01 口腔機能

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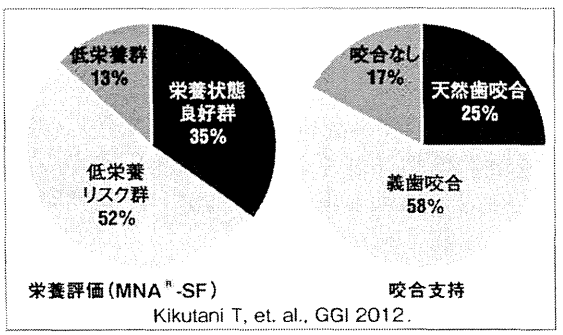
舌の評価とサルコペニア

⊙低栄養と口腔の問題

8020運動をはじめとする歯科保健の推進によって、高齢者においても多くの歯を保持する者が増加している。とはいえ、多くの高齢者が歯の喪失によって咬合支持の崩壊を招いている。著者らが平成22年に行った調査では[1]、在宅療養中の高齢者(716名、平均年齢83.2歳)の75%が天然歯による咬合支持を失っており、そのうち3分の1が義歯によっても回復されることなく咬合支持の崩壊状態であった(**図1**)。咬合支持が維持されていなければ、食事摂取が困難になることが容易に想像でき、年齢、性別、ADL、認知機能など低栄養と関連を示すほかの因子を調整してもなお、咬合支持が維持されている者に対し、咬合支持の崩壊した者の低栄養リスクは有意に高かった(義歯咬合支持維持群:1.7倍、咬合崩壊群3.19倍)(**図2**)。さらに、食物の窒息事故の問題も深刻である。この事故による死亡は不慮の事故の中でもっとも多く、年間5000人を超えるという。介護老人福祉施設で行った私たちの調査においては、そのリスク因子として示されたものは、認知機能の低下などとともに、咬合支持の状態が挙げられた。咬合支持が維持されている者に対し、咬合支持の崩壊した者の窒息リスクは有意に(咬合崩壊群:1.75倍)高いことが示された(**図3**)[2]。

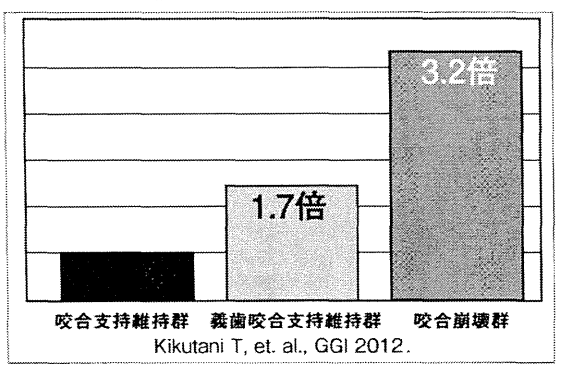
このように、高齢者に見られる歯の欠損は咀嚼障害を招き、低栄養につながる。さらには、窒息の危険といった問題にも、高齢者の歯の欠損と欠損状態の放置がある。高齢者医療における歯科との連携は重要である。

図1 咬合支持と栄養状態



在宅療養中の高齢者のうち75%が天然歯による咬合支持を失っており、そのうち3分の1が義歯によっても回復されることなく咬合支持の崩壊状態であった

図2 低栄養リスクと咬合支持の関係

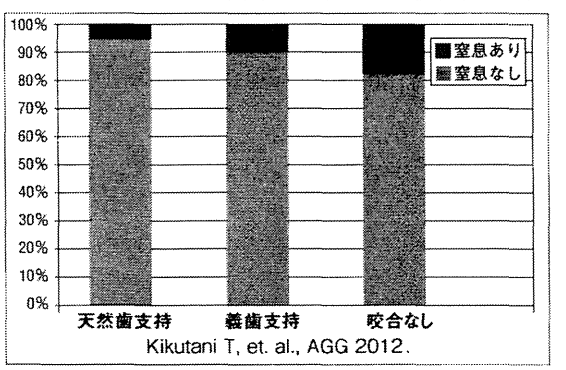


咬合支持の崩壊した者の低栄養リスクは咬合支持を維持している者に比して3.2倍を示した

⊙口腔に見られるサルコペニア

サルコペニアの原因や病態については他項にゆずるが、口腔は、口唇や頬、軟口蓋といった筋によって成り立つ器官に囲まれ、さらに、中

図3 2年半の追跡期間中に発症した窒息事故の割合



咬合支持の崩壊した者の窒息リスクは、維持している者に比して1.8倍高かった

央には舌という筋の塊が鎮座し、これを構成している。咀嚼は左記に示したような歯の役割が大きいが、一方で、食物を捕食し、歯によって構成される咀嚼面に食物を運び保持し、咀嚼後に咽頭に送り込むといった食物を口腔内で移動させているのは筋の役割である。全身の筋量の低下に伴い、さらには、口腔の運動が十分に行われないと口腔内の筋肉量が低下し、筋量もあわせて低下する。いわば、口腔のサルコペニアといった状態である(**図4**)。私たちは、口腔のサルコペニアの指標として舌の筋量や舌の筋力について検討している。

図4 舌に見られるサルコペニア

口腔の筋肉量の減少、ひいては筋力の減少が咀嚼障害、嚥下障害をもたらす

◉舌の筋量はどのように減少するのか?

加齢に伴い舌の筋量は低下するのか? この疑問に答えるために、健康高齢者を対象に各年齢層の舌の厚みを測定した。その結果、年齢層によって相違は認められなかった[3]。一方、舌の運動の力である口蓋への押しつけ圧(舌圧)は、年齢によって徐々に低下することが知られており、加齢による影響を受けることがわかる。しかし、舌圧の著しい低下は特に75歳以上に認められ、75歳未満まではその低下の程度は緩やかである(**図5、6**)[4]。下肢などの骨格筋の場合、筋量と筋力は相関を示す。しかし、舌の場合には、筋量と筋力との相関は認められない。さらに、下肢をはじめとするほかの骨格筋量との相関も認めない。これは、舌は口腔という口蓋と下顎に囲まれた固有口腔という空間に存在していることが原因と考えられる。一方、要介護高齢者に対する検討においては、舌の筋量と筋力が相関を示す。さらに、舌の筋量は全身の筋肉量の指標と相関を示し、全身のサルコペニアとの関連が示唆される(**図7**)[5]。また、嚥下障害を有する者は舌圧が有意に低いことが

図5 年齢と最大舌圧との関係(男性)

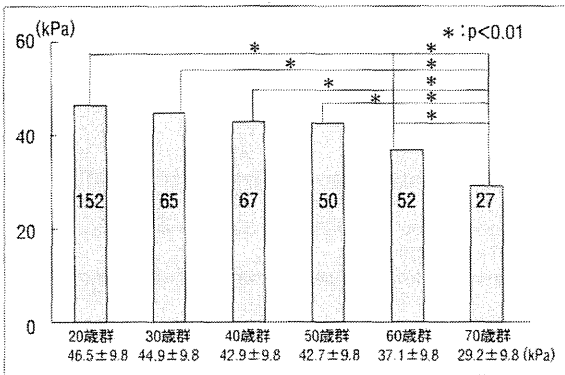
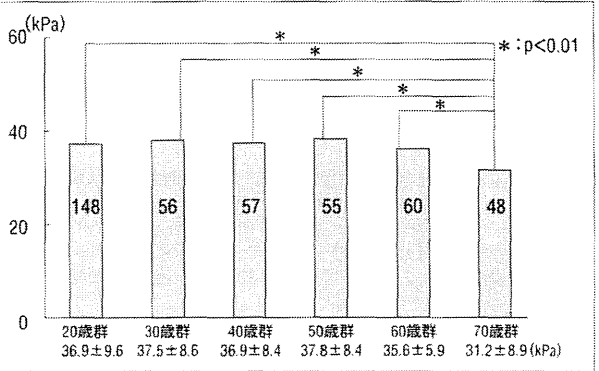


図6 年齢と最大舌圧との関係(女性)



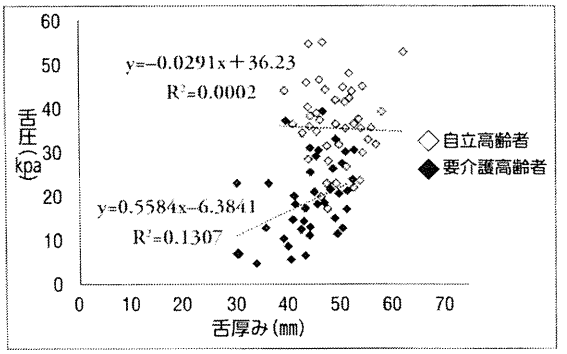
健康高齢者の場合、舌圧の低下は特に75歳以上に認められ、75歳未満まではその低下の程度は緩やかである

示されており（**図8**）[6]、舌に見られるサルコペニアはほかの骨格筋に見られるサルコペニアとは若干異なる病態を示すが、要介護高齢者においては骨格筋同様減少を示し、嚥下障害などとの関連も示唆されると言える。

◎全身のサルコペニアと口腔のサルコペニアの関連

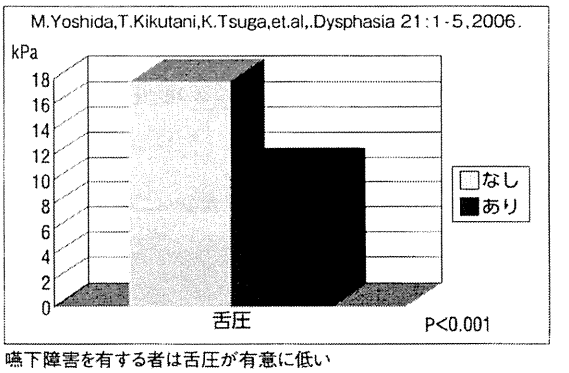
全身の筋肉の減少は、筋力の低下にもつながり、身体機能の低下を招く。筋肉は身体の中でも体熱を多く産生する重要な器官となる。すなわち、筋肉が衰えると、基礎代謝量が減少し、エネルギーの消費量の低下を招く。これは、不十分な栄養摂取につながり、体たんぱく質の合成を低下させ、サルコペニアを取り巻く「負のスパイラル」を形成する。全身のサルコペニアに伴って口腔のサルコペニアが生じると、咀嚼機能や嚥下機能に悪影響を与え[7]、摂取量の低下を招き、口腔のサルコペニアが全身のサルコペニアに拍車をかけることになる。そこで、口腔のサルコペニア対策として、口腔にレジスタンス運動を負荷することで、口腔機能の改善を図り、全身のサルコペニアの負のスパイラルを断ち切ることができるのではないかと考えている（**図9**）[8]。

図7　舌厚みと舌圧の相関・自立高齢者と要介護高齢者



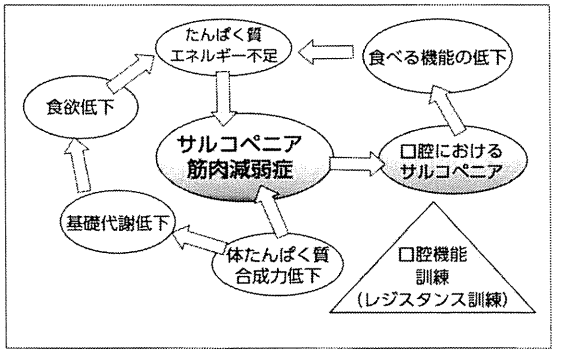
要介護高齢者においては舌の厚み（筋量）と舌圧（筋力）が相関を示す

図8　舌圧と嚥下障害の関係



嚥下障害を有する者は舌圧が有意に低い

図9 全身に見られるサルコペニアと口腔のサルコペニア



口腔へのレジスタンス運動はサルコペニアの負のスパイラルを断ち切ることを目的としている

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口から食べる幸せの実現に向けて

今、私たちができること、やるべきこと

9月19日、日本摂食・嚥下リハビリテーション学会のホームページにて、「嚥下調整食学会分類2013」が発表された。
これにより、急性期から在宅まで、嚥下調整食の物性について、共通の「ものさし」ができたことになる。
在宅療養者の経口アプローチへの道が大きく開かれた今、「食」にかかわる専門職が果たすべき役割とは何か?
3人の専門職の方々に話し合っていただいた。

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きくたに・たけし◎1988年、日本歯科大学歯学部卒業。89年、同歯学部附属病院高齢者歯科診療科入局。2001年、同附属病院口腔・リハビリテーションセンターセンター長に就任。05年に准教授、08年に教授に就任。12年から現職

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摂食嚥下療法部 部長

こやま・たまみ◎1978年、国立病院機構熊本医療センター附属看護学校卒業。同年、神奈川県立総合リハビリテーション事業団神奈川リハビリテーション病院看護部に入職。95年、同事業団七沢リハビリテーション病院脳血管センター看護師長に就任。2006年、東名厚木病院摂食嚥下療法部課長、13年に同部長に就任

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在宅NST 訪問管理栄養士

もりた・ちかこ◎石川県の給食受託会社に就職し、結婚後、子育てをしながら国家試験を受験して管理栄養士資格を取得。その後、介護老人保健施設の管理栄養士、居宅のケアマネジャー、有料老人ホームの管理栄養士の経験を経て、2014年4月よりフリーランスとして独立。東京都や神奈川県を中心に各業界と契約し活動中

急性期の段階で入院即日に介入する

――まず、皆さんの所属施設の特徴と業務内容についてお聞かせください。

菊谷　昨年まで日本歯科大学附属病院で歯科医として勤務していました。そこでは口腔リハビリテーションセンターで摂食・嚥下障害の方々を対象とした外来を担当していたのですが、昨年10月に東京都小金井市に口腔リハビリテーション多摩クリニックを設立し、以後はそこで外来と訪問歯科診療を行なっています。

小山　当院は267床の急性期病院です。地域医療支援病院であり、救急搬送されてくる方が多いのが特徴です。当院に入職した7年前、救急搬送されてきた方々が、静脈栄養のチューブにつながれたまま、まったく経口アプローチされていない状況を目にして、悲壮な心情を抱きました。そうした患者さんたちの口腔ケアや摂食・嚥下訓練などを行なっていきながら、成功事例を細々と積み上げてきました。結果、口から食べられるようになって早期に退院する患者さんが増え、肺炎の発症率も低減しました。こうしたアウトカムを示したことで、現在では摂食嚥下療法部として、手術部や看護部、救急部などと同じく独立した組織として院内に位置づけられています。

森田　当会は「安心して最期まで自宅で生活できる」という当たり前のことを実現するために24時間対応、機能強化型の在宅療養支援診療所を展開しています。今年4月に在宅NSTを立ち上げ、医師、歯科医師、歯科衛生士、理学療法士、管理栄養士が同じ法人内で連携して活動しています。

――小山先生が口腔ケアと摂食・嚥下訓練を行なうことで肺炎が減ったとおっしゃいましたが、食べられるようにアプローチすることで誤嚥性肺炎は低減するということですね。

小山　そのとおりです。経口アプローチの結果、誤嚥して肺炎になるよりも、口腔ケアなどをまったく行なわず放置した結果、乾燥などによって口腔内に雑菌が繁殖し、それが肺炎の原因になるほうがはるかに多いと言えるでしょう。事実、当院では7年前、入院中に肺炎を発症する患者さんは15%もいたのですが、リスクの管理を行ないながら積極的な口腔ケアや早期経口摂取の開始などを行なった結果、2年間で2%にまで低減しました。また、それ以前は経口摂取再開までに2～3週間かかっていましたが、約1週間にまで短縮できました。結果、脳梗塞患者さんの場合（死亡された方を除いて）、92%が3食経口摂取可能、95%が何らかの経口摂取可能となって退院しています。50日近くあった脳梗塞患者さんの平均在院日数も30日くらいにまで短くすることができました。

――摂食嚥下療法部は具体的にどのような形で介入するのですか？

小山　急性の症状が進行し、やむを得ず絶飲食が必要な場合以外には基本的に、入院当日に医師から摂食機能療法の指示が出ます。それを受けて当部では、その日のうちに主治医と調整しながら摂食嚥下機能評価をし、可能であればすぐに経口摂取を試みます。意識レベルがジャパン・コーマ・スケール（以下、JCS）でⅢ桁レベルや消化管に問題がある方などは、径の細い

撮影＝関口宏紀

食べることで生きる希望がつながることがあります。在宅ならではのそんな感動をぜひ共有してほしいですね。

経鼻胃管を留置して栄養管理を行ないます。そのうえで、循環動態をモニタリングしながら口腔ケアと口腔周囲筋・嚥下筋群の基礎訓練、呼吸ケアを実施し、症状の改善を待ってタイムリーに再評価します。JCSでⅡ桁レベルに上がれば、上体を起こして覚醒をうながし、嚥下食ピラミッドのレベル0のゼリーをスライス法で食べていただきます。そして、朝にゼリーを1個食べられたら、昼には3個。次の朝にまた評価して問題がなければ、ゼリーにお粥ゼリーを付けるなど、1食～1日ごとにレベルを上げていきます。

――1食が勝負というわけですね。

小山　とにかくできるだけ早期にチューブ類を抜いて、患者さんから生活者に復帰していただくこと。それが私たちの使命です。そのためには咀嚼・嚥下機能もそうですが、呼吸機能、手足などの身体機能においても、動かせるところはできるだけ動かし、廃用による心身の機能低下をさせないことが大事です。

在宅へとつなぐ食べる幸せの輪

菊谷　小山先生は1食たりとも放置せず、経口アプローチを行なうとおっしゃいましたが、在宅では1食どころか、何年間も経口アプローチが行なわれない状態で放置されているような方ばかりです。

――なぜそのような状態の方ばかりになるのですか？

菊谷　一般に急性期の病院では末梢静脈栄養で管理しています。短い在院日数のなかで退院にあたって口から食べられないとなると、患者さんとそのご家族は胃ろうを造設するかどうかの判断を迫られます。末梢静脈栄養のエネルギー投与量には限界があり、いつまでももつものではない。このまま食べられなければ2、3週間で亡くなる可能性もある。そうなると、とりあえず胃ろうを造設するしかないからです。しかし、多くの高齢者施設は、胃ろうの方を受け入れていません。結果、療養型病院に移るか、介護力のある家ならば在宅で暮らすことになります。しかし、今は食べられないとしても、その後の嚥下機能評価や嚥下訓練をどうするのか？　その指示がまったくないまま、胃ろうの方々は地域の中で漫然と、経腸栄養管理下で口から食べることなく暮らしている状況にあるのです。

――そのような方たちに対し、菊谷先生はどのような方法で介入されているのですか？

菊谷　病院では言語聴覚士や摂食・嚥下障害看護認定看護師がいて、入院患者さんの経口アプローチを行なっていても、退院後のフォローアップまで行なっている施設は多くありません。これまで、私たちは、近隣の病院に入院する方や、在宅療養中の患者さんに経口アプローチをしてきました。それが実を結び、最近は病院で胃ろうを造設された方々や嚥下障害をもったまま退院する方の退院前カンファレンスに呼ばれるようになってきたのです。また、当院の近所には在宅療養支援診療所が多々あって、そこの医師が在宅訪問歯科診療の依頼をしてくれるようになりました。

小山　当院でも外来患者さんの受け入れをしていますし、退院患者さんのフォローアップの必要性を痛感しています。気になる退院患者さん

食べられるようになるとおいしく食べる幸せの笑顔が生まれます。生活者として生きる喜びと幸せをサポートしたいと思っています。

がいれば、訪問看護でサポートしますし、9～21日間での摂食嚥下評価入院というサービスも始めました。

森田　私の契約している法人の場合、法人内に本部を含め7つの診療所がありますので、それらの診療所の医師から食欲不振や疾患に対する療養食についての在宅訪問栄養食事指導の依頼を受けて、患者さんのお宅にうかがうことがほとんどです。実際にお会いすると、経済的にゆとりがなくて食べられない方、冷蔵庫がなくて生鮮食品が食べられない方、極度の偏食で3食ビールが主なエネルギー源の方など、長年培ったさまざまな暮らしがあります。多くの方が低栄養状態にあり、口腔内をみると、口内炎があったり歯茎が腫れていたりなど、さまざまなトラブルを抱えています。

――在宅という使えるものが限られた環境のなかで、どのように在宅訪問栄養食事指導をされているのですか？

森田　在宅において、管理栄養士1人では何もできません。ご利用者さまの暮らしを尊重しつつ、お食事をつくることや、食事介助を手伝うこともありますが、毎日の食事をつくって提供するのは介護職員やご家族なので、そうした方々にレトルト食品の活用法や栄養補助食品の使い方、介護食のレシピなどを伝えています。ただし、ご家族の生活環境はさまざまですし、介護職員の方々の意識やスキルも多様です。これを調整するのは大変なことですが、栄養管理については管理栄養士がコーディネートしていかなければならないと思います。「どんな低栄養か？」ではなく、「なぜ低栄養になったか？」を考えなければいけないのです。

小山　当院が位置する厚木市には幸い、地域栄養ケアPEACH厚木（代表・江頭文江氏）があるので、退院後の栄養管理と経口維持をつなぐことができて助かっています。しかし、在宅の方々をサポートしてくれる管理栄養士さんは非常に少なく、苦慮されている地域が多いと思います。

菊谷　私たちのクリニックでは、訪問診療先の高齢者施設との連携システムは、かなり形になりました。嚥下機能評価の場に必ず、管理栄養士や看護師、ご家族が同席し、その場で評価したことを皆で話し合い、ケアプランに盛り込んで次回の訪問の際に再検討するという流れです。ところが在宅の場合、まずこのチームを形成するのが難しい。医師や看護師、介護職員、言語聴覚士などの専門職が異なった施設に所属しているので、各事業所それぞれの思いを背負っています。まずその思いを1つにまとめることが難しいのです。さらに在宅で活動する管理栄養士がなかなか見つからないという大きな問題もあります。そこで当院では常勤の管理栄養士を雇用しましたし、院内にアイランド型のキッチンを設置した研修室をつくり、在宅への意識の高い地域の管理栄養士たちに開放し、在宅訪問栄養食事指導の勉強会を日々行なっています。

――在宅の領域に管理栄養士がいないのなら、養成しようという発想ですね。

菊谷　そうです。先ほど森田先生がおっしゃっていましたが、摂食・嚥下障害について取り組んでいると、必ずと言っていいほど低栄養状態と食形態の調整の問題が出てくるのです。私自身はカレーライスくらいしかつくったことがないので、どう指導すればいいのか限界を感じた

在宅での食べられるようになった喜びを少しでも多くの仲間と共有したいと思います。

のです。

――食形態の調整のお話が出ましたが、今年9月に発表された「嚥下調整食学会分類2013」についてどう思いますか？

菊谷　今まで我々は訪問先で嚥下機能評価を行なった際、どういう食形態ならば適正かを考えたとき、自分たちが考える物性を訪問先の施設で作成している嚥下調整食に当てはめて提案していました。つまり、我々の食形態の言語と異なるので、その都度翻訳しなければならなかったのです。しかもその翻訳がいつも理解されるとはかぎらない。それがストレスだったのですが、この分類ができたことで翻訳の必要性がなくなり、スムーズな連携につながっていくと思います。我々は積極的に使っていこうと思います。

小山　神奈川県では嚥下食ピラミッドを基本にした「NST・嚥下連絡票」があり、それを使って食事形態の連携を図ってきました。「嚥下調整食学会分類2013」も基本的には嚥下食ピラミッドをベースにしたものなので、学会が発表したものに改変していきますし、全国的に広げていく必要があると思います。

――最後に読者にメッセージをお願いします。

菊谷　食べることは人に大きな力を与えてくれます。私が担当した患者さんで3カ月間意識のなかった方がいます。その方は目が覚めたときに手足が動かず、チューブだらけの自分の姿を知って、「なぜ、このまま逝かせてくれなかったのか！」と訴え、ご家族を困らせていました。しかし、経口摂取が可能になってくると、お孫さんと遊ぶことが楽しみになり、生きる希望をつなぎました。またある患者さんの場合、プリンを食べられるようになると、介護者であるご家族がその方のために何か食べられるものをスーパーで選ぶことが楽しみになったそうです。こうした感動的な出来事は、在宅だからこそ得られるものです。ぜひ、読者の方々にもこの感動を共有してほしいと思います。

小山　まったく食べられない方がお家にいると、ご家族は気を遣って匂いを発しないようにして料理したり、こっそりと食べたりするわけです。結果、介護者の方々はひどくやせてしまったり、ストレスが高じてしまいます。しかし、食べられるようになると、食卓での団らんが蘇ります。おいしく食べる幸せの笑顔が生まれます。管理栄養士の方々には栄養管理だけでなく、生活者として生きる喜びと幸せをサポートしてほしいと願っています。

森田　在宅での取り組みは非常に難しいことが多く、教科書がないなかで試行錯誤の毎日です。しかし、苦労の末に少しでも食べられるようになると、そこからパッと生きる力がわくことを実感しています。ご家族だけでなく多職種と連携して、この喜びを少しでも多くの方と共有していきたいと思います。

「嚥下調整食学会分類2013」について

以下は今年９月19日に日本摂食・嚥下リハビリテーション学会のホームページ上にアップされた嚥下調整食の新たな「ものさし」である。表１の食事の早見表を図式化したものが図のスキーマである。基本的に嚥下食ピラミッドを踏襲したものであるが、コード０を「ゼリーから始めるもの」と「とろみから始めるもの」の２つに区分している。これは、すべての症例がゼリーからスタートするわけではなく、ペースト状から食べ始める場合もあることに配慮したものである。また、コード２を2-1と2-2の２段階に設定している。これは、とろみから経口摂取を始める場合、次の段階としてペースト食に移行するが、不均質なペースト食はハードルが高いため、まず均質なペースト食を摂取し、その次に不均質なペースト食をとってもらえるように配慮したものである。とろみについては表２に示したように、「薄いとろみ」「中間のとろみ」「濃いとろみ」の３段階を設定している。

この分類は食事の形態調整において施設間で連携を図るための共通言語であり、これらの図表のコードナンバーを使って転院先との連携に活かしていくように策定されている。

※「嚥下調整食学会分類2013」についての詳しい内容は、日本摂食・嚥下リハビリテーション学会ホームページにアップされている「嚥下調整食学会分類2013」の本文をご参照ください。また、本誌53ページからの栢下淳先生の誌上講演もぜひご覧ください。

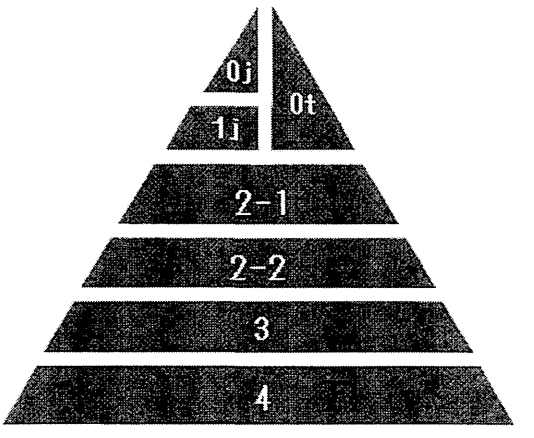
表１　学会分類2013(食事)早見表

コード【0～4項】		名称	形態	目的・特色	主食の例	必要な咀嚼能力【0～4項】	他の分類との対応【0～4項】
0	j	嚥下訓練食品j	均質で、付着性・凝集性・硬さに配慮したゼリー 離水が少なく、スライス状にすくうことが可能なもの	重度の症例に対する評価・訓練用 少量をすくってそのまま丸のみ可能 残留した場合にも吸引が容易 たんぱく質含有量が少ない		若干の送り込み能力	嚥下食ピラミッドL0 えん下困難者用食品許可基準Ⅰ
	t	嚥下訓練食品t	均質で、付着性・凝集性・硬さに配慮したとろみ水 (原則的には、中間のとろみあるいは濃いとろみ・のどちらかが適している)	重度の症例に対する評価・訓練用 少量ずつ飲むことを想定 ゼリー丸呑みで誤嚥したり ゼリーが口中で溶けてしまう場合 たんぱく質含有量が少ない		若干の送り込み能力	嚥下食ピラミッドL3の一部 (とろみ水)
1	j	嚥下調整食1	均質で、付着性、凝集性、硬さ、離水に配慮したゼリー・プリン・ムース状のもの	口腔外で既に適切な食塊状となっている (少量をすくってそのまま丸のみ可能) 送り込む際に多少息遣いて口蓋に舌を押しつける必要がある 0jに比し表面のざらつきあり	おもゆゼリー ミキサー粥のゼリー など	若干の食塊保持と送り込み能力	嚥下食ピラミッドL1・L2 えん下困難者用食品許可基準Ⅱ UDF区分4「ゼリー状」 *UDF ユニバーサルデザインフード
2	1	嚥下調整食2	ピューレ・ペースト・ミキサー食など、均質でなめらかで、べたつかず、まとまりやすいもの スプーンですくって食べることが可能なもの	口腔内の簡単な操作で食塊状となるもの (咽頭では残留、誤嚥をしにくいように配慮したもの)	粒がなく、付着性の低いペースト状のおもゆや粥	下顎と舌の運動による食塊形成能力および食塊保持能力	嚥下食ピラミッドL3 えん下困難者用食品許可基準Ⅱ・Ⅲ UDF区分4
	2		ピューレ・ペースト・ミキサー食などで、べたつかず、まとまりやすいもので不均質なものも含む スプーンですくって食べることが可能なもの		やや不均質(粒がある)でもやわらかく、離水もなく付着性も低い粥類	下顎と舌の運動による食塊形成能力および食塊保持能力	
3		嚥下調整食3	形はあるが、押しつぶしが容易、食塊形成や移送が容易、咽頭でばらけず嚥下しやすいように配慮されたもの 多量の離水がない	舌と口蓋間で押しつぶしが可能なもの、押しつぶしやすり込みの口腔操作を要しあるいはそれらの咽頭を経活し、かつ誤嚥のリスク軽減に配慮がなされているもの	離水に配慮した例 など	舌と口蓋間の押しつぶし能力以上	嚥下食ピラミッドL4 準備者ソフト食 UDF区分3
4		嚥下調整食4	硬さ・ばらけやすさ・貼りつきやすさなどのないもの 箸やスプーンで切れるやわらかさ	誤嚥と窒息のリスクを配慮して素材と調理方法を選んだもの 菌がなくても対応可能だが、上下の歯槽提間で押しつぶすあるいはすりつぶすことが必要で舌と口蓋間で押しつぶすことは困難	軟飯・全粥 など	上下の歯槽提間の押しつぶし能力以上	嚥下食ピラミッドL4 準備者ソフト食 UDF区分1-2

表２　学会分類2013(とろみ)早見表

	段階1 薄いとろみ 【0～3項】	段階2 中間のとろみ 【0～2項】	段階3 濃いとろみ 【0～4項】
英語表記	Mildly thick	Moderately thick	Extremely thick
性状の説明 (飲んだとき)	「drink」するという表現が適切なとろみの程度 口に入れると口腔内に広がる液体の種類・味や温度によっては、とろみがついていることがあまり気にならない場合もある 飲み込む際に大きな力を要しない ストローで容易に吸うことができる	明らかにとろみがあることを感じがありかつ、「drink」するという表現が適切なとろみの程度 口腔内での動態はゆっくりですぐには広がらない 舌の上でまとめやすい ストローで吸うのは抵抗がある	明らかにとろみがついていて、まとまりが良い 送り込むのに力が必要 スプーンで「eat」するという表現が適切なとろみの程度 ストローで吸うことは困難
性状の説明 (見たとき)	スプーンを傾けるとすっと流れおちる フォークの歯の間から素早く流れ落ちる カップを傾け、流れ出た後には、うっすらと跡が残る程度の付着	スプーンを傾けるととろとろと流れる フォークの歯の間からゆっくりと流れ落ちる カップを傾け、流れ出た後には、全体にコーティングしたように付着	スプーンを傾けても、形状がある程度保たれ、流れにくい フォークの歯の間から流れでない カップを傾けても流れ出ない (ゆっくりと塊となって落ちる)
粘度(mPa・s) 【0～5項】	50 - 150	150 - 300	300 - 500
LST値(mm) 【0～5項】	36 - 43	32 - 36	30 - 32

図　学会分類2013のスキーマ



日本摂食・嚥下リハビリテーション学会ホームページより(一部改変)
http://www.jsdr.or.jp/

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COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

Interrelationship of oral health status, swallowing function, nutritional status, and cognitive ability with activities of daily living in Japanese elderly people receiving home care services due to physical disabilities

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Abstract – *Objectives:* Malnutrition and cognitive impairment lead to declines in activities of daily living (ADL). Nutritional status and cognitive ability have been shown to correlate with oral health status and swallowing function. However, the complex relationship among the factors that affect decline in ADL is not understood. We examined direct and indirect relationships among oral health status, swallowing function, nutritional status, cognitive ability, and ADL in Japanese elderly people living at home and receiving home care services because of physical disabilities. *Methods:* Participants were 286 subjects aged 60 years and older (mean age, 84.5 ± 7.9 years) living at home and receiving home care services. Oral health status (the number of teeth and wearing dentures) was assessed, and swallowing function was examined using cervical auscultation. Additionally, ADL, cognitive ability, and nutritional status were assessed using the Barthel Index, the Clinical Dementia Rating Scale, and the Mini Nutritional Assessment-Short Form, respectively. Path analysis was used to test pathways from these factors to ADL. *Results:* The mean number of teeth present in the participants was 8.6 ± 9.9 (edentates, 40.6%). Dysphagia, malnutrition, and severe cognitive impairment were found in 31.1%, 14.0%, and 21.3% of the participants, respectively. Path analysis indicated that poor oral health status and cognitive impairment had a direct effect on denture wearing, and the consequent dysphagia, in addition to cognitive impairment, was positively associated with malnutrition. Malnutrition as well as dysphagia and cognitive impairment directly limited ADL. *Conclusions:* A lower number of teeth are positively related to swallowing dysfunction, whereas denture wearing

Key words: activities of daily living; cognitive ability; elderly people with physical disabilities; nutritional status; oral health status

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contributes to recovery of swallowing function. Dysphagia, cognitive impairment, and malnutrition directly and indirectly decreased ADL in elderly people living at home and receiving home nursing care. The findings suggest that preventing tooth loss and encouraging denture wearing when teeth are lost may indirectly contribute to maintaining or improving ADL, mediated by recovery of swallowing function and nutritional status.

In almost every country, the proportion of older people is increasing relative to younger age groups (1). Especially in Japan, the population is aging rapidly because of dramatic reductions in early mortality and declines in fertility. Indeed, the population aged 65 years old and older in Japan accounts for 23% of the total population in 2011 (2), and this percentage is the highest in the world. As the number of elderly people increases, so does the number of those requiring long-term nursing care, such as those who are bedridden and suffering from dementia (3).

Since 2000, nursing services supporting the daily lives of elderly individuals who require long-term care because of physical disability have been provided through the social insurance system enacted in Long-term Care Insurance Act in Japan (4). In this system, applicants for services are classified into five grades according to the severity of their physical disability, and the amount of nursing care service provided is determined by grade (5). The number of elderly receiving long-term care based on this act was about 4 million in 2010 according to a report by Japanese Ministry of Health, Labour and Welfare (6). Another report showed that 29% of elderly Japanese requiring long-term care deteriorated as measured by the grade of care service needed, and 23% of them died within 2 years (7). For elderly people receiving nursing care, further deterioration in their ability to conduct activities of daily living (ADL) such as bathing, dressing, and walking is an important concern.

Previous studies have suggested that malnutrition and cognitive impairment can lead to deterioration in ADL (8, 9), and malnutrition has been associated with cognitive impairment in elderly people (8). Moreover, nutrition and cognitive function have also been shown to correlate with oral health status (10, 11) and swallowing function (12, 13). However, these studies focused on direct relationships between bivariates. We need to also take into account that decline in ADL is affected by complex direct and indirect interactions among multiple factors. That is, it is not enough to analyze an association incorporating multiple factors as independent variables to show comprehensively how these risk factors affect deterioration in ADL.

Furthermore, most studies about the effects of oral condition on malnutrition and decline in ADL have been limited to elderly people in nursing homes and hospitals (11–13); few studies have examined these associations in elderly people living at home. In Japan, about 3 million people received home care services, and about 1 million people received facility services, such as at a nursing home, via long-term care insurance in 2010 (5, 14). In the United States, because of social trends toward reduced nursing home use, the number of disabled elderly people needing home care support has increased (15). Considering the growing number of aged people and the inevitable subsequent increase in the number who will require long-term nursing care in most developed countries, an increase in the number of elderly people requiring home care is expected to be a major issue in modern societies worldwide. Therefore, it is useful to investigate the many factors leading to a decline in ADL among elderly people living at home.

In the present study, we examined the direct and indirect effects of oral health status, including number of teeth and denture wearing, swallowing function, nutritional status, and cognitive ability, on ADL in Japanese elderly people living at home and receiving home care services because of physical disabilities. We hypothesized the following: (i) cognitive impairment leads to eating difficulties (e.g., difficulty chewing food, difficulty swallowing food), and these difficulties impair nutritional status (16); (ii) oral health status affects eating difficulties (17); (iii) cognitive impairment affects oral health status (18), or, conversely, oral health status affects cognitive impairment (19); (iv) cognitive impairment and malnutrition lead to a decline in ADL (9) (Fig. 1). The conceptual model was proposed, based on empirical evidence.

Materials and methods

Study setting and study population

This cross-sectional study was undertaken in two midsized municipalities in Fukuoka prefecture (western Japan) between November 2010 and

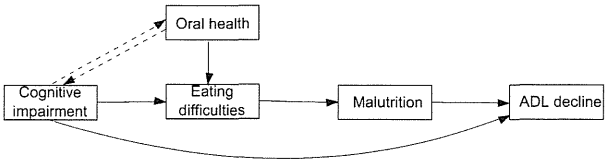

Fig. 1. The conceptual model. Dotted lines indicate paths explored the direction in this study.

February 2011. The study population comprised 337 participants aged 60 years or older who were living at home and using an in-home long-term care support center that coordinates home care services such as home nursing care, visiting rehabilitation, visiting bathing service, day service, and day care (rehabilitation) by service providers. Of these, 51 participants with missing data were excluded. Finally, 286 participants (75 men, 211 women) were included.

The study was approved by Kyushu University Institutional Review Board for Clinical Research. We obtained participants' or their family members' consent, as required for approval by the review board.

Assessment of oral health status and swallowing function

Oral health status and swallowing function were assessed by qualified dental hygienists. Oral health status was assessed by recording the number of teeth and denture wearing.

Swallowing function was examined by cervical auscultation, a non-invasive method of listening with a stethoscope to the sounds of swallowing 3 ml of water during the pharyngeal phase, following the method of Zenner et al. (20) with minor modifications. When breath sounds after swallowing material were clear, we evaluated swallowing function as normal. When stridor, coughing, or throat clearing was heard after swallowing material or when swallowing was repeated, we evaluated this as impaired swallowing function (i.e., dysphagia).

Measurement of ADL, cognitive ability, and nutritional status

Participant's ADL, cognitive ability, and nutritional status were recorded by a nurse or a care worker at the in-home long-term care support center. ADL was assessed using the Barthel Index, which covers all aspects of self-care independence in daily living activities such as transfer, walking stairs, toilet use, dressing, feeding, and bathing (21). A total score of 100 points indicates complete self-sufficiency, whereas a score of zero indicates that the person is completely dependent (21).

Cognitive ability was assessed using the Clinical Dementia Rating (CDR). CDR status was assigned according to the presence or absence of dementia and, if present, its severity (none, questionable or very mild, mild, moderate, or severe cognitive impairment), as described previously (22).

Nutritional status was evaluated using the Mini Nutritional Assessment-Short Form (MNA-SF) (23). The MNA-SF has the option of using calf circumference when body mass index is not available because of a bedridden and immobile state. Nutritional status was defined in three classifications by the MNA-SF: 0–7 points = malnourished; 8–11 points = at risk of malnutrition, and 12–14 points = well nourished.

Comorbid conditions

We assessed comorbidity with the Charlson comorbidity index (24, 25), which provides a weighted score for a participant's comorbidities taking into account how many of 19 predefined comorbid conditions an individual has, because elderly people generally live with multiple diseases, and the presence of comorbidities has a negative effect on both physical and cognitive function (26).

Statistical analysis

Bivariate associations between oral health status and swallowing function, nutritional status, cognitive ability, ADL, or confounding variables such as age, gender, and comorbid conditions were tested with the chi-square or ANOVA test. Oral health status was categorized as 20 or more teeth with dentures; 20 or more teeth without dentures; 10 to 19 teeth with dentures; 10 to 19 teeth without dentures; 0 to 9 teeth with dentures; or 0 to 9 teeth without dentures. A P value < 0.05 was considered to indicate statistical significance. The SPSS software (ver. 19.0 for Windows; IBM SPSS Japan, Tokyo, Japan) was used for data analyses.

To test the hypothesis, we conducted path analysis using the M-plus statistical package (27). Path analysis can be used instead of several separate regressions to examine mediating effects within a single model (28). Additionally, path analysis allows testing of causal relationships among a set

of observed variables (29). We tested the hypothesized model using path analysis (Fig. 2). The model examined the interactive effects of nine constructs. We hypothesized that cognitive ability and nutrition status directly affect ADL. We also hypothesized that the number of teeth, denture wearing, and cognitive ability precede swallowing function. Additionally, the number of teeth, denture wearing, and swallowing function precede nutrition status. Considering the association between cognitive ability and oral health status, it is possible that cognitive impairment affects oral health status (18) or, conversely, that oral health status affects cognitive impairment (19). We tested alternative path models each with different directionalities among the number of teeth, denture wearing, and cognitive ability. We adjusted for age, gender, and comorbid condition.

Data used in this study included both continuous and dichotomous variables. Thus, the path model was analyzed using weighted least-squares mean and variance adjustment estimation (WLSMV). WLSMV uses a diagonal weight matrix with robust standard errors and mean- and variance-adjusted chi-square test statistics (27). We used a significance level of $P < 0.05$ for the regression coefficients. The degree of correspondence between the hypothesized models and the actual data was assessed with a goodness-of-fit test. Criteria for the goodness-of-fit test include a comparative fit index (CFI), a Tucker-Lewis index (TLI), a root-mean-square error of approximation (RMSEA), and the weighted root-mean-square residual (WRMR). Values of >0.95 for the CFI, >0.95 for the TLI, <0.06 for the RMSEA, and <0.90 for the WRMR are considered to indicate a good fit of the data to the model (27) (30).

Statistical power was considered for this analysis. In path analysis, sample sizes of around 150 to 200 are more desirable (31). With an alpha level of 0.05 and 286 subjects, it is estimated that the statistical power for this study reached 0.95.

Results

The participants were 75 men and 211 women. The age of the study population ranged from 61 to 104, and the mean age ± SD was 84.5 ± 7.9 years (79.1 ± 7.9 years for men and 86.4 ± 6.9 years for women). The mean number of teeth present was 8.6 ± 9.9, and 40.6% of participants were edentulous, while the mean number of teeth present was 14.4 ± 8.9 in 170 dentate subjects. The proportion of participants who did not visit a dental clinic was 75.9%.

Activities of daily living, cognitive ability, and nutritional status according to different categories of oral health status (including number of teeth, denture wearing), and swallowing function are presented in Tables 1 and 2. Subjects having 0 to 19 teeth and no dentures showed lower levels of ADL, cognitive function, and nutritional status than did those who had more than 20 teeth or who wore dentures. Subjects with dysphagia had lower ADL, more severe cognitive impairment, and more malnutrition than those with normal swallowing (Table 3).

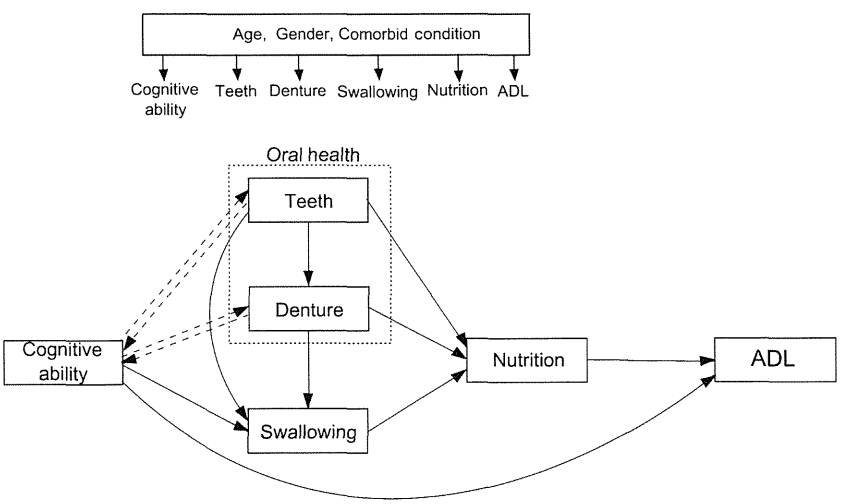

Fig. 2. The hypothesized model. The model consists of nine observed variables including confounding variables such as age, gender and comorbid conditions. Dotted lines indicate paths explored the direction in this study.

Table 1. Functional ability, cognitive function, and nutritional status according to the number of teeth [*n* (%)]

Variable	0–9 teeth (*n* = 179)	11–19 teeth (*n* = 48)	≥ 20 teeth (*n* = 59)	Total	*P* value
Age, mean ± SD	86.4 ± 7.1	82.8 ± 7.2	80.0 ± 8.5	84.5 ± 7.9	<0.001
Female	144 (80.4)	33 (68.8)	34 (57.6)	211 (71.3)	0.002
Dysphagia	57 (31.8)	16 (33.3)	16 (27.1)	89 (31.1)	0.743
Functional ability (Barthel Index), mean ± SD	57.2 ± 26.7	59.8 ± 28.4	62.1 ± 30.2	58.6 ± 27.7	0.467
Nutritional status (MNA-SF), mean ± SD	10.2 ± 2.1	9.7 ± 2.4	10.3 ± 2.6	10.1 ± 2.2	0.361
Nutrition status category					0.311
Normal (12–14)	52 (29.1)	13 (27.1)	23 (39.0)	88 (30.8)	
Risk of malnutrition (8–11)	105 (58.7)	25 (52.1)	28 (47.5)	158 (55.2)	
Malnutrition (0–7)	22 (12.3)	10 (20.8)	8 (13.6)	40 (14.0)	
Cognitive function (CDR)					0.262
None/Questionable	48 (26.8)	11 (22.9)	23 (39.0)	82 (28.6)	
Mild/Moderate	90 (50.3)	25 (52.1)	28 (47.5)	143 (50.0)	
Severe	41 (22.9)	12 (25.0)	8 (13.6)	61 (21.3)	
Comorbid condition (Charlson Comorbidity Index), mean ± SD	1.3 ± 1.1	1.5 ± 1.2	1.7 ± 1.3	1.4 ± 1.2	0.100

SD, standard deviation.

Table 2. Functional ability, cognitive function, and nutritional status according to oral health status [*n* (%)]

Variable	0–9 teeth, no denture (*n* = 26)	0–9 teeth with denture (*n* = 153)	10–19 teeth, no denture (*n* = 18)	10–19 teeth with denture (*n* = 30)	≥ 20 teeth, no denture (*n* = 49)	≥ 20 teeth with denture (*n* = 10)	*P* value
Age, mean ± SD	88.5 ± 6.6	86.1 ± 7.2	81.8 ± 7.5	83.3 ± 7.1	78.4 ± 8.2	87.6 ± 5.4	<0.001
Female	19 (73.1)	125 (81.7)	12 (66.7)	21 (70.0)	26 (53.1)	8 (80.0)	0.005
Dysphagia	15 (57.7)	42 (27.5)	7 (38.9)	9 (30.0)	13 (26.5)	2 (20.0)	0.061
Functional ability (Barthel Index), mean ± SD	38.1 ± 29.6	60.4 ± 24.8	53.9 ± 28.6	63.3 ± 28.2	59.8 ± 30.3	73.5 ± 28.0	0.001
Nutritional status (MNA-SF), mean ± SD	9.2 ± 2.1	10.4 ± 2.0	9.3 ± 2.4	10.0 ± 2.4	10.1 ± 2.8	11.4 ± 1.2	0.041
Nutritional status category							0.313
Normal (12–14)	4 (15.4)	48 (31.4)	4 (22.2)	9 (30.0)	18 (36.7)	5 (50.0)	
Risk of malnutrition (8–11)	16 (61.5)	89 (58.2)	10 (55.6)	15 (50.0)	23 (46.9)	5 (50.0)	
Malnutrition (0–7)	6 (23.1)	16 (10.5)	4 (22.2)	6 (20.0)	8 (16.3)	0 (0.0)	
Cognitive function (CDR)							0.038
None/Questionable	4 (15.4)	44 (28.8)	3 (16.7)	8 (26.7)	17 (34.7)	6 (60.0)	
Mild/Moderate	10 (38.5)	80 (52.3)	9 (50.0)	16 (53.3)	25 (51.0)	3 (30.0)	
Severe	12 (46.2)	29 (19.0)	6 (33.3)	6 (20.0)	7 (14.3)	1 (10.0)	
Comorbid condition (Charlson Comorbidity Index), mean ± SD	1.3 ± 0.9	1.3 ± 1.2	1.1 ± 0.5	1.7 ± 1.4	1.7 ± 1.4	1.6 ± 1.3	0.151

SD, standard deviation.

Path analysis

First, we estimated an initial model with all hypothesized pathways corresponding to the estimated variables directly or indirectly affecting ADL. Then, some insignificant paths were eliminated, and others who showed significant bivariate correlations were added while confirming the model-fit indices. A final model was then estimated with only statistically significant paths retained. The final model was a fairly good fit [χ^2 (14) = 19.805; P = 0.136; CFI = 0.972; TLI = 0.945; WRWR = 0.571; RMSEA = 0.038 (0.001 to 0.074)]. Figure 3 shows parameter estimates for the final path model. The model showed the following

Table 3. Activities of daily living, cognitive ability, and nutrition status with or without dysphagia [*n* (%)]

Variable	Dysphagia (*n* = 89)	Normal (*n* = 197)	*P* value
Age, mean ± SD	84.5 ± 8.6	84.5 ± 7.5	0.991
Female	55 (61.8)	156 (79.2)	0.002
ADL (Barthel Index), mean ± SD	42.8 ± 28.3	65.8 ± 24.3	<0.001
Nutritional status (MNA-SF), mean ± SD	9.3 ± 2.3	10.5 ± 2.1	<0.001
Nutritional status category			<0.001
Normal (12–14)	16 (18.0)	72 (36.5)	
Risk of malnutrition (8–11)	52 (58.4)	106 (53.8)	
Malnutrition (0–7)	21 (23.6)	19 (9.6)	
Cognitive impairment (CDR)			<0.001
None/Questionable	32 (36.0)	60 (30.5)	
Mild/Moderate	35 (39.3)	108 (54.8)	
Severe	22 (24.7)	29 (14.7)	
Comorbid condition (Charlson Comorbidity Index), mean ± SD	1.4 ± 1.1	1.4 ± 1.2	0.976

SD, standard deviation.

significant direct paths: (i) ones from 'Age' and 'Gender' to 'Teeth'; that is, increasing age decreased the number of remaining teeth [β (standardized coefficient) = −0.36] and females had fewer teeth than males (β = −0.14); (ii) one from 'Teeth' to 'Denture'; fewer teeth led to wearing denture (β = −0.79); (iii) one from 'Teeth' and 'Denture' to 'Swallowing'; having many teeth and wearing dentures promoted normal swallowing function (β = 0.78, 0.81, respectively); (iv) one from 'Gender' to 'Swallowing'; female tended to have normal swallowing function (β = 0.22); (v) one from 'Cognitive Ability' to 'Denture' and 'Nutrition'; a high level of cognitive ability led directly to wearing dentures and better nutritional status (β = 0.23 and 0.34, respectively); (vi) one from 'Swallowing' to 'Nutrition'; normal swallowing function promoted normal nutritional status (β = 0.25); (vii) ones from 'Swallowing', 'Cognitive Ability', and 'Nutrition' to 'ADL'; normal swallowing function, a high level of cognitive ability, and normal nutritional status resulted in a higher level of ADL (β = 0.33, 0.26, and 0.35, respectively); (viii) one from 'Comorbid Condition' to 'ADL'; severer comorbid condition caused a lower level of ADL (β = −0.10); and (ix) double-headed arrows among 'Age', 'Gender', 'Comorbid Condition', and 'Cognitive Ability'; age was correlated with cognitive ability, gender, and comorbid conditions. On the other hand, the number of teeth and denture wearing were not directly associated with either nutritional status or ADL.

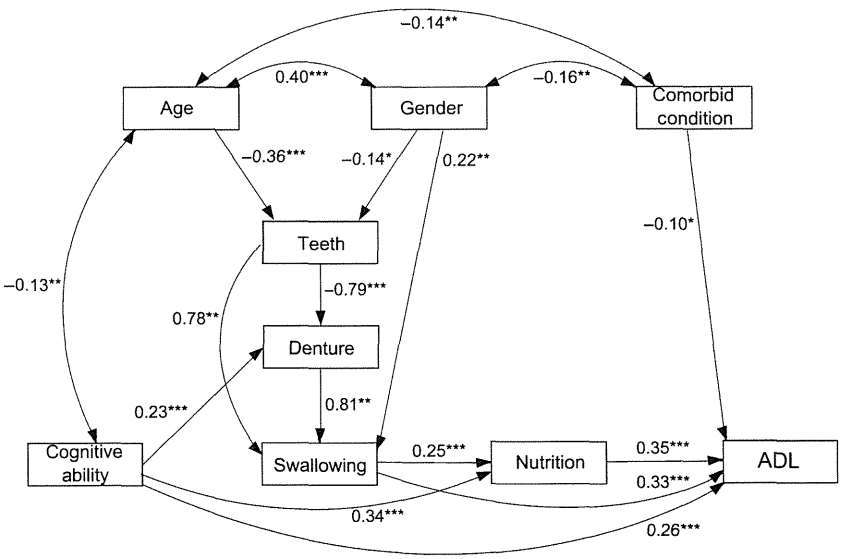

Fig. 3. The final model. Double-headed arrows indicate covariance. All significant values (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$) indicate standardized coefficients. Continuous variables are 'Age', 'Comorbid Conditions' (Charlson Comorbidity Index), 'Nutrition' (MNA-SF), 'Teeth', and 'ADL' (Barthel Index). Categorical or ordered variables are 'Gender' (1 = male, 2 = female), 'Dentures' (0 = not wearing, 1 = wearing), 'Swallowing' (0 = dysphagia, 1 = normal swallowing function) and 'Cognitive Ability' (1 = severe cognitive impairment, 2 = moderate, 3 = mild, 4 = questionable, 5 = none).

Discussion

This study showed the complex pathway from cognitive ability and oral health status via swallowing function and nutritional status to ADL in aged Japanese people living at home and receiving home care, using path analysis. To the best of the authors' knowledge, this is first study to show the interaction between multiple factors leading to a decline in ADL. Path analysis is an analytical technique that allows the testing of causal models using cross-sectional data. Possible pathways leading to ADL decline, based on our findings and those of previous studies, are as follows. Having fewer teeth leads to wearing dentures, but severe cognitive impairment disrupts denture wearing because of problems in accessing dental care; chewing difficulties resulting from having fewer teeth and no dentures can lead to dysphagia; dysphagia impairs the ability of elderly people to consume adequate amounts of food to meet their nutritional needs, leading to malnutrition (16); cognitive impairment, in turn, causes potential problems related to the inability to eat or to lack of access to food (32), hence leading to malnutrition. Swallowing function, cognitive ability, and nutritional status had direct effects on ADL. This finding agrees with previous studies in elderly people (9, 13). Malnutrition and cognitive impairment are associated with poor muscle strength and reduced physical performance (33), leading to disability, which reduces the ability to perform the basic activities of daily living. Although the effect of oral health status on ADL was indirect in this study, we cannot ignore it because of the moderate association between oral health status and swallowing function. Understanding various factors related to deterioration in ADL among these subjects would contribute to considering a multilateral approach for maintaining ADL in elderly people who are living at home.

The results of the present study suggested that oral health status, as measured by indicators such as the number of teeth and denture wearing, had a direct effect on swallowing function. A previous study reported that laryngeal penetration, usually because of neuromuscular disorder, occurs with much greater frequency in edentulous elderly people who are not wearing dentures than in those who dentulous (34). In our study, when the effect of denture wearing on swallowing function in edentulous persons was examined, 10 of 15 edentates (66.7%) without dentures showed dysphagia, whereas 29 of 101 edentates (28.7%) wearing dentures did. Tamura et al. described that wearing dentures and keeping the appropriate mandible position and proper occlusion were important for smooth swallowing in elderly individuals (35). Additionally, loss of occlusal support and loss of mandibular stopping by occlusion may disturb the coordination of swallowing function (34).

In this study, we did not find a statistically significant association between oral health status and nutritional status in the path analysis. This finding conflicts with those of previous studies (11, 12). There may be at least two reasons that oral health status was not associated with nutritional status in the present study. First, our path model included some factors related to nutritional status, such as oral health status, swallowing function, cognitive ability, and ADL. However, previous studies (11, 12) that demonstrated an association between oral health status and nutritional status failed to incorporate these factors into their analyses. Probably, because factors other than oral health status more strongly affect nutritional status, the relationship would be less obvious in our study. Second, even when elderly people do not have enough teeth, do not wear dentures, and do not chew satisfactorily, food preparation by a caregiver may make food easy to chew and thereby prevent nutritional deterioration. Nutritional status was related to swallowing function, but not to oral health status, in this study, suggesting that swallowing function may have a greater direct effect than chewing ability on malnutrition. However, there was an association between swallowing function and oral health status in our study, and oral health status may still indirectly influence nutritional status.

Our results suggest that maintaining or improving oral health status and swallowing function indirectly or directly contribute to preventing a decline in ADL in elderly people who require home care. Yoneyama et al. (36) reported that oral care reduced febrile days and the risk of pneumonia in older patients receiving nursing care. These findings indicate that dental interventions, such as provision of dentures, treatment for dental caries or periodontal disease, professional oral care, swallowing training, and oral care training for caregivers, have a beneficial indirect effect on general health in those requiring long-term nursing care. However, our results also showed that 75.9% of participants had not received dental treatment; many elderly people requiring home care have difficulty in gaining access to professional dental care. Further efforts are needed to develop a long-term

care system or community system that provides ready access to dental services.

Our study had some limitations. Using path analysis, our study made causal inferences about the relationships among various factors related to ADL; however, the cross-sectional design means that we cannot rule out reverse causation. Further longitudinal study is needed to examine a temporal relationship. Second, we did not incorporate sociological factors, such as socioeconomic status and education level, into this study. Several studies have reported a relationship between sociological factors and oral health status, ADL, cognitive ability, and nutritional status (9, 37–39). ADLs are associated with psychosocial factors (9). Because sociological factors and psychosocial factors were considered to have more indirect effects on ADL than oral health status, cognitive ability, and nutritional status, we did not gather this information in this survey. Third, we did not assess the prevalence of specific oral diseases such as dental caries and periodontal disease. Finally, we recruited the subjects using an in-home long-term care support center in two midsized municipalities in Japan. Our sample may limit the ability to extrapolate our findings to all Japanese elderly people. Caution is warranted in generalizing our findings to the rest of the Japanese population.

In conclusion, based on the present study, we propose a potential causal pathway by which oral health status directly affects swallowing function, and dysphagia, cognitive impairment, and malnutrition directly or indirectly affect ADL in elderly people living at home and receiving home nursing care. These findings suggest that maintaining the number of teeth from a younger age and wearing dentures when teeth are lost may indirectly reduce malnutrition and subsequent ADL decline in these people.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Relationship between nutrition status and dental occlusion in community-dwelling frail elderly people

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Aim: This study aimed to determine the risk of malnutrition in some communities where the frail elderly receive public long-term care insurance. We also clarified the dental problems in those at risk of malnutrition.

Methods: A total of 716 frail elderly who lived in eight cities in Japan (240 males and 476 females with a mean age of 83.2 ± 8.6 years) were divided into three groups according to Mini Nutritional Assessment short form results: well nourished, at risk of malnutrition and malnourished. They were also divided into three groups in terms of remaining teeth occlusion and denture occlusion: group A, natural dentition with adequate function; group B, partially or fully edentulous, but maintaining functional occlusion with dentures in either or both jaws; and group C, functionally inadequate occlusion with no dentures. The relationship between nutrition status and dental occlusion was evaluated using logistic regression analysis with sex, age, activities of daily living and cognitive function as covariates.

Results: The number of participants in each of the groups was as follows: 251 well nourished, 370 at risk of malnutrition and 95 malnourished. When they were divided into just two groups, (i) well nourished and (ii) at risk of malnutrition plus malnourished, in order to study malnutrition risk factors, there were significant relationships between their nutritious status and sex, Barthel index, and occlusion.

Conclusion: This large-scale cross-sectional survey showed that loss of natural teeth occlusion was a risk factor for malnutrition among community-dwelling frail elderly. **Geriatr Gerontol Int 2013; 13: 50–54.**

Keywords: frail elderly people, Mini Nutritional Assessment short form, nutrition, occlusion.

Introduction

The intake of nutrients from daily meals is the foundation of life. Low nutrition decreases the immunological defenses, reduces physical functions, and can be a direct or indirect cause of morbidity and mortality among the elderly.[1,2] It has been reported that 1–15% of outpatients and 15–60% of the institutionalized elderly suffer from protein-energy malnutrition (PEM),[3] suggesting that the condition of elderly at risk of malnutrition should be investigated and improved without delay.

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Several screening methods are available for determining malnutrition, but the use of a questionnaire is a simpler and more convenient method for a large-scale survey.[4] Especially, The Mini Nutritional Assessment short form (MNA-SF) has been highly utilized worldwide, and its sensitivity and specificity have already been shown.[5,6]

The present study evaluated the malnutrition risk for community-dwelling frail elderly receiving public long-term homecare insurance in Japan using the MNA-SF to determine whether dental occlusion might influence the risk of malnutrition.

Methods

The participants were 716 elderly individuals living at home and receiving public long-term care insurance services (240 males and 476 females with a mean age of

83.2 ± 8.6 years) in eight prefectures in Japan (Tokyo, Fukushima, Kanagawa, Yamanashi, Shizuoka, Niigata, Fukuoka and Okinawa). Their malnutrition risk was evaluated using the MNA-SF, and also age, sex and underlying medical problems using the Charlson index[7] were determined. In addition, activities of daily living (ADL) and cognitive function were evaluated using the Barthel index[8] and the Clinical Dementia Rating,[9] respectively, based on information from caregivers or care managers. This evaluation also determined one of the living environment factors, whether or not living alone.

The participants received oral examinations by a dentist or dental hygienist at home or at the day care facility they usually used, and molar occlusion was classified into the following three groups according to edentulous condition and denture-wearing status:

- Group A, natural dentition with adequate function
- Group B, partially or fully edentulous, but maintaining functional occlusion with dentures in either or both jaws
- Group C, functionally inadequate occlusion with no dentures

Swallowing function was evaluated using a stethoscope to determine whether cervical auscultation of swallowing sounds was normal or abnormal.[10] Before the examination, the dentist and dental hygienist in charge were instructed about the cervical auscultation method.

The participants were divided into three groups according to the result of the MNA-SF: (i) well-nourished; (ii) at risk of malnutrition; and (iii) malnourished. The relationship between participants' general condition and oral status was analyzed using the χ^2-test and one-way ANOVA. In addition, participants were also divided into two groups: (i) well-nourished; and (ii) at risk of malnutrition or malnourished. Logistic regression analysis was carried out to study the significant risk factors influencing malnutrition. Participants were also divided into two groups according to whether they were: (i) well-nourished *plus* those at risk of malnutrition; and (ii) malnourished. Logistic regression analysis was carried out to clarify the characteristics of malnourished subjects. PASW Statistics 18 (IBM, Tokyo, Japan) was used for statistical analysis with the significance level set at 95%.

Results

The MNA-SF showed the following: 251 individuals (94 males and 157 females) were well nourished, 370 (120 males and 250 females) were at risk of malnutrition and 95 (26 males and 69 females) were malnourished. Table 1 shows the general condition of participants, number of missing teeth and number of remaining teeth roots among those without occlusion according to nutrition group. The number of participants who lived alone by nutrition group was 30 in the well-nourished group (17.9%), 29 in the at risk of malnutrition group (14.0%) and 16 in the malnourished group (28.6%; $P < 0.05$).

The number of participants by occlusal relationship was 174 in group A (80 males and 94 females with a mean age of 78.7 ± 9.0 years), 421 in group B (120 males and 301 females with a mean age of 84.6 ± 8.0 years) and 121 in group C (40 males and 81 females with a mean age of 84.9 ± 7.7 years), which indicated that there was a significant correlation between occlusal relationship and nutrition status ($P < 0.05$; Fig. 1).

Cervical auscultation showed that the 516 participants exhibited normal swallowing sounds (151 males and 365 females with a mean age of 82.8 ± 8.4 years) and 200 had abnormal swallowing sounds (89 males and 111 females with a mean age of 84.0 ± 9.0 years). There was a significant relationship between normal swallowing sounds and nutrition status ($P < 0.05$, Fig. 2).

The results of the logistic regression analysis showed a significant relationship between malnutrition risk and sex, Barthel index, and occlusal relationship (Table 2).

Table 1 General condition and the number of missing teeth by nutrition group

	Well nourished	At risk of malnutrition	Malnourished
Age	81.9 ± 8.6	83.9 ± 8.3*	83.8 ± 9.3
Charlson index	1.4 ± 1.5	1.6 ± 1.4	1.8 ± 1.4**
Barthel index	77.1 ± 20.8	57.2 ± 27.8*	34.3 ± 28.6***,****
Clinical dementia rating	0.8 ± 0.9	1.2 ± 1.0*	1.4 ± 1.1**
No. missing teeth	20.2 ± 10.6	22.4 ± 9.8*	21.2 ± 9.6
No. remaining teeth root	0.9 ± 2.2	1.7 ± 3.3*	2.3 ± 4.0**
No. occlusal group (group A/B/C)	80/145/26	66/232/72	28/44/23†
No. swallowing sounds (normal/abnormal)	208/43	262/108	46/49†

One-way ANOVA and Games-Howell pairwise comparison test were used for parametric variables. *$P < 0.05$, well-nourished versus at risk of malnutrition; **$P < 0.05$, well nourished versus malnourished; ***$P < 0.05$, at risk of malnutrition versus malnourished. †The χ^2-test was used for non-parametric variables (<0.05).