、代謝の維持とともに発育(成長・発達)を考慮した栄養管理が必要とされ、経口からの栄養摂取困難を考慮した長期にわたるきめ細かな栄養管理が行われている場合が多い。NSTの目指す栄養投与ルートのゴールは経口摂取であり、嚥下障害のリハビリテーションにおいても嚥下障害に対するリハビリテーションを通して経口摂取を可能にしてより良い栄養状態にすることが目標である。

小児の嚥下障害の主訴は、ミルクが飲めない、食物を飲み込まない、嘔吐が頻繁にある、むせやぜい鳴が常にある、流涎がある、鼻漏がある、食べることを拒否する、などさまざまである。また、嚥下障害のある小児に特徴的なのは、出生直後の乳児期から吸啜機能が不全で哺乳障害の既往が多いことである。つまり、哺乳障害により経管栄養となり、その後は嚥下障害によって経口からの摂取が進まず、多くの小児は継続してNGチューブや胃ろうなどによる栄養摂取が主となっている。

小児の嚥下障害に対するリハビリテーションの特徴は、嚥下障害の原因となる疾病特長に加えて、食物を摂取する摂食器官である口腔・咽喉頭領域の形態的な成長を考慮したリハビリテーションの対応を常に必要とするところにある。また、嚥下機能不全のために口からの摂取経験が極端に少ないため、嚥下時にどのように口腔・咽頭・喉頭部を協調して動かすかを学ぶことができずに嚥下障害の程度が重度となっている場合も多く、随意的な嚥下の機能獲得後に嚥下障害となった成人の嚥下障害とは異なった対応が必要とされる場合もあり、小児の嚥下障害の対応には十分な注意が必要である。

Dysphagia rehabilitation of the infant

【1. 小児の嚥下障害の原因と対応の基本】

周産期から嚥下障害を含む経口からの摂食困難を呈している小児は、その原疾患や症状から未熟児性、顎口腔・咽喉頭・食道領域の形態異常、神経・筋系障害、口腔・咽喉頭・食道機能障害、精神心理的問題に分けることができるが、これらが重複して原因となっている場合も多い[1]。その後の対応を考えると大きく2つの分けると理解しやすい。一つは唇顎口蓋裂、小顎症(ピエール・ロバン症候群など)、喉頭軟化症、食道閉鎖症等の主に形態面の異常(静的嚥下障害)が原因となる機能障害である。このような形態に原因がある場合には、形態修復のための手術などが行われ機能障害の改善が図られる。しかし、症例によっては術後の経口摂取制限が長期間にわ

表1　新生児期、乳児期、小児期の摂食・嚥下障害の原因となる主な疾患の分類
6.精神心理状態に追加　知的発達障害、広範性発達障害(PDD)　田角[1]の一部改変

1.未熟性(未熟児, 低出生体重児, 早産児)	
2.解剖学的な構造異常(先天性, 後天性)	
A.口腔	唇裂, 口蓋裂, 粘膜下口蓋裂
B.舌	巨舌(先天性リンパ管腫, Down症候群), 無舌・小舌症
C.鼻腔	先天性後鼻孔閉鎖症・狭窄, 鼻炎, 副鼻腔炎
D.下顎	小顎症(Pierre Robin症候群, Treacher-Collins症候群など), 顎関節強直症
E.咽頭	嚢腫, 膿瘍, 腫瘍, 扁桃肥大, 喉頭麻痺, 喉頭軟化症, 喉頭蓋炎
F.食道	食道閉鎖症, 狭窄症(先天性, 裂孔ヘルニアによる食道炎など), 気管食道瘻, 血管輪, 縦隔腫瘍
3.中枢神経, 末梢神経, 筋障害	
A.大脳, 小脳	1.脳性麻痺(原因としては下記の疾患も含まれる)
	2.出生前原因：脳形成不全, 染色体異常, 奇形症候群, 低酸素・虚血性障害, 胎内感染症
	3.周産期原因：低酸素性虚血性脳症, 核黄疸, 低血糖, 中枢神経系感染症, 頭蓋内出血, 外傷, 中毒
	4.その他：感染症・感染症後(亜急性硬化性全脳炎, 後天性免疫不全症候群), Lesch-Ny-han症候群, Wilson病, ミトコンドリア脳筋症, 多発性硬化症, 若年性Huntington病, Pelizaeus-Merzbacher病, 薬剤性(精神安定剤, 催眠薬, 抗痙攣薬など)
B.脳幹	Arnold-Chiari奇形, 脊髄空洞症, 脳神経核欠損(Möbius症候群等), 骨形成不全(大孔狭窄, osteopetrosis), 腫瘍(脳幹, 後頭蓋窩), 外傷性, 脳血管障害, 脳動静脈奇形, 脳幹脳炎, 多発性硬化症
C.脳神経(Ⅴ, Ⅶ, Ⅸ, Ⅹ, Ⅻ), 脊髄, 末梢神経	先天性(Werdnig-Hoffmann病), 腫瘍(神経線維腫症), 外傷性(分娩麻痺, 脳底部骨折), 感染症・感染症後(ジフテリア後麻痺, ダニ麻痺, ポリオ, Guillain-Barré症候群, 破傷風), 血管性, 脱髄, 若年性側索硬化症, 進行性球麻痺
D.筋, 神経・筋接合部	進行性筋ジストロフィー症, 筋強直性ジストロフィー症, 先天性筋ジストロフィー症, 先天性ミオパチー, Prader-Willi症候群, ミトコンドリア脳筋症, 内分泌・代謝性(甲状腺機能低下症, 先天性代謝異常症), 皮膚筋炎・多発性筋炎, 重症筋無力症, 薬剤・中毒症(ボツリヌス, 有機リン中毒)
4.咽頭・食道機能障害	
一過性咽頭機能不全, 輪状咽頭筋機能不全, 食道弛緩症, 食道無弛緩症(アカラシア), 食道炎, 薬剤性(β-アドレナリン作動性, 抗コリン作動性, 筋弛緩薬)	
5.全身状態	
感染症, 中枢神経疾患, 心疾患, 呼吸器疾患	
6.精神・心理的問題	
拒絶, 食事恐怖症, 経管栄養依存症, 医原性栄養過剰, 好き嫌い, 反芻など	
7.その他の問題	
口腔乾燥(Sjögren症候群, 薬剤性), 口内炎など 薬剤・中毒症	

たったことが原因と考えられる心理的に経口摂取を拒否する摂食・嚥下障害が認められることも多い。

他は神経・筋疾患などによる運動機能の異常が原因(動的嚥下障害)となる摂食・嚥下障害で、脳性麻痺、筋ジストロフィー、ミオパチーなどで、摂食・嚥下機能が発達途上で、嚥下の口腔期が原因と診断される例も多い。このような発達の視点からの機能評価がなされないままに在宅で養育されると、障害の種類や程度によっては、低栄養や脱水に陥る可能性も多く、誤嚥や窒息が起きる危険性も考えられる。

小児の嚥下障害の対応における特徴は、摂食・嚥下機能が営まれる口腔・咽頭部が成長途上であることから、形態成長を考慮した摂食・嚥下機能の発達的視点からの対応が常に求められている。、嚥下機能の発達途上で、嚥下の口腔期が原因と診断される例を示した。対応の基本として、形態の成長を考慮しながら、摂食・嚥下に関わる機能全体の特徴的な動きを基にした8段階の発達過程のどの段階で機能不全がみられているかの評価[2]と、一回の食物の口への摂り込みから嚥下までを5期(先行期、準備期、口腔期、咽頭期、食道期)に分けて[3]機能不全がどの期にあるかについての評価を組み合わせると診断が容易となり効果的なリハビリテーションが可能となる。

嚥下障害の小児に対する摂食・嚥下リハビリテーションは、多領域の専門職が連携して行うことが望まれる。主治医の医師や看護師に加えて、誤嚥・窒息などの予防を考慮して摂食を営むために頭頸部が安定した摂食姿勢をとることができるように理学療法士のリハビリテーションが必要であり、口腔領域の訓練を行うためには口

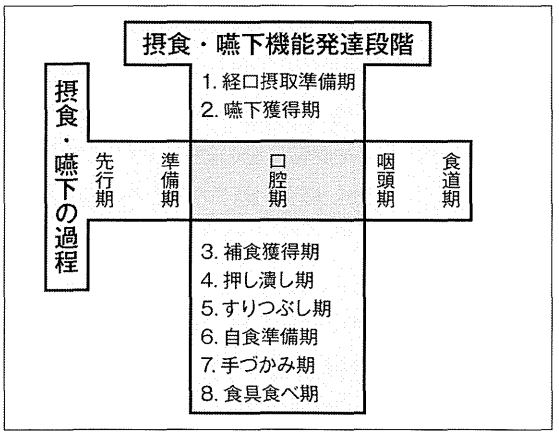

図1　摂食・嚥下過程と機能発達との関連

腔内を清潔に保つための口腔のケアの専門職である歯科衛生士の関与も不可欠である。また、口腔の形態の不調和(高口蓋、開咬、上顎前突、咬合異常など)のある嚥下障害の小児には、口腔領域の成長変化を考慮しながら種々の装置(舌接触床など)の利用や種々の口腔疾患や機能不全を考慮したリハビリテーション[5]のために歯科医師の連携が望まれる。低栄養や脱水を考慮した摂食・嚥下機能の障害程度に合わせた調理形態指導のための栄養士や機能訓練を担当する看護師、言語聴覚士、歯科衛生士などチーム医療での関与が望まれる。

【2.発達的視点からみた小児の摂食・嚥下障害のリハビリテーション】

摂食・嚥下過程にみられる特徴的な症状について、発達障害的な視点から、まとめてみてみたい。摂食・嚥下過程を追って診ることは、摂食・嚥下障害のある小児の機能発達を促す臨床的対応としての指導や訓練方法に結びつきやすい[8]。

嚥下は、意識下に嚥下反射の誘発が可能なように随意性に富むものの、食物摂取時には食塊の口狭部や咽頭部への触圧覚刺激によって嚥下反射が誘発される。このような触圧覚刺激も、受容する小児が与えられた刺激に対して過剰に反応してしまう(過敏)場合がある。このような症状によって嚥下反射に結びつくことができないことが主な原因の場合を触覚過敏による嚥下障害と呼ばれている。また、哺乳のための原始反射である探索反射や吸啜反射などが残存していて、嚥下の随意的な動きを阻害しているために嚥下障害になっている場合もみられる。口を使った遊びなどを工夫して触覚刺激に少しずつ慣らす日常生活の対応が必要である。

嚥下反射の誘発による喉頭挙上に伴っておこる咽頭・喉頭部の動きは、喉頭蓋による気道の封鎖と輪状咽頭筋の弛緩による食道入口部の開大である。乳児期には口蓋垂と喉頭蓋が接近しているが、成長につれて離れることで中咽頭が形成される。この成長変化によって、呼吸と嚥下の協調障害があると、成長に伴って哺乳期にはなかった乳汁や食物の気道への流入(誤嚥)が見られるようになる。

また、嚥下の咽頭期障害の症状には、喉頭挙上不全のために喉頭蓋による気道閉鎖不全や食道入口部の開大

不全などがある。いずれも嚥下造影検査(VF)や内視鏡検査などによって診断が可能である。体幹や頸部などの角度を考慮した食事姿勢や食物形態、一口量などの対応をしながら、間接的訓練による機能訓練が必要である。

【3.原因疾患別の対応】

1)未熟性(早産児)の哺乳・嚥下障害とその対応

吸啜・嚥下の動きは胎生13～14週頃から出現する[4]が、24週頃までにみられる吸啜運動はnonnutritive patternで[5]、吸啜の動きがリズミカルになるのは在胎28週、嚥下を伴った哺乳運動が確立するのは在胎34週頃以降である。早産児の多くは修正35～36週まで経管栄養を必要とし、超早期産児では3ヶ月以上に及ぶ場合もある。早産の未熟児が経口からの哺乳が困難な理由の一つに口腔の形態的な特徴(異常)がある。早産児は胎生中と異なり、保育器の中での管理になるため、顔面は横向きの頻度が多くなり、所謂未熟児顔貌と呼ばれる特徴ある形となるが、乳首を口腔内に捉えて吸啜を行う場である口蓋の形態も特徴的な形となり、乳首が安定せず吸啜圧がかかり難い。

このような吸啜・嚥下機能が未熟な早産児への対応の基本は、吸啜や嚥下の動きの中心をなす口唇や舌などの口腔領域への感覚刺激の経験の圧倒的な少なさを補うことにある。non-nutritive sucklingはポリペプチドホルモンの分泌を増加させ、胃液分泌の増加をもたらすとの報告[6]のように、non-nutritive sucklingによる感覚刺激は、消化活動に対する効果、ホルモン分泌効果、体重増加作用などがあるとの報告もある。経管による栄養確保を基に、いつ頃から経口摂取を開始するかは、哺乳反射の消長、触覚に対する過敏の程度、口腔領域の動き、消化状況などを考慮しながら、個々の状態を診た上での検討が必要である。

2)中枢神経・抹消神経・筋障害による摂食・障害とその対応

大脳、小脳の障害による摂食・嚥下と呼吸の協調障害、不随意運動、筋緊張の亢進や低下などは摂食・嚥下障害の原因となる。

・脳性麻痺(以下、CPと略)児においては、1歳までに吸啜障害が57%、嚥下障害が38%に認められ、経管栄養の既往は80%であったとの報告[7]もある。また、療育医療施設の摂食外来を受診したCP児122名における初診時の嚥下障害に関する我々の調査では、むせが64.8%に、嘔吐様の動きで嚥下する逆嚥下(乳児嚥下を含む)が31.2%に認められ[8]、小児期のCP児の嚥下障害への対応の重要性が示されている。

1歳～3歳のCP児の摂食機能障害の症状と粗大運動発達との関連をみた研究[9](図2)から、摂食機能の発達と障害症状と粗大運動発達程度に関連が強いことがわかる。発達期のCP児の摂食・嚥下障害への対応では、摂食機能療法に摂食時の姿勢訓練や全身の運動発達を促す訓練を合わせて行うこと必要であろう。

複数の脳神経の神経核や神経線維が侵されることによって起こる摂食・嚥下障害には、新生児仮死、低酸素性虚血性脳症、脳炎後遺症などがあり、摂食・嚥下障害の症状はCPと同様な症状を呈する場合が多い。

・筋ジストロフィーは摂食・嚥下関連筋の変性が摂食・嚥下障害の主原因となる。準備期から食道期にいたる各期に機能不全がみられる。小児に多いDuchenne型筋ジストロフィー(DMD)は、咬筋の筋力低下や舌の肥大による下顎位の固定不全が原因と思われる喉頭蓋反転不全、食道入口部拡大不全などにより摂食・嚥下障害を呈している。また、福山型筋ジストロフィー(FCMD)では、開咬・不正咬合、口唇閉鎖不全、舌の肥大による下顎位の固定不全による食塊形成・送り込み不全がみられる[10]。加えて喉頭蓋谷・梨状窩拡張、食道入口部拡大不全、口腔・咽頭逆流、食道・咽頭逆流などにより摂食・嚥下障害が重篤となる。

・先天性ミオパチーは、咽頭・頸部の筋障害により仰臥位での頭部挙上が困難になるなどの重度の嚥下障害や呼吸筋も侵されることが多い。これらの神経・筋疾患による嚥下障害は、嚥下時の舌突出の動きや筋の弛緩などによる開咬など、成長や異常運動の継続に伴って口腔領域の形態面の不調和が、摂食・嚥下の改善を阻害する大きな原因となっている[11]。

3)精神・心理的問題による嚥下障害とその対応

嚥下障害児の対応にあたっては、精神・心理的問題を常に意識しておくことが必要である。乳児期から長期にわたる継続した経管栄養のために経口摂取を拒む「経

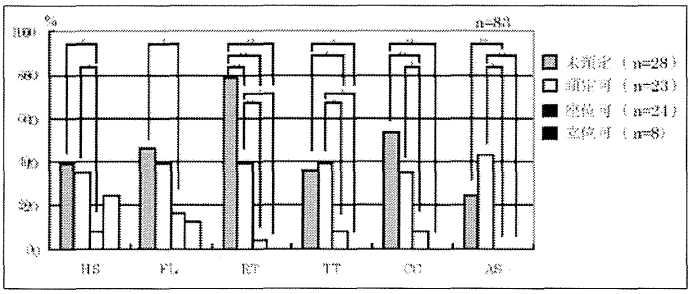

図2　脳性麻痺児における粗大運動発達程度別の摂食・嚥下障害の症状の出現率

管依存症」[12]、十分な栄養が経管から入るために経口から摂取した食物を嚥下しようとしない場合、嚥下機能が未発達な時期に経口からの無理な摂取によってむせや嘔吐などを繰り返した経験と推察される拒食、などに注意が必要である。

・**経管依存症**の場合は、過敏が強く、口腔内に食物を入れることさえ拒否され、機能検査が不可能な場合も多い。検査が可能な場合には、嚥下造影検査では機能が発揮されるにもかかわらず、チューブを指差して注入を要求し続けるなどの状態がみられる。

・**先天性食道閉鎖症**などは、出生直後の口腔咽頭領域の形態の異常や機能の遅れが認められないことが多いが、哺乳経験もほとんどないままに経管栄養となり、継続して経管のみによる栄養摂取の場合には、口腔咽頭領域の個々の動きが改善されても、口からの摂取経験がないために、口腔咽頭領域の触覚過敏によるムセや嘔吐など拒否が強く表出される。このような不快症状に加えて摂食時にどのように口腔・咽頭・喉頭部を動かすかの協調を経験(学ぶ)することができていないために、経口からの摂取が進まない場合も多くみられる[13]。

原疾患による長期の経管栄養の持続は、原疾患が改善されても、経管に固執して経口摂取を拒否する経管依存症状を呈する子どもも多い。このような小児の摂食・嚥下障害の障害特徴は、器質的な異常と機能的な発達遅滞に加えて、精神心理的な要因の関与が大きいことにある。対応としては持続的な脱感作などにより拒否を弱め、食事を受容できるような行動療法が必要となる。

機能の発達程度にかかわらず、摂食拒否が強い場合には、時として経口からの無理強いがみられるが、精神的な虐待なども疑われる場合もあることから、症状の注意深い観察評価と対応が望まれる。

4) 知的障害による摂食・嚥下障害とその対応

知的障害の摂食・嚥下障害は、摂食に関わる神経や筋に機能不全の原因があるのではなく、摂食時にどのように口唇・舌・顎などを協調して動かすことで目的とした摂食動作ができるかを学ぶ途上にあると考えられる。1～3歳の知的障害が主である幼児65名の摂食機能障害の初診時の症状と粗大運動発達程度との関連から、CP児に比較して、摂食機能の障害症状と粗大運動発達程度に関連が弱いとの報告[9]がある。発達期の知的障害児への摂食・嚥下障害における摂食機能療法では、誤嚥窒息などの予防を含めた直接訓練による食物処理に最適な口唇・舌・顎などの協調運動の訓練が対応の中心となる。

5) 広範性発達障害(PDD)による摂食・嚥下障害とその対応

自閉症スペクトラムの小児には、口いっぱいに食物を詰め込む、よく噛まないで丸飲みするなどの先行期や準備期・口腔期の障害がみられ、誤嚥や窒息の原因となることも多い。篠崎ら[14]は自閉症スペクトラムの幼児128名の調査から、その原因の多くが先行期障害であると報告している。また、この疾患に多くみられる摂取食物の極端な偏りは、栄養の偏りや丸呑みなどの準備期障害の原因ともなっているが、それまで食べていたものを拒否して食べられなくなる食品が非常に多くなる時期が2歳過ぎで、逆に4歳過ぎるとそれまで食べなかった多くの食物を食べるようになる場合が多いとも報告している。これらの疾患の特徴の一つである摂取食物の極端な偏りも、発育と共に大きな変化がみられ、家庭や療育担当者がその対応に苦慮されているところであるが、先行期障害である詰め込みや口腔期障害の丸呑みなどの機能症状についても発達変化が推察され、発育変化の予後を判断しながら、無理のない適切な臨床対応が望まれるところである。

【4. 嚥下障害の診断】

嚥下障害の診断法には、嚥下造影検査(VF)、嚥下内視鏡検査(VE)が有効であるが、これらの嚥下障害の検査では小児の協力が必要なため他の診断法に頼らざるを得ない場合が多い。比較的容易に対応可能な診断法としては、フードテスト、頸部聴診法など[4]がある。

1) フードテスト：プリンなどのテスト食を用いて嚥下後の状態の変化及びテスト食の口腔内残留程度から嚥下障害の程度を5段階に評価する[3]。

2) 頸部聴診法：食塊を嚥下する際に咽頭部で生じる嚥下音と嚥下前後の呼気音を頸部から聴診する。聴診部位は、甲状軟骨側面の皮膚上で最も呼気音が聴診しやすい部位が適当である。1)、2) の検査は併用する場合が多い。

【5. 小児の嚥下障害における栄養評価とその対応】

嚥下障害の小児における栄養必要量の推定は重要であるが、基礎代謝量とエネルギー消費量の算出は容易ではない。年齢や身長、体重から推定した基礎代謝量では多くの場合で誤差が大きく、日常生活内容に疾患や病態など個々の特徴を考慮して評価することが必要となる。

嚥下障害のあるCPの小児などでは、年齢、体重などが同程度でも筋緊張、不随意運動、努力性呼吸、咳き込み、などの症状の軽重や頻度によってエネルギー消費量は大きく異なる。栄養必要量を推定するための確立された方法はない現状では、身長、体重から推定される基礎代謝をもとに種々の活動量などを考慮して基礎代謝量の1.5倍前後から開始し、個々の症例毎に調整していく方法[15]がとられることも多い。

また経管栄養で摂食・嚥下リハビリテーションを行いながら経口摂取量を増加していく場合には、関節訓練によるエネルギー消費量、直接訓練による経口摂取の量などを考慮した経管からの栄養量、水分量の考慮も必要である。

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LETTER TO THE EDITOR

Antibiotic sensitivity of bacteria on the oral mucosa after hematopoietic cell transplantation

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We reported recently that bacterial substitution of mainly coagulase-negative staphylococci (CoNS) for streptococci occurred frequently on the oral buccal mucosa after hematopoietic cell transplantation (HCT), and other bacterial species not usually found in the normal flora were also identified [1]. We also reported that multidrug-resistant opportunistic bacteria appearing in the gingiva may be involved in fatal sepsis [2]. These observations prompted an interest in the antibiotic sensitivity of bacteria after HCT, which may explain the bacterial substitution on oral mucosa after HCT. Therefore, we performed a pilot study to determine the antibiotic sensitivity of bacteria on the oral mucosa after HCT.

We examined the antibiotic sensitivity of bacteria detected after HCT, focusing on the period from day 0 to 13, when the severity of clinically evident mucosal damage generally peaks and can cause bacteremia via the oral mucosa [3–5]. A total of nine consecutive patients (M, 4; F, 5; 47.3±11.0 years) receiving HCT at Okayama University Hospital were enrolled in this study. The diseases in these nine patients were as follows: acute myelogenous leukemia (n=3), myelodysplastic syndrome (n=1), and malignant lymphoma (n=5). Autologous HCT, conventional allogeneic HCT, and reduced-intensity HCT were administered to two (M, 2; F, 0; average, 61.0 years), five (M, 0; F, 5; 39.4±7.7 years), and two (M, 2; F, 0; average, 53.5 years) patients, respectively. Informed consent for examination of oral bacteria was obtained from each subject, and the Ethical Committee of Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences approved this study (no. 263). General infection control and oral management were performed as described in our previous report [1]. Briefly, fluoroquinolone for prophylaxis against bacterial infection was administered orally. Neutropenic fever was managed according to the guidelines of Hughes et al. [6]. A fourth-generation cephalosporin (e.g., cefepime) or carbapenem (e.g., meropenem) was administered intravenously as empirical antibiotic therapy.

Buccal mucosal swab samples were obtained from each patient twice with a 1-week interval from day 0 to +13. Samples were obtained about 2 h after breakfast by swabbing from the whole surface of the buccal mucosa. All samples were plated onto agar plates under aerobic conditions, and two to five major colonies that were visibly different from each other were collected. A total of 67 colonies were collected from nine HCT patients. Collected colonies were subjected to microbial identification and antibiotic sensitivity test. Identification of colonies thus obtained was performed using rapid ID 32 STREP API®, rapid ID 32 E API®, or ID 32 GN API® identification kits (Japan bioMérieux, Tokyo, Japan) according to the manufacturer's instructions. Due to the laboratory's capacity, almost all bacterial identification was limited to the genus level. Antibiotic sensitivity test was performed by the broth microdilution method, and the minimum inhibitory concentration was determined. Definitions of susceptibility, intermediate resistance, and resistance were made according to the National Committee for Clinical Laboratory Standards susceptibility testing guidelines for bacterial species.

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Abbreviations for antibiotics are as follows: PCG, benzylpenicillin; ABPC, amoxicillin; MPIPC, mecillinam; CVA/AMPC, clavulanate/amoxicillin; CCL, cefaclor; CDTR, cefditoren; CFPM, cefepime; CEZ, Cefazolin; CTM, cefotiam; CTX, cefotaxime; CZOP, ceftizoxime; CPR, cefpirome; FMOX, flomoxef; IPM/CS, imipenem/cilastatin; MEPM, meropenem; GM, gentamicin; CAM, clarithromycin; CLDM, clindamycin; MINO, minocycline; CP, chloramphenicol; and LVFX, levofloxacin.

A total of 38 *Streptococcus* spp. colonies were identified and subjected to sensitivity test for the following antibiotics: PCG, ABPC, CCL, CDTR, CFPM, CTM, CTX, CZOP, CPR, IPM/CS, MEPM, CAM, CLDM, MINO, CP, and LVFX. Of detected streptococcal colonies, 7.9–42.1 % were resistant or showed intermediate resistance to penicillins (PCG, ABPC) and cephems (CCL, CDTR, CFPM, CTM, CTX, CZOP, and CPR). Furthermore, 28.9–55.2 % of these colonies were also resistant or showed intermediate resistance to macrolides (CAM, CLDM). A total of nine CoNS spp. colonies were identified and subjected to sensitivity test for the following antibiotics: PCG, MPIPC, ABPC, CCL, CFPM, CEZ, CTM, CZOP, FMOX, IPM/CS, CVA/AMPC, and FOM. All of the CoNS detected after HCT showed resistance or intermediate resistance to CFPM (100 %), which was our first-choice antibiotic in empirical antibiotic therapy. CoNS also showed high degrees of resistance to penicillins (55.6–100 %), e.g., PCG, MPIPC, and ABPC. A total of two colonies of *Staphylococcus aureus* were identified and subjected to sensitivity testing; both colonies were methicillin-resistant *S. aureus* (MRSA). Sensitivity was limited to ABK, VCM, and TEIC only. One colony of *Pseudomonas* spp. was subjected to sensitivity test for the following antibiotics: ABPC, PIPC, CCL, CFPM, CEZ, CTM, CZOP, CAZ, CMZ, LMOX, IPM/CS, MEPM, AZT, GM, and AMK. This colony was resistant or showed intermediate resistance to ABPC, CCL, CFPM, CEZ, CTM, CMZ, LMOX, and AZT. This *Pseudomonas* spp. colony was sensitive to PIPC, CZOP, CAZ, IPM/CS, MEPM, GM, and AMK. Other bacteria identified were as follows: *Neisseria* spp. (n=9), *Corynebacterium* spp. (n=5), *Enterococcus* spp. (n=3), and *Haemophilus parainfluenzae* (n=2). All colonies were sensitive to most of the antibiotics tested.

The results of the present study indicated that there were many antibiotic-resistant bacteria in the oral cavity after HCT, especially during the period in which the severity of oral mucositis reached its peak. Oral mucositis could be a potential route of antibiotic-resistant infections. In our previous study, bacterial substitution mainly of CoNS for streptococci occurred frequently on the oral buccal mucosa after HCT [1]. High levels of antibiotic resistance in CoNS may explain bacterial substitution of CoNS for streptococci. On the other hand, streptococci with antibiotic resistance and/or intermediate resistance have also been detected at relatively high frequencies. Note that two colonies of MRSA and one colony of *Pseudomonas* spp. resistant to many types of antibiotic were detected. These observations are a reminder of the risk of appearance of MRSA and/or multidrug-resistant *Pseudomonas aeruginosa* (MDRP), and the oral cavity may be a site of MRSA and/or MDRP growth. Further studies regarding the association with bacteremia/sepsis by DNA fingerprinting will yield additional insight into the clinical relevance of the present findings. Examination of specific patient-related- or therapy-related risk factors for developing resistance may contribute to determination of personalized importance of oral care before and after HCT.

In conclusion, many antibiotic-resistant bacteria were detected in the oral cavity after HCT, especially during the period in which the severity of oral mucositis reaches its peak.

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Conflict of interest We have no conflicts of interest related to this study.

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Videoendoscopic assessment of swallowing function to predict the future incidence of pneumonia of the elderly

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SUMMARY **The purpose of the present study was to examine what dysphagic signs identified by videoendoscopy (VE) could predict the incidence of pneumonia and body weight loss in elderly patients living in nursing homes. This study was performed at six nursing care facilities in Japan from March 2007 to February 2009. The 148 subjects (85·1 ± 8·0 years, male/female: 43/105) were evaluated for their feeding and swallowing movements by clinical and VE examinations during the consumption of a regular meal. The VE examination items included the existence/absence of pharyngeal residue, laryngeal penetration, and aspiration of food and saliva. The patients were followed-up for 3 months with individualized feeding therapy based on the results of the clinical/VE examination at baseline, and the incidence of pneumonia was examined as the primary outcome. In patients without pneumonia, the body weight change was also measured as a secondary outcome. The risk factors for pneumonia and body weight loss (of 3% or more) were identified among the clinical/VE examination items by a Cox proportional hazard analysis. Even with elaborative feeding therapy, 12 (8·1%) of the 148 patients developed pneumonia during the 3 months follow-up period. The existence of signs of 'silent aspiration of saliva' or 'aspiration of saliva' detected by VE examination was a significant risk factor for both pneumonia and a body weight loss of 3% or more. This study shows that 'aspiration of saliva' detected by VE is a significant risk factor for both pneumonia and body weight loss in elderly patients living in nursing homes.**

KEYWORDS: **videoendoscopy, aspiration-related pneumonia, dysphagia, aspiration of saliva, body weight loss**

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Introduction

Dependent elderly patients are at high risk for feeding and swallowing disorders as a consequence of disease and/or aging (1–3). Studies done in long-term care facilities have shown a prevalence of such disorders ranging from 60% to 87% (4, 5). Among the various disorders, special attention has been given to dysphagia because it may lead to malnutrition with immune system compromise, dehydration, asphyxiation, or even aspiration pneumonia (1–3). Moreover, a previous follow-up study of patients with dysphagia in such care facilities revealed an incidence of pneumonia of 43% and a mortality rate of 45% at 1 year following the detection of their swallowing disorder (6). Therefore, clinicians should be able to identify dysphagia in order to predict those patients at risk of developing complications secondary to dysphagia, as well as to develop and implement a rehabilitation plan stressing prevention and compensation.

Videofluorography (VF) has been regarded as the most popular adjunctive instrument for the

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examination of patients with suspected oropharyngeal dysphagia. Previous studies have examined the use of VF as a means to predict those at risk for dysphagia and its complications (7, 8). For instance, Mann *et al.* (7) found that the single best independent predictor for chest infection following an acute stroke was a delayed or absent swallowing response in acute stroke patients. Teraoka *et al.* (8) found that the single best predictor of oral intake in post-stroke patients with dysphagia was the presence of aspiration detected by VF assessment. Nevertheless, one major disadvantage of VF for patients living in long-term care facilities is that the patients need to be transported to a hospital setting, which is sometimes inconvenient or may disorientate the patient because of the sudden change in the environment. Other disadvantages are related to the exposure to x-ray radiation and the risk of aspiration during VF assessment in some patients with severe physical or mental alterations (9).

On the other hand, videoendoscopic (VE) examination of swallowing allows for easy assessment of patients in their usual environment because the instrument is portable and does not require a radiology suite (10). Additionally, although VE is most useful for the examination of the integrity of the upper airway before and after a swallow response, it enables the evaluation of the tongue function during mastication and deglutition, as well as the detection of aspiration by the objective visualization of the airway (11, 12).

Videoendoscopic examination has been shown to successfully estimate the existence of accumulated oropharyngeal secretions, thus resulting in excellent prediction of aspiration (13, 14). In addition, Ota *et al.* (15) reported that the secretion scale based on the VE examination is a useful evaluation tool for predicting not only aspiration, but also pneumonia, in acute-phase dysphagic stroke patients. Furthermore, Link *et al.* (16) reported that there was a relationship between the VE-based pooled hypopharyngeal secretions, laryngeal penetration, aspiration and recurrent pneumonia with neurological disorders in pediatric patients. It is therefore evident that VE is the best tool to examine pooled hypopharyngeal secretions, laryngeal penetration, and aspiration. Therefore, even though the agreement rate between the VF and VE findings on dysphagia was shown to be high (90%) (17), VE examinations are becoming increasingly popular for examining the aspiration of saliva and food at the bedside and in long-term care facilities (17, 18).

In a prospective study with acute stroke patients, Lim *et al.* (19) found a strong association between aspiration detected by VE and the development of aspiration pneumonia. However, the predictors of aspiration pneumonia in dependent elderly patients with dysphagia in long-term care facilities have not been sufficiently investigated using VE. Therefore, the purpose of this prospective cohort study was to investigate whether the dysphagic signs identified by VE were risk factors for pneumonia and body weight loss in patients living in long-term care facilities.

Materials and methods

Subjects

Six hundred and forty-seven inpatients were initially identified from six nursing care facilities in Tokyo, Japan from March 2007 to February 2009 (Fig. 1). All patients, except for 28 subjects who were tube-fed, were screened for dysphagia by a check-list given to the patient's caregiver. The screening check-list contained 11 items: pooling of food, uncomfortable feeling in the throat, previous history of asphyxiation, previous history of aspiration, previous history of pneumonia, increased phlegm production, choking on saliva, choking on food, choking after a meal, prolongation of their eating time, and insufficient intake. The 171 patients who had at least one item checked positively by the caregiver were suspected to have dysphagia and comprised the intended sample population. However, 23 patients were excluded because of cognitive failure or refusal to participate in this study. Consequently, the final study population consisted of 148 patients (male/female: 43/105) with a mean age of 85·1 ± 8·0 years and an age range from 59 to 100 years. The protocol for this study was approved by the Ethics Committee of the Nippon Dental University School of Life Dentistry at Tokyo (#08-10).

Baseline measurements and feeding therapy

At the baseline measurement, a medical doctor assessed the patients' general health condition, and none of the patients fulfilled the Mann's criteria (7) for a diagnosis of pneumonia, that is, the presence of at least three of the following signs and symptoms: fever >38 °C, productive cough with sputum, tachypnea higher than 22 breaths per minute, inspiratory crackles,

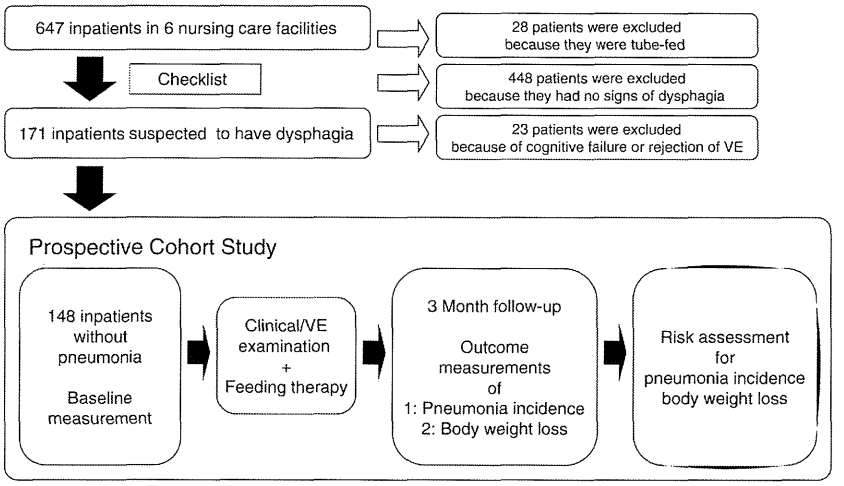

Fig. 1. The sampling process used for this study.

an abnormal chest x-ray, or positive gram staining and cultures.

All included subjects had their eating ability and dysphagic signs and symptoms evaluated clinically according to a clinical examination form regarding the signs and symptoms of dysphagia (spilling food, pooling food, oral food residue after a swallow, inability to open the mouth, choking/coughing, increased phlegm while eating, dyspnea, wet hoarseness, other), the hand and mouth coordination during the meal (feeding posture, prolongation of eating time) and the caregiver's technique used for feeding assistance.

In addition, each patient's swallowing function was examined by VE, which consisted of a flexible endoscope (ENF-V2*) connected to a high-intensity compact light source (CLH-SC*) and a video recorder (OTV-SC*).The endoscope was passed transnasally to the hypopharynx at a vantage point that provided a full view of the laryngeal vestibule, and was kept in place for a period of 10–15 min to assess the patient's eating ability, or saliva swallows when the patient was not consuming a meal. The patients were examined in their usual eating position, that is, the ambulatory patients were seating in the upright position, while the bed-bound patients were sitting on a bed. All swallows were recorded on videotapes for the further analyses by experienced physicians familiar with endoscopic swallowing studies and who were blinded to the intentions of the study. Each patient's video-recording data were reviewed for the presence or absence of pharyngeal residue, and penetration and aspiration of food or saliva. 'Penetration' was defined as a passage of material into the larynx that does not pass below the vocal folds, while 'aspiration' was defined as passage of material below the level of the vocal folds. In cases where the aspiration of food or saliva did not induce a cough, it was defined as 'silent aspiration' according to the criteria proposed by Rosenbek *et al.* (1996) (20). To assess the inter-rater reliability of the swallowing evaluations, the three investigators who were unaware of the original evaluation results, separately reviewed a random 10% sample of these evaluations. The overall agreement rate between investigators was substantial according to the Landis and Koch criteria (21) (kappa coefficient = 0·660).

On the basis of these aforementioned evaluations, the patients received various feeding therapies (22) during the follow-up period, for example, confirmation of feeding conditions [76 patients (51·4%) of 148 patients, multiple answers possible], appropriate feeding assistance [69 patients (46·6%)], food modification [32 patients (21·6%)], modification in feeding posture [19 patients (12·8%)] and modification in food intake [four patients (2·0%)] for 3 months. Food modification involved changing the dietary consistency. We modified the food and liquid texture individually according to the National Dysphagia Diet recommendations (23). Food intake and feeding assistance required modifications to accommodate the individual needs of the patients, such as changes in the rate and amount of the food consumed, appropriate utensils and the

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method used for self-feeding (22). Modifications in the feeding posture were applied in order to maximize the physical capabilities and improve swallowing, and involved strategies such as head-turn or chin-tuck maneuvers or whole body-positioning strategies including the patient tilting to the side or back, side-lying, or maintaining an upright posture (22). All patients received oral health care after every meal by the caregiver who was instructed once a week about the oral care procedures by a dental hygienist. Caregivers cleaned each patient's oral cavity using a toothbrush for approximately 5 min after each meal. The brushing was carried out as usual for daily tooth brushing without paste, and included brushing the palatal and mandibular mucosa and tongue dorsum. Dentures were also cleaned with a denture brush every day.

The 3 month follow-up and outcome measurement

The first outcome variable after 3 months of follow-up was the incidence of pneumonia diagnosed according to the same criteria applied at the baseline measurement. Once the patients received a diagnosis of pneumonia, they were sent to a local hospital for treatment, without exception. Consequently, their oral feeding was prohibited to prevent further aspiration pneumonia and their body weight typically decreased as a result (24). The incidence of pneumonia and body weight loss were therefore strongly correlated after the development of pneumonia. Thus, when pneumonia was identified, follow-up measurements of the patient's body weight were terminated.

The second outcome variable during the follow-up period was a change in body weight demonstrated by monthly measurements. Since there is a close relationship between pneumonia and body weight loss, the incidence of body weight loss of 3% or more was examined in patients who had not been diagnosed with pneumonia during the 3 months of follow-up. Once the patients developed a body weight loss of 3% or more, the patients received some form of nutrition therapy, and thus, the follow-up observation was terminated.

Statistical analysis

A survival curve of the patients who had not been diagnosed with pneumonia was drawn for a Kaplan–Meier analysis. According to the presence/absence of pneumonia during the 3 months of follow-up, we divided the final sample population into pneumonia and non-pneumonia sub-groups, and performed a *t*-test, chi-square analysis or Fisher's exact test to analyse the differences between the two groups.

Similarly, a survival curve of those patients who had not lost more than 3% of their body weight was drawn for a Kaplan–Meier analysis (outcome event: the incidence of body weight loss of 3% or more). Differences between the weight gain/no change sub-group (body weight gain, or a small weight loss of no more than 3% of the initial body weight) and the weight loss group (body weight loss of 3% or more (10, 25)) were analysed with the same statistical tests utilized for the incidence of pneumonia.

Additionally, a Cox proportional hazard analysis was performed to identify the risk factors for the incidence of pneumonia and the body weight loss of 3% or more. The analysed predictors were age, self-feeding ability, the Barthel activities of daily living (ADL) index, a body mass index (BMI) lower than 18·5, pharyngeal residue, laryngeal penetration, aspiration of food and aspiration of saliva. Regarding the aspiration of food or saliva, the data were handled as ordinal variables (negative, positive, positive as silent aspiration). The data were analyzed with the Statistical Package for the Social Sciences software program (SPSS version 15.0†). A *P*-value <0·05 was considered to be statistically significant.

Results

Baseline condition of the patients

Examination of the medical conditions of the initial 148 patients showed the presence of a prior stroke in 83 (comorbidity admitted) (56·1%), dementia in 74 (50·0%), Parkinson's disease in 10 (6·8%), cardiovascular disease in 10 (6·8%), hypertension in 8 (5·4%), previous pneumonia in 5 (3·4%), diabetes mellitus in 3 (2·0%), fractures in 3 (2·0%) and other comorbidities in 14 patients (9·5%).

The clinical examination regarding the eating ability and signs and symptoms of dysphagia before the VE evaluation showed choking/coughing in 110 out of 148 patients (multiple choice admitted), pooling of food in 28, prolongation of the eating time in nine, inability to

†SPSS Japan Inc., Tokyo, Japan.

open the mouth in two, and spilling of food in one patient.

The VE evaluation detected pharyngeal residue in 97 (65·5%) out of the 148 patients, laryngeal penetration in 67 (45·3%), aspiration of food in 41 (27·7%), silent aspiration of food in 19 (12·8%), aspiration of saliva in 8 (5·41%), and silent aspiration of saliva in 10 (6·76%) patients (Table 1).

Risk factors for pneumonia and body weight loss

Even with elaborative feeding therapy, during the 3 months of follow-up after the baseline measurement, 12 (8·1%) of the 148 patients developed pneumonia (Fig. 2). In addition, among the non-pneumonia patients, 90 (66·2%) of them presented with weight gain, no change or weight loss of 3% or less (weight gain/no change group), while 46 patients (33·8%) lost 3% or more of their body weight (weight loss group) (Fig. 3).

The differences between the pneumonia and non-pneumonia groups concerning the clinical/demographic data and the dysphagic signs detected by VE are shown in Table 1. The unpaired *t*-test showed that there were no significant differences in the patient age ($P = 0·505$), gender ($P = 0·244$), self-feeding ability ($P = 0·419$), number of patients with a BMI lower than 18·5 ($P = 0·190$), and the Barthel Index ($P = 0·060$) between the subjects with and without pneumonia. On the other hand, there was a significant difference in the frequency of 'aspiration of saliva' between the pneumonia and non-pneumonia patients ($P = 0·026$). In contrast, a comparison between the body weight gain/no change and body weight loss groups showed that there were no significant differences concerning any of the analysed variables (Table 2).

The results of the Cox proportional hazard analysis revealed that a sign of the 'aspiration of saliva' detected by VE was a significant risk factor for pneumonia (Table 3) and for a body weight loss of 3% or more (Table 4).

Discussions

The presence of aspiration-related pneumonia is known to be associated with a high mortality rate in the elderly. Patients in nursing homes may have a higher incidence of pneumonia because of their multiple underlying diseases, which may lead to immunosuppression, excessive use of medications, generalized decreased functional status, as well as factors related to malfunctioning of the masticatory and orophraryngeal systems and inadequate oral care. In particular, dysphagia is known to be strongly associated with aspiration pneumonia. Teramoto *et al.* (26). reported

Table 1. The relationship between the clinical/VE signs and the incidence of pneumonia

	Total subjects	No pneumonia ($n = 136$)	Pneumonia ($n = 12$)	*P*-value
Age (mean ± s.d.)	148	85·0 ± 8·1	86·8 ± 5·4	0·505†
Male/female	148	38/98	5/7	0·244††
Self-feeding (yes/no)	148	47/89	5/7	0·419††
Barthel Index (mean ± s.d.)	116*	13·1 ± 18·1	7·2 ± 7·12	0·060†
BMI < 18·5**	118**	43/110 (39·1%)	5/8 (62·5%)	0·190††
Pharyngeal residue	148	88 (64·7%)	9 (75·0%)	0·354††
Laryngeal penetration	148	62 (45·6%)	5 (41·7%)	0·519††
Aspiration of food	148			0·326††
Silent aspiration	19	19	0	
Aspiration	41	38	3	
NA	88	79	9	
Aspiration of saliva	148			0·026††
Silent aspiration	10	7	3	
Aspiration	8	7	1	
NA	130	122	8	

*Of 116 patients, 107 were in the no pneumonia group and nine were in the pneumonia group.
**Of 118 patients, 110 were in the no pneumonia group and eight were in the pneumonia group.
†*T*-test.
††Chi-square test.

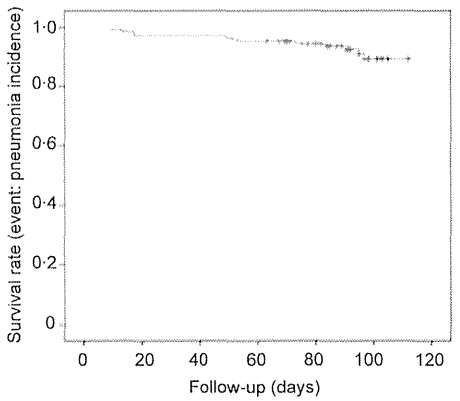

Fig. 2. The survival curve of the patients who did not suffer from pneumonia. The survival curve was drawn for a Kaplan–Meier analysis (outcome event: incidence of pneumonia).

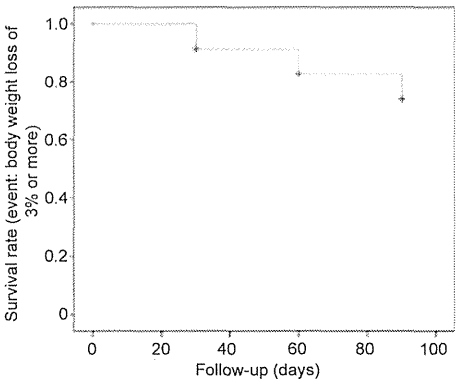

Fig. 3. The survival curve of the patients who did not suffer from a body weight loss of 3% or more. The survival curve was drawn for a Kaplan–Meier analysis (outcome event: incidence of body weight loss of 3% or more).

that 70% of the pneumonia in the elderly occurred due to aspiration, and Yamaya *et al.* (27). reported a high prevalence of silent aspiration in older persons leading to the deterioration of swallowing function due to cerebrovascular disease. In a previous study, Doggett *et al.* (28) estimated that approximately 43–54% of stroke patients have dysphagia and aspiration of food or saliva, and that approximately 37% of these patients would develop aspiration-related pneumonia.

In this present study, penetration and aspiration (apparent or silent) was observed in 67 subjects (45·2%) and 60 subjects (40·5%), respectively. The prevalence of aspiration found in this investigation was relatively high compared to previous studies utilizing VE examination (29%) (29), but was similar to the range observed in a previous review article where it was reported to occur in 15–39% of subacute dysphagic stroke patients (30). According to this review, the exact prevalence of aspiration remains unknown because of the differences in the size and methodology used in the existing studies.

The incidence of pneumonia was 12 (8·1%) among the 148 subjects (Table 1), which is in accordance with the study by Lim *et al.* (19), who reported that five patients (10%) developed pneumonia during their inpatient stay, and that all of them were at risk of aspiration of saliva or food as determined by a VE examination. On the other hand, Croghan *et al.* (6) reported that 55% of their nursing home patients presented with aspiration on VF examination, and 43% developed pneumonia.

One possible reason for such a discrepancy in the association of pneumonia and aspiration or penetration could be due to the technique (VE vs. VF) utilized to assess the swallowing disorders. Although a number of methods have been used to detect the symptoms of dysphagia, it is very difficult to evaluate 'silent aspiration of saliva' with a bedside clinical assessment alone, because it has been shown that it is missed in up to 40% of the patients aspirating silently (31, 32). At present, VF and VE are regarded as the best methods to evaluate swallowing function. In particular, VF has been used as a gold standard to evaluate swallowing because it can detect aspiration. However, it may not be as accurate in identifying 'silent aspiration of saliva', as compared to VE, because the latter enables direct visualization of the aspiration of saliva (18, 33, 34). Kelly *et al.* (35) reported that penetration and aspiration are perceived more sensitively in VE images than in VF images of the same swallows. It is also well known that VE can identify the microaspiration and aspiration of secretions with a high reliability, whereas VF cannot (36, 37). Additional advantages of VE are related to its application. Inpatients may become agitated or fatigued in the radiology suite or may not respond well to the taste of barium-coated boluses, or may even reject the radiation exposure, limiting the applications of VF. Videoendoscopy allows the patient's examination to be performed regardless of his/her altered mental status or immobility (38). Finally, Wu *et al.* (39) stated that VE is conclusively a safe, more efficient and sensitive method than VF for evaluating swallowing.

Another reason for the discrepancy could be the effect of the feeding therapy provided in this study, which could have reduced the symptoms of dysphagia,

Table 2. The relationship between the clinical/VE signs and the change in body weight

	Total subjects	Gain/no change (n = 90)	Weight loss (n = 46)	P-value
Age (mean ± s.d.)	136	84·6 ± 8·0	85·7 ± 8·6	0·464†
Male/female	136	25/65	13/33	0·553††
Self-feeding (yes/no)	136	29/61	16/30	0·454††
Barthel Index (mean ± s.d.)	107*	14·9 ± 18·7	9·6 ± 17·0	0·163†
BMI < 18·5	110**	30/74 (40·5%)	13/36 (36·1%)	0·655††
Pharyngeal residue	136	61 (67·8%)	27 (58·7%)	0·294††
Laryngeal penetration	136	44 (48·9%)	18 (39·1%)	0·2797††
Aspiration of food	136			0·975††
Silent aspiration	19	13	6	
Aspiration	38	25	13	
No aspiration	79	52	27	
Aspiration of saliva	136			0·342††
Silent aspiration	7	4	3	
Aspiration	7	3	4	
No aspiration	122	83	39	

Weight loss was diagnosed as the loss of 3% or more of the body weight from the baseline measurement.
*Of the 107 patients, 72 were in the gain/no change group and 35 were in the weight loss group.
**Of the 110 patients, 74 were in the gain/no change group and 36 were in the weight loss group.
†T-test.
††Chi-square test.

Table 3. The results of the Cox proportional hazard analysis for the possible predictors of the incidence of pneumonia

Predictors	B	P-value	HR	95% CI
Age	0·011	0·860	1·011	0·900–1·135
Self-feeding	0·105	0·909	1·111	0·182–6·785
Barthel Index	−0·010	0·769	0·990	0·927–1·057
BMI < 18·5	2·064	0·070	7·874	0·844–73·440
Pharyngeal residue	−0·621	0·615	0·537	0·048–6·067
Laryngeal penetration	0·571	0·642	1·771	0·160–19·644
Aspiration of food (negative/positive/ positive with SA)	−0·216	0·830	0·805	0·112–5·794
Aspiration of saliva (negative/positive/ positive with SA)	1·290	0·025	3·634	1·174–11·242

HR, hazard ratio; CI, confidence interval; SA, silent aspiration.

Table 4. The results of the Cox proportional hazard analysis for the possible predictors of a body weight loss of 3% or more

Predictors	B	P-value	HR	95% CI
Age	0·019	0·448	1·019	0·971–1·070
Self-feeding	0·530	0·228	1·698	0·718–4·014
Barthel Index	0·000	0·992	1·000	0·976–1·025
BMI < 18·5	0·859	0·032	2·362	1·074–5·191
Pharyngeal residue	−0·060	0·896	0·942	0·381–2·325
Laryngeal penetration	0·019	0·970	1·019	0·374–2·780
Aspiration of food (negative/positive/ positive with SA)	−0·203	0·569	0·816	0·405–1·644
Aspiration of saliva (negative/positive/ positive with SA)	1·186	0·000	3·275	1·828–5·866

HR, hazard ratio; CI, confidence interval; SA, silent aspiration.

pharyngeal residue, laryngeal penetration, and aspiration of food, as demonstrated by the fact that 66% of the subjects were able to increase their body weight or keep the body weight loss to within 3%. Nevertheless, a detailed analysis of the effectiveness of feeding therapy on the reduction of the symptoms of dysphagia could not be performed, because it was beyond the scope of this study.

Additionally, the differences in the target populations and their respective medical conditions could also have affected the overall incidence of pneumonia. This study gathered a heterogeneous patient population consisting of patients presenting with well-known disorders/diseases associated with the symptoms of dysphagia (e.g. stroke, Parkinson's disease, dementia) as well as other non-debilitating diseases/disorders (hypertension, fractures). On the other hand, a strong point in this study was the inclusion of a relatively high number of subjects from six nursing care facilities, which was large compared to other follow-up studies. Therefore,

the incidence of pneumonia may have been relatively lower in such a large heterogeneous study sample.

Regarding the risk factors associated with the development of pneumonia, some of them were reported to be age, primary disease, consciousness disorders, nutritional status, poor ADL, poor oral status, and swallowing dysfunction (40, 41). In the present study, among the analysed predictors, the 'aspiration of saliva' detected by VE was the only significant risk factor for pneumonia. In cases of bad oral health, saliva contains numerous bacteria. Therefore, patients with silent aspiration of saliva (without a cough reflex) are aspirating bacteria, which may be the main factor responsible for increasing the risk of pneumonia.

Additionally, even with the elaborative feeding therapy provided in this study, the control of aspiration of saliva or silent aspiration of saliva was generally difficult. In the present study, there was also a tendency for there to be a higher incidence of pneumonia in poor ADL patients. Langmore *et al.* (42) also reported that severely dependent functional status was an especially potent predictor of aspiration pneumonia. Riquelme *et al.* (40) reported that there was a significant relationship between the ADL and mortality rate. It was also observed that patients with a BMI < 18·5 had a higher tendency to develop pneumonia ($P = 0{\cdot}070$) compared with those with a poor ADL ($P = 0{\cdot}769$). It is well known that a lower nutrition condition affects the host immunological function, thus making the subjects more susceptible to pneumonia (43).

On the other hand, aspiration of saliva was also detected as a significant risk factor for body weight loss in this study. This finding could be explained by the possible presence of subclinical aspiration-related pneumonia in those subjects with a body weight loss of 3% or more.

The overall findings in this study demonstrated that it is still very difficult to prevent aspiration of saliva even if physicians provide elaborative feeding therapy and even if patients do not eat and drink anything through the mouth. Effective strategies to prevent the silent aspiration of saliva will therefore be an important target for future research.

Conclusion

The results of this study showed that, even with elaborative feeding therapy, 'aspiration of saliva' as detected by videoendoscopic examination was found to be a significant risk factor for pneumonia and a body weight loss of 3% or more in elderly patients living in nursing homes.

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