

## 4. 音声機能・言語機能・咀嚼機能障害

### 1) 音声機能障害

#### (1) 器質性構音障害

唇顎口蓋裂などに伴う構音障害では共鳴の異常と構音の障害がある。

#### (2) 機能性構音障害

発達途上の構音の誤り、特異な構音操作による誤りなどがある。

#### (3) 運動障害性構音障害

発声発語の神経・筋系が障害されると、運動麻痺、錐体外路性運動障害、運動失調などの症状が見られる。構音障害は、弛緩性、痙性、失調性、運動低下性、運動過多性、混合性に分けられる。

構音障害に対する歯科対応としては、構音機能を獲得する前の場合は4歳半頃から開始する。舌癖などが見られる場合は、口腔筋機能療法も行う。また、器質的構音障害の場合には、顎義歯、口蓋閉鎖床、バルブ型スピーチエイド、軟口蓋挙上装置、舌接触補助床など補綴的治療を行うこともある。

咀嚼障害は乳幼児期の発達の障害に起因することが多い。咀嚼運動には多くの器官、組織の協調が必要であり、その獲得のためには患者自身の自発的な運動を引き出す必要がある。

## 5. 精神および行動の障害

- 1) 統合失調症 (schizophrenia)
- 2) 気分障害 (mood disorder)
- 3) 神経症
- 4) 心身症 (psychosomatic disease)
- 5) 摂食障害 (eating disorder)

1)～5)の詳細は、p.518:第5章「5. 歯科(口腔)心身症」を参照。

(渡邊 裕)

## 10-3 認知症

### 1. 定義

認知症は「いったんは正常に発達した知的機能が、その後起こった慢性の脳の器質的障害のために広汎に継続的に低下し、社会生活を営めない状態」(WHO)と定義されている。

#### 疫学

- ・認知症高齢者数は462万人との推計値が厚生労働省研究班(2013年)から出され、2025年には700万人を超えるとの推計値が出されている。この状況は世界でも同様であり、2015年時点で約4680万人、2030年までに7470万人に、さらに2050年までに1億3150万人に達すると報告されている。
- ・認知症は高齢者にのみに見られるものではなく、若い人でも認知症はさまざまな疾患に伴って出現する。認知症の原因疾患としてはおよそ70程度が知られているが、高齢者に限った場合、日本では約半数が「アルツハイマー型認知症」、3割が「血管性認知症」、1割がレビー小体型認知症との報告が多い。表1にこれら認知症タイプ別に特徴、治療法などをまとめた。

#### 診断

- ・認知症タイプで診断基準がある(表1)。それに基づき、脳を中心とした画像検査(CT(図4)、MRI、脳血流検査)を行い、さらに記憶・知的(認知)機能などに関する心理検査などの評価を行う。さらに、認知症に類似した症状を引き起こす疾患(うつ、譫妄など)との鑑別も行う。
- ・認知症による認知機能低下および日常生活変化への評価法は、対象者への直接質問する様式のもと、観察式のものがある。前者は主に認知症診断を目的として診療室などで使用され、代表的なものに、長谷川式簡易知能評価

スケール改訂版(HDS-R)、mini mental state examination(MMSE)がある。後者は、本人を直接観察することや、家族・介護者からの情報を基に評価するもので、認知症の重症度を把握する目的で使用されることが多く、代表的なツールとして、clinical dementia rating(CDR)、認知症高齢者の生活自立度、functional assessment staging(FAST)などがある。

#### 認知症の精神症状

- ・認知症で生じる精神症状は中核症状と周辺症状<sup>\*</sup>に分けられる(図5)。中核症状は認知症による脳機能障害の症状で、記憶や判断力、失語・失行・失認などの知的(認知)機能、段取りがわからない、予定が立てられないなどの実行(遂行)機能障害が含まれる。周辺症状とは、

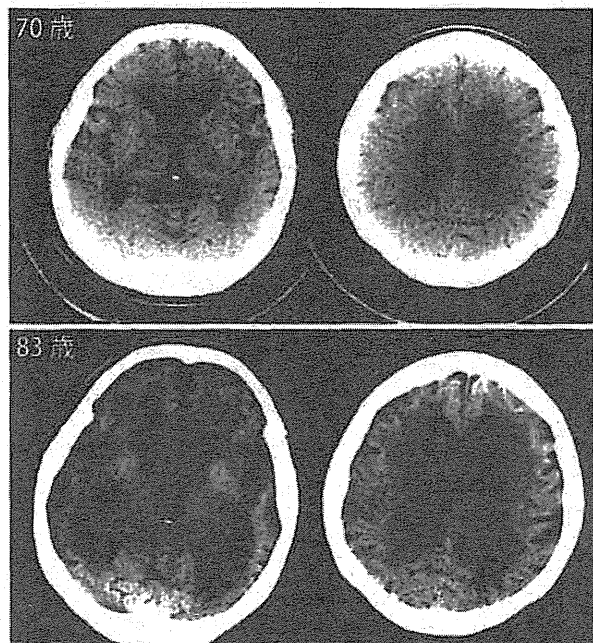


図4 アルツハイマー型認知症患者の脳のCT像  
13年間で脳の萎縮が進行している。(脳の萎縮により脳室(黒く見える)が広がっている。)  
(東京都健康長寿医療センターブレインバンク資料より)

表1 認知症タイプ別概要

	アルツハイマー型認知症	血管性認知症	レビー小体型認知症	前頭側頭型認知症
特徴	65歳以上では最も多い認知症の原因疾患。病的には、大脳萎縮を伴う神経細胞脱落・老人斑・神経原線維変化が出現する。 近時記憶障害（特にエピソード記憶障害が多い）を求め、視空間認知機能の障害も認める。重度化するに従い、失語・失行・失認などが生じる。	65歳以上では2番目に多い認知症の原因疾患。脳出血や脳梗塞など脳血管障害が原因で生じる。日本では小梗塞が多発することによる多発性脳梗塞（ラクナ梗塞）が多い。 症状は、脳の損傷部位により異なる。 以前は、脳血管障害を伴うアルツハイマー型認知症を混合性認知症と呼んだが近年は使用しない。	大脳皮質ニューロンに出現するレビー小体が病理学的特徴の一つである。 認知症症状、精神症状、意識症状の著しい変動（日内、週内など）を認める。 注意、覚醒レベルの変動があり、それに関連する認知機能の動揺を認める。 具体的に詳細な内容の幻視を認める多くの場合、パーキンソン症状を認める。	前頭葉と側頭葉の萎縮が顕微鏡に発症、進行する。早期から性格変化、社交性が消失。毎日、同じ時間に、同じ行動をとる（時刻表的行動）ケースが多い。 手続き記憶、エピソード記憶、視空間認知機能は比較的保持される。 運動性失語症候群（進行性非流暢性失語）、固執失語（意味性認知症）が認められる。
診断	複数の診断基準があるが、NINCDS-ADRDA 診断基準が妥当性が高く広く用いられている。その中の臨床的診断基準として、認知症の臨床検査（知能検査など）で確認される、2つ以上の認知機能領域欠陥を認める、記憶および認知機能領域で進行性低下を認める、意識障害がない、などがあげられている。 以上、臨床症状、心理検査結果、画像所見などを総合して診断する。	複数の診断基準が提唱されているが診断精度は低い。 血管性認知症は病巣部位によりその臨床像は多岐にわたることから、均一的な臨床像（症候群）として集約できない点が明確な診断基準の精度が低くなる一因となっている。	レビー小体型認知症の改訂臨床診断基準（2005年）が最も広く受け入れられており、以下の2つの特徴により診断する。 中核的特徴：①注意や覚醒レベルの著明な変化をともなう認知機能の変動、②繰り返される、典型的な形が明確で細部まで明らかな幻視、③特発性のParkinson症候 示唆的特徴：①REM睡眠行動障害、②抗精神病薬への過敏性、③SPECTまたはPETで検出される基底核のdopamine transporter 取り込み低下。	前頭側頭型認知症は、前頭側頭葉変性症の3つの臨床症候群の一つとして分類されるが、神経病理的背景が多岐であるためしばしば同義語として使用される。The Lund and Manchester group (1994年)、Neary(199年)、McKhann (2001年)の診断基準がある。 本表にあげた日常生活上の状況が基準に含まれており、さらに画像所見として前頭側頭葉前部で異常も含め診断される。
精神症状	取り繕い、場合合わせの反応（一連の当該反応があるため、診療場面では認知症の進行が過小評価されることがあるので配慮が必要）、妄想（もの盗られ妄想）、意欲低下（アパシー）、易怒性も認める。	障害部位により異なるが、意欲の低下、自発性の低下、抑うつ症状、感情失調、夜間騒音などを認める。	幻覚（特に幻視）、体系化された妄想、幻覚・妄想に基づく不安、焦燥、興奮、異常行動、注意や明晰さの顕著な変動を認める。意欲の低下などを認めるケースもある。	被影響性の亢進（周囲の影響を受けやすくなる）、脱抑制（抑制が効かないので、社会性が保てなくなる）、常同行動、自発性が低下する。特定の物事に執着するケースもある。
身体症状・神経症状	重度に進行すると、歩行障害、尿失禁が出現する。転倒を契機に身体機能低下が亢進するケースが多い。最終的には失外産症候群（全ての精神活動失われた状態）が出現する。 高度に進行すると、筋剛直などの筋緊張異常、ミオクローヌス、痙攣発作などを認める。	脳血管障害の背景にある動脈硬化のリスク（高血圧、心疾患、糖尿病など）を認めることが多い。また、脳血管障害の結果として、排尿障害、歩行障害、麻痺、病的反射、仮性球麻痺に伴う嚥下障害、構音障害などを認めるが、脳損傷部位によって症状は異なる。	抗精神病薬に対する重篤な過敏症状、レム睡眠行動障害（レム睡眠中に夢に一致した行動）の出現を多くの場合認める。自律神経障害による繰り返される転倒・失神、一過性の意識消失が見られるケースがある。	特徴的な身体症状はない。 一般的に、麻痺や拘縮など局所神経症状兆候は初期には見られない。運動ニューロン疾患型では、上肢に顕著な筋力低下と筋萎縮を認める。
治療	①中核症状である認知機能障害を改善する治療、②変性疾患進行過程に作用する治療、③BPSDの治療。 「アセチルコリン仮説」に基づきコリンエステラーゼ阻害薬（ドネペジル、ガランタミン、リバスチグミン）、グルタミン酸神経系の過剰活性に着目して開発された、N-methyl-D-aspartate (NMDA) 受容体拮抗薬であるメマンチンが抗認知症薬として本邦では用いられている。	①認知機能障害を改善する治療、②BPSDの治療、③血管障害のリスク因子（高血圧、糖尿病など）への治療による、進行阻止および再発予防。	①認知機能障害を改善する治療、②BPSDの治療、③パーキンソニズムや自律神経症状に対する治療。 上記を目的とした薬物治療は他の症状を増強することがあり配慮が必要である。抗精神病薬に対する感受性が高く、パーキンソニズムを呈することがあるが、抗Parkinson病薬は幻覚、妄想などを増悪させる。 認知機能障害に対しては、ドネペジル、リバスチグミンが有効とされるが、本邦では保険適応はない。	BPSDの治療。 十分に確立された治療法は無いが、選択的セロトニン再取り込阻害薬（SSRI）などの薬物治療が試みられている。

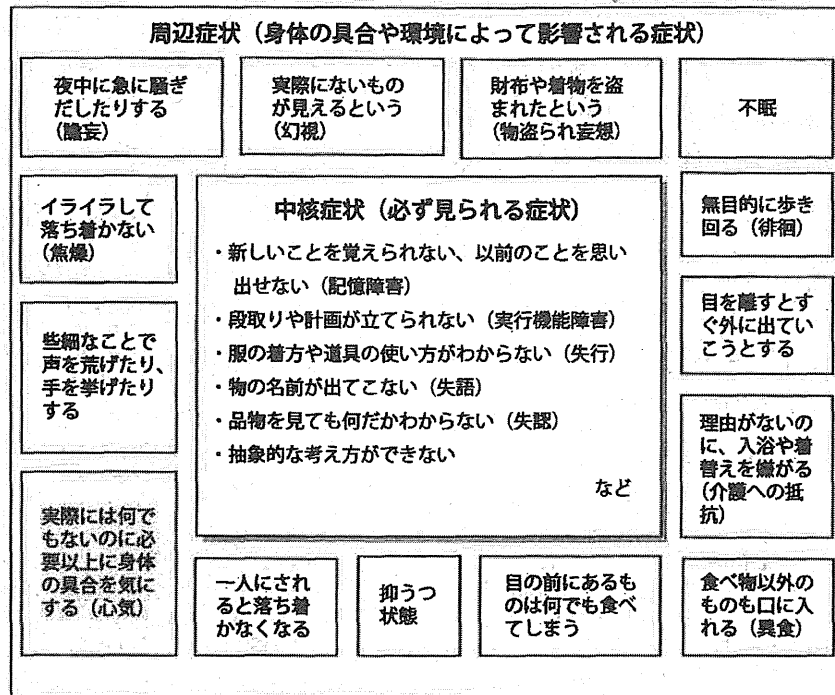


図5 認知症の中核症状と周辺症状

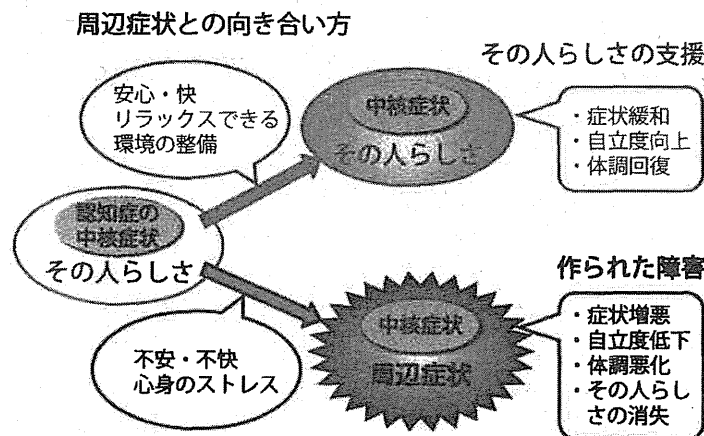


図6 パーソンセンタードケアのイメージ (「図解 認知症バリアフリー百科」TBSブリタニカより引用)

中核症状によって二次的に出現するさまざまな精神症状や行動の障害をさす。周辺症状は身体疾患や心理環境要因などのさまざまな要因の影響を受け出現する。

### 認知症への対応

- ・前述のように認知症の症状には“中核症状”と“周辺症状”がある。現時点では中核症状

を改善する治療は困難であり、認知症の進行とともに徐々に障害の程度は悪化する。一方、周辺症状とは、身体疾患や心理環境要因などのさまざまな要因の影響を受け日常生活の中で顕在化する症状である。つまり認知症高齢者にとって不快な要因に囲まれていれば、できるはずのこともできなくなるが、心地よい

\* : 周辺症状は近年、BPSD (behavioral and psychological symptoms of dementia、認知症の行動と心理症状) と呼ばれることが多くなった。

## 1 歯科と関連する全身疾患

状況であれば穏やかな心で持てる力を十分に発揮できるということとなる。こうした特徴をケアに効果的に反映させたのが、世界的に最も広く知られている認知症ケア理論の一つであるパーソンセンタードケア (person-centered care : PCC) である。PCC は、疾患あるいは症状を対象にしたアプローチではなく、生活する個人を対象としたケアとされ、イギリスの心理学者 Tom Kitwood によって提唱された (図 6)。認知症高齢者にとって

周辺症状が現れている状況は、本人にとって“不安、不快、心身のストレス”がある状況と捉え、そうならないようにストレスの原因を把握し、“安心してリラックスできる環境”を整えていくことを主眼とする。現在薬物治療による認知症の根治は望めないことから、周辺症状を出現させない PCC などのケア視点が重要視されている。

(平野 浩彦)

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# Question 53

## 認知症の人に口腔ケアを行う際に、 アルツハイマー病、血管性認知症、 レビー小体型認知症では、 対応や方法に配慮すべき点がありますか？

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**Key Words**

アルツハイマー病、血管性認知症、レビー小体型認知症、BPSD

**Answer**

どんなに熟練したスタッフでも、初めて会った認知症の人にはうまく口腔ケアを行えないものです。認知症の人のデリケートな口腔に触れるには、対象者とのコミュニケーションを通じて介入を受け入れやすいタイミングや会話の流れなどを熟知しておくことがポイントです。事前に認知症の原因疾患を確認し、普段から神経心理学症状や処方内容、日常生活上のエピソードなどを把握することが必要です。それぞれの認知症の人が抱えているさまざまな困難、そしてその心理状態を理解しようとするのが重要なポイントです。

### ■ 認知症の症状・治療が口腔に及ぼす影響

#### 1 認知症の人の神経心理学的症状

**\*◎BPSD**

Behavioral and psychological symptoms of dementia. 「周辺症状」とよばれるせん妄や抑うつ、徘徊などの認知症の行動・心理症状。

**\*◎精神科薬剤による認知症の人への影響**

認知症の人にとって、特に精神科の薬剤は副作用が起こりやすく、また多剤服用 (polypharmacy) により思わぬ副作用が出現して神経心理学症状や身体症状も生じる。さらに加齢変化や依存疾患の影響なども相まって、口腔内環境にもさまざまな影響が及ぼされる。

■ 中核症状と関連して発症する BPSD には、対象者中心のケアによる対応が主流。

◆ 認知症の神経心理学的症状は、記憶障害や実行機能障害、失認・失行・失語などの「中核症状」と、中核症状があることによって周囲の環境を把握しきれなくなって適切に対応できないことで起こってしまう「周辺症状」(BPSD \*◎) に分けられます。

◆ 認知症の人が社会性をもつ大人として自立して生活したい想いと、徐々に進行する中核症状により周囲の世界を把握しづらくなることの狭間で苦しい思いをしている時期には、いっそう BPSD が出現しやすいといえます。現在は BPSD に対しては、薬剤による治療よりも、ケアによる対応のほうが主流です。BPSD へのケアは、認知症の人を中心に、その人にとって心地よい環境を提供し BPSD を可及的に軽減するように行います。

■ 精神科薬剤投与により口腔内にもさまざまな影響が生じる。

◆ しかし考えられる限りのケアを行っても BPSD に対応困難な場合には、医師より精神科薬剤などが処方されることとなります\*◎。

#### 2 投与薬剤の副作用として現れる口腔内のトラブル

■ 抗コリン剤の副作用により口腔乾燥や口腔機能低下などが生じる。

◆ 薬剤の副作用によって起こりやすい口腔のトラブルの代表が、抗コリン作用による唾液量の減少や口腔乾燥、錐体外路症状による嚥下反射遅延、過鎮静による意識レベ

表1 精神科薬剤の副作用〔文献<sup>1)</sup>より〕

		過鎮静	抗コリン作用	錐体外路症状	その他
身体・認知機能への影響		覚醒レベル不安定、注意力低下	唾液分泌障害、口腔乾燥、便秘、排尿困難、徐脈、認知障害	筋強剛、安静時振戦、仮面様顔貌、動作緩慢、構音障害、嚥下障害、アカシジア、ジストニア	
抗精神病薬	定型	++	++	++	悪性症候群
	非定型	++	+	+	悪性症候群
抗うつ薬	三環系・四環系	++	++	-	セロトニン症候群
	SSRI・SNRI	+	-	-	セロトニン症候群
抗不安薬・睡眠薬		++	-	-	
抗けいれん薬			++	-	-

++：高用量で発生の可能性が高い，+：発生する可能性がある，-：発生する可能性が低い

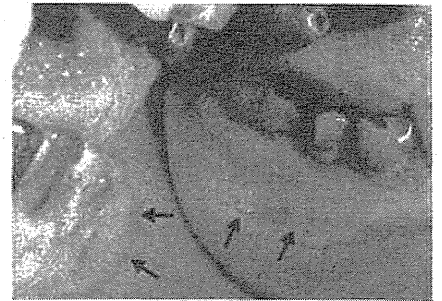


図1 薬剤の口腔内残留により潰瘍形成した症例  
顎堤と頬粘膜の間に広範囲な溝状の潰瘍を形成（右は鏡像）。

ルの不安定さなどです（表1）<sup>1)</sup>。身体状況や体格の変化（体重減少など）、他の内服薬の中断、認知症の進行に伴い、1年前にはちょうどよい処方量であった精神科薬剤でも、急に副作用が出現することも少なくありません。認知症が進行性の疾患であることを十分に理解したうえで、薬剤と上手につきあう必要があります。

■ 薬剤の口腔内残留による潰瘍・粘膜炎にも注意が必要。

◆ 薬剤経口投与に関し、認知症の人の口腔機能低下や嚥下反射の遅れ、口腔内への食物溜め込みに加え、開口困難でなかなか口腔ケアが十分にできない場合は、薬剤の口腔内残留による潰瘍にも注意しなければなりません（図1）。認知症の人の口腔内の知覚が鈍化している場合では、口腔内に潰瘍があっても疼痛を感じることがない、または感じていても表現できないことも少なくありません。潰瘍や粘膜炎など痛みを生じるような口腔粘膜疾患がある際は、よりいっそう開口困難になるため、痛みに留意しながら手早く確認し、歯科診療につなげるのが重要です。

■ 認知症の人への口腔ケア時の留意点

1 認知症の人への身体介助の際の配慮

\*◎原因疾患に応じた口腔ケアの留意点

①血管性認知症…  
脳の損傷部位による症状の個人差が大きく、病名のみで口腔ケアの困難さを判断することはできない。変性性認知症との違いは麻痺や知覚障害、失語などの巣症状（脳血管障害部位に応じた機能障害）があることで、それらは経過の中で加齢や廃用に修飾されて進行する<sup>2)</sup>。

■ 安心できる環境作りと不安・恐怖を取り除く身体への触れ方に留意する。

◆ 精神科薬剤は、上手に使える、身体介助に対するBPSDも制御することができます。しかしどうしても、口腔ケアなどのとてもデリケートな部分への介入に対しては、防衛反応としての拒否行動・言動が起こりやすいものです。

◆ 介助者の言葉や表情を理解できない状態の認知症の人が、急にデリケートな部分を触れられたときの恐怖感を想像してみましょう。口腔ケアを行う際には、認知症の人にとって安心できる環境を作り、口腔ケアを行う意図や行為の内容がわかりやすいように伝える工夫、不安や恐怖を取り除く身体への触れ方が重要になります。認知症の中核症状の存在を理解することによって、言葉かけや言葉以外の伝え方も工夫できます。

②アルツハイマー病…認知症が重度になる頃までは口腔咽喉頭に関する機能低下は緩徐、軽度や中等度の時期に見当識障害や理解力の低下が進み始めると身体介助に対する拒否行動・言動が出現してしまう人も多く見受けられる。自尊心を傷つけないように日常生活行為（特に口腔ケアを含む清潔行為）へ誘導するための工夫が必要<sup>3)</sup>。

③レビー小体型認知症…一日の中でも覚醒の変動や認知機能の変動があり、また記憶障害が軽度な早期から錐体外路症状による嚥下障害が出現するという特徴がある。比較的理解力があり、十分会話に参加することができる時期でも、咽喉感覚の低下や嚥下反射の遅延などの嚥下障害が出現することが多いため、口腔ケア中の水分や姿勢の保持、含嗽（うがい）などには注意が必要である<sup>4)</sup>。

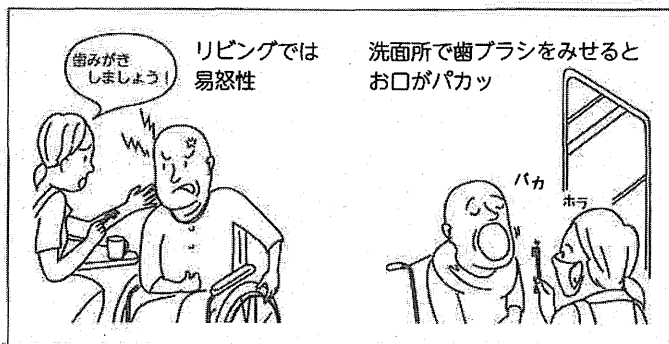


図2 血管性認知症のAさんの場合 (Case 1)

リビングで口腔ケアを行おうとすると失語のため理解できず易怒性が出現し非協力的になってしまうが、洗面台で歯ブラシをみせてからケアを行うパターン継続により、洗面台での口腔ケアに応じてくれるようになった。

## 2 認知症の原因疾患による口腔ケア時の留意点

原因疾患の特徴による留意点の違いをとらえる。

◆認知症の原因疾患はさまざまですが、血管性認知症とアルツハイマー病、レビー小体型認知症では、それぞれの原因疾患に口腔ケアの際に把握しておいたほうがよい特徴があります\*③。

十分な関係作りにより適切な口腔ケア法を探る。

◆実際に身体に接触するケアを行う際には、対象となる人の認知症の進行具合や原因疾患に加え、人生の歴史や性格までも把握した関係作りをするとともに、適切なケアの方法、タイミングなどを探っていく作業が重要になります。

◆認知症の人に健忘症状があるといっても、「慣れ」、「なじみ」、「習慣」が利用できることも多いものです<sup>5)</sup>。たとえば、いつもの介護者の微笑み、毎回同じような優しいトーンの温かい声かけや握手の仕方をするなどでまずは慣れてもらうこと、そして毎回同じようなタイミングで他の利用者と同じように口腔ケアをするような習慣作りをすることが、ケアの一步です。

## CLINICAL CASES

### Case 1 血管性認知症の人の症例

Aさんは脳血管障害により右側の片麻痺、失語、理解力の低下がある人です。特養に入所した頃の頃は、会話において文脈の推測ができていたようで、片言ながらも受け答えができましたが、数年後には言語的な指示は伝わらなくなり、また身体が思うように動かないことでやりたいことができずに易怒性が出現しました。失語と理解力低下の進行から、「歯みがきしましょう」といってリビングルームで口腔ケアをしようとしても、協力を得ることが困難になってしまいました。

しかし失語があっても、物品をみせたり、指さしするなどの視覚的情報は比較的理解しやすいようだったので、毎回の口腔ケアは、①必ず同じ洗面台で行うこと、②言葉での誘導は最小限にして、歯ブラシをみせて理解してもらうことを徹底して継続しました。そうしたかかわりを継続して数カ月、しだいに歯ブラシをみると口を開けてくれるようになり、コップをもって洗面台に吐き出せるような姿勢を介助することで、うがいもできるようになりました (図2)。

Aさんの場合は、機能は保存されていても、認知症の症状があることで、ケアに協力できない例でしたが、物品をみたときに物品の意味が理解でき、物品と行為の関連付け (洗面台-歯ブラシ-歯みがき、コップ-前傾姿勢-ブクブクうがい) ができることを、度重なるかかわりと観察の中から見出したケア戦略でした。



## Case 2 アルツハイマー病の人の症例

- Bさんはアルツハイマー病があり身体全体の廃用によりリクライニング車いすで生活している人です。食事は介助によってミキサー食の経口摂取をしていますが、口にたくさん食事を頬張ったまま飲めずに困っている姿も時折みかけるくらいの嚥下障害、口腔咽頭筋の廃用性萎縮があります。認知症や廃用の進行に従い「口腔ケア時に不機嫌になってしまい、くいしばってしまうのでケアが困難。協力できるときとできないときの差がある」という報告が介護担当者からあり、様子を観察してみました。
- 体調の差もあるようでしたが、口腔ケアに協力できないときは、①介助者が抑揚のない声で淡々と歯みがきを開始している、②くいしばってしまうため、「開けて」など指示系の言葉が多い、③本人が嚥下したいタイミングでもケアを継続してしまっている（Bさんは苦しくなってしまう）、などという特徴がありました。
- 一方で上手に協力できるときの口腔ケアは、①口腔ケア開始前にも天気の話や雑談をして、Bさんの笑顔を引き出している、②開口しなくてもケアできる部分をみがきながら自然に開口するのを待っている、③時折閉口してもらい、息継ぎや嚥下、咳払いを誘導している、という特徴がありました。
- 口腔咽頭筋の廃用性萎縮があると、開口し続けるための筋肉の持続力も低下しているので、開口保持困難になります。また開口させ続けることで、ケアの際に出てきた唾液が咽頭に貯留し苦しくなってしまいます。こうした高齢者の口腔咽頭機能の特徴を理解することも、安全で心地よい口腔ケアには重要です。本例はさらにBさんの特徴を把握することで、さらに心理的な負担感をもコントロールしてケアを行っている例です。

## Case3 レビー小体型認知症の人の症例

- Cさんは冗談をいってくれるぐらい理解力良好な人ですが、会社の重役をしていた人なので、プライドの高さから、特に男性介護職員に対しては口腔ケアをさせてくれませんでした。レビー小体型認知症による錐体外路症状が出現していて、いつも咽頭の唾液貯留がありガラガラとうがいをしているような声で話をします。また後頸部が固縮してきていて、自由に姿勢を変えることができない様子です。食後の口腔ケアが困難だと、歯間や義歯に食物残渣が付着したままで過ごすこともあり、歯周炎やう蝕も進行していくことが予想されました。嚥下障害も心配です。
- そこで新しく作った義歯に満足していることを利用して、「やっぱり歯がそろって素敵ですよ」「歯が入って声がしっかり出るようになりましたね、すごい」などの褒め言葉、また「Cさんがいることがとても役に立っている」「ありがたい」などの感謝の言葉、「お手伝いさせてください」というお願いの言葉を使ってケアの導入を試みました。
- ほどなく心理的な抵抗も減ったばかりか、口腔への介入による心地よさを理解してくれてケアに協力してもらえるようになりました。姿勢と嚥下障害に関しては、水分が咽頭に落ちないで口腔外にこぼれてくれるように（タオルで吸い取る）ケアを行い嚥下障害に対応しています。

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ORIGINAL ARTICLE: EPIDEMIOLOGY,  
CLINICAL PRACTICE AND HEALTH**Factors associated with self-rated oral health among community-dwelling older Japanese: A cross-sectional study**Yuki Ohara,<sup>1,2</sup> Hirohiko Hirano,<sup>1</sup> Yutaka Watanabe,<sup>3</sup> Shuichi Obuchi,<sup>4</sup> Hideyo Yoshida,<sup>1</sup> Yoshinori Fujiwara,<sup>5</sup> Kazushige Ihara,<sup>6</sup> Hisashi Kawai<sup>4</sup> and Shiro Mataki<sup>7</sup>

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**Objectives:** A cross-sectional study was carried out to investigate the determinants of self-rated oral health among community-dwelling older people in Japan.

**Methods:** The participants were 897 (357 men and 540 women) aged 65 years and over who participated in a comprehensive geriatric health examination, which included an oral examination, a face-to-face interview assessing cognitive function, questionnaires regarding depressive symptoms and functional capacity, and a medical examination. The oral examination measured indices of oral health status: number of present teeth, number of functional teeth, occlusal force and amount of resting saliva. Multiple logistic regression analyses were carried out to determine the factors associated with poor self-rated oral health.

**Results:** The mean age of the participants was  $73.5 \pm 5.0$  years. The prevalence of poor and rather poor self-rated oral health was 11.5% and 29.5%, respectively. Multiple logistic regression analyses showed that the number of present teeth (odds ratio [OR] 0.97, 95% confidence intervals [CI] 0.95–0.99), difficulty in mastication (OR 3.20, CI 2.18–4.70), presence of xerostomia (OR 1.43, CI 1.02–2.01), total score on the MoCA-J (OR 1.06, CI 1.01–1.11), and reduction in frequency of leaving the house (OR 1.64, CI 1.12–2.41) were significantly associated with poor self-rated oral health.

**Conclusions:** The present results suggested that self-rated oral health was a significant factor in oral health status as well as overall well-being among community-dwelling older Japanese people. *Geriatr Gerontol Int* 2015; 15: 755–761.

**Keywords:** community-dwelling, lifestyle, oral function, self-rated oral health, xerostomia.

**Introduction**

As the Japanese population ages, researchers have become increasingly interested in the oral health of older people<sup>1–3</sup> Oral health is integral to overall health and well-being, and shares many of the same risk factors and determinants as other chronic diseases, such as cardiovascular disease, cancer, chronic respiratory disease and diabetes.<sup>4,5</sup> Oral health problems can result

in pain and discomfort, and lead to problems with eating, communication and appearance.<sup>6</sup>

Older adults in particular tend to experience higher rates of tooth loss, dental caries, periodontal disease and oral cancer.<sup>7–9</sup> Self-rated oral health is a personal assessment of the functional, psychological and social impact of oral disease on overall well-being, and it can be used both to summarize a person's oral health status and as an oral health outcome measure.<sup>10,11</sup> Self-rated questionnaires provide a simple, direct way of capturing perceptions of health and oral health that are valid, reliable, and cost-effective.<sup>12</sup> International studies have identified several factors associated with self-rated oral health in older people.<sup>1,3,4,6,10,11</sup> However, to the best of our knowledge, few studies in Japan have investigated the relationship between self-rated oral health and well-being,

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including psychosocial factors and cognitive function. The aim of the present study was to investigate the factors associated with poor self-rated oral health in community dwelling older adults.

## Methods

### *Study population*

Community-dwelling older people ( $n = 897$ , 357 men, 540 women; age 65–84 years) were invited to undergo a comprehensive geriatric health examination by the Tokyo Metropolitan Institute of Gerontology. The mean age of the participants was  $73.5 \pm 5.0$  years. The examinations were carried out over 11 days in the Itabashi Ward, which is located in the north of Tokyo, in October 2011.

### *Instruments*

#### *Self-rated oral health*

Self-rated oral health was assessed with the question “What do you think of your oral health?” with four response options. For the statistical analysis, the categories “good” and “rather good” were combined, as were the categories “rather poor” and “poor.”

#### *Self-assessed oral function*

We asked three dichotomous questions regarding oral function, as follows: “Do you have difficulty in chewing solid food?”, “Do you choke when drinking tea or soup?” and “Does your mouth feel dry?”, which were indicators of difficulty in mastication, difficulty in swallowing and xerostomia (i.e. chronic dry mouth),<sup>13</sup> respectively.

#### *Oral examination*

Oral examinations were carried out by dental hygienists who received standardization training before the study. The examination consisted of several different components. The number of present teeth and functional teeth were counted. Functional teeth were defined as present teeth and missing teeth treated by prosthesis, such as dentures or dental implants; teeth with severe decay and stump teeth were omitted from the definition of functional teeth, because they are not used for mastication.<sup>14</sup>

Occlusal force was measured using a pressure-sensitive film (Dental Prescale 50HR Type R; Fuji Photo Film, Tokyo, Japan) and its analytical equipment (OCCLUZER, FPD-707; Fuji Photo Film). Participants sat on a chair with their heads upright and unsupported, in a natural position, with their Frankfurt horizontal plane parallel to the floor. Participants were asked to

bite the pressure-sensitive film with maximal force. Those who wore a removable denture bit the sheets with their dentures in place.<sup>15</sup> Occlusal force was measured in newtons (N).

Resting saliva was collected using the modified cotton roll method.<sup>16–18</sup> A preweighed cotton roll was placed under the tongue, and the participants were instructed to close their mouth for 30 s, after which the cotton roll was removed. The amount of saliva absorbed by the cotton was then measured using an electronic scale. This measurement was carried out once for each participant.

#### *Measurements of functional capacity*

Functional capacity contains two major components: “basic activities of daily living (ADL)” and “higher-level functional competence”.<sup>19</sup> We assessed higher-level competence (e.g. preparing meals, managing money, taking medications) using the Tokyo Metropolitan Institute of Gerontology index of competence (TMIG-IC; Table 1). This multidimensional 13-item competence index has been shown to have high reliability and validity.<sup>20</sup> Higher scores reflect a higher level of functional competence. This index is widely accepted and used in Japan to evaluate functional capacity in older adults.

#### *Cognitive function*

The Japanese version of the Montreal Cognitive Assessment (MoCA-J) was used to assess cognitive function. The MoCA-J is a useful cognitive test for screening mild cognitive impairment, and has been recommended for use in community-based geriatric health screenings.<sup>21</sup> This scale provides a total score ranging from 0 to 30 points, with higher scores representing better cognitive function.

#### *Lifestyle factors*

These dichotomous questionnaire items assessed what factors negatively influenced older people’s lives. Participants were asked whether their frequency of leaving the house had reduced in the last year, whether they had been hospitalized in the last year, whether they had fallen in the last year and whether they smoked.

#### *Zung Self-Rating Depression Scale*

The Zung Self-Rating Depression Scale (SDS), a widely used instrument for assessing the severity of depression, was administered.<sup>22,23</sup> The Japanese version of the SDS is a self-report 20-question instrument that assesses the psychological and somatic symptoms of depression. Ten questions are positively worded, and 10 are

**Table 1** Questions on the Tokyo Metropolitan Institute of Gerontology index of competence

1. Can you use public transportation (bus or train) by yourself?
2. Are you able to shop for daily necessities?
3. Are you able to prepare meals by yourself?
4. Are you able to pay bills?
5. Can you handle your own banking?
6. Are you able to fill out forms for your pension?
7. Do you read the newspaper?
8. Do you read books or magazines?
9. Are you interested in new stories or programs dealing with health?
10. Do you visit the homes of friends?
11. Are you sometimes called on for advice?
12. Are you able to visit sick friends?
13. Do you sometimes initiate conversations with young people?

The response to each item can be "yes" (able to do) or "no" (unable). The total score is the number of items answered "yes". The possible range of competence score in this index is 0–13 points. Therefore, a higher score indicates higher functional capacity.

negatively worded. Each question is scored on the following four-point scale: 1, a little of the time; 2, some of the time; 3, a good part of the time; and 4, most of the time. To obtain the total score, the positive items are reversed, and then the items are summed.<sup>24</sup>

### Data analysis

The  $\chi^2$ -test (for categorical variables), Student's *t*-test, and the Mann-Whitney *U*-test (for continuous variables) were used to examine differences between the good and poor oral health groups. Multiple logistic regression analysis (forced entry analysis) was carried out to identify factors associated with self-rated oral health. The dependent variable was poor self-rated oral health, whereas variables that resulted in a *P*-value of <0.2 in the bivariate analysis were determined to be independent variables. Before multiple logistic regression analysis, the dependent variables for which correlation coefficients were  $\geq 0.8$  were deleted in order to avoid multicollinearity. All statistical analyses were carried out using SPSS Statistics version 20.0J software for Windows (IBM, Tokyo, Japan). The level of significance was set at *P* < 0.05.

### Ethical considerations

The present study was approved by the ethics board of the Tokyo Metropolitan Institute of Gerontology (Issue # 23–1235 in 2011). Written informed consent was obtained from each participant.

### Results

Participants' background and oral health status statistics are shown in Table 2. The prevalence of poor and

rather poor self-rated oral health was 11.5% and 29.5%, respectively. Comparisons between the good and bad oral health groups are shown in Table 3. There were significant differences in the number of present and functional teeth, occlusal force, functional capacity, depressive symptoms, smoking habit, reduction in frequency of leaving the house, a fall in the last year, difficulty in mastication and swallowing, and the presence of xerostomia between the groups.

Table 4 presents the results of the multiple logistic regression analyses of self-rated oral health. Multiple logistic regression analyses showed that the number of present teeth (odds ratio [OR] 0.97, 95% confidence intervals [CI] 0.95–0.99), difficulty in mastication (OR 3.20, CI 2.18–4.70), presence of xerostomia (OR 1.43, CI 1.02–2.01), total score on the MoCA-J (OR 1.06, CI 1.01–1.11) and reduction in frequency of leaving the house (OR 1.64, CI 1.12–2.41) were significantly associated with poor self-rated oral health.

### Discussion

In the present study, we investigated broader factors associated with poor self-rated oral health among the community-dwelling older Japanese population, including oral health status, psychosocial factors, functional capacity and cognitive function. Approximately 40% of the older participants in the present study reported poor oral health. Previous reports showed that the percentages of poor self-rated oral health in the older population ranged from 17.4% to 61.3%.<sup>1,3,6,10,25,26</sup> This wide variability might be due to the differences among the study populations. The percentage of poor self-rated oral health found in the present study was within the range of the previous reports.

**Table 2** Basic characteristics of the study population

Continuous variables	Total ( <i>n</i> = 897)	
	Mean	SD
Age (years)	73.5	5.0
No. present teeth	19.5	9.2
No. functional teeth	26.7	3.8
Occlusal force (N)	497.9	341.3
MoCA-J total points	23.2	3.7
TMIG-IC total points	12.4	1.3
SDS total points	34.4	9.0
Amount of resting saliva (g)	0.3	0.2
Categorical variables	<i>n</i>	%
Self-rated oral health		
Good	59	6.6
Rather good	470	52.4
Rather poor	265	29.5
Poor	103	11.5
Smoking habit (% yes)	92	10.3
Reduction in frequency of going out (% yes)	197	22.0
Hospitalization in the past 1 year (% yes)	105	11.7
Experience of fall in the past 1 year (% yes)	205	22.9
Difficulty in mastication (% yes)	215	24.0
Difficulty in swallowing (% yes)	186	20.8
Xerostomia (% yes)	312	34.8

MoCA-J, Japanese version of Montreal Cognitive Assessment; SD, standard deviation; SDS, Self-rated Depression Scale; TMIG-IC, Tokyo Metropolitan Institute of Gerontology index of competence.

In the present study, poor self-rated oral health was significantly associated with chewing problems and the number of present teeth. Although the participants of the present study rated their own oral function regarding mastication, swallowing, and xerostomia, there was no significant association between swallowing problems and self-rated oral health, and the OR of xerostomia was relatively lower than that of chewing problems. It is interesting that chewing problems was a stronger factor associated with poor self-rated oral health compared with other oral complaints, such as swallowing problems and xerostomia. Locker *et al.* reported one of the main complaints of older people was not biting well, and masticatory function is an essential factor affecting the independently living older population in particular.<sup>27</sup> Furthermore, decline in chewing ability is related to higher-level functional capacity,<sup>28</sup> general health status,<sup>29</sup> cognitive function<sup>30</sup> and food intake.<sup>31</sup> Therefore, it is important to ensure that older adults have proper chewing ability, as this will help maintain their quality of life.

The present study showed an association between poor self-rated oral health and xerostomia in older persons. Xerostomia is another common complaint among the older population.<sup>16,32-34</sup> Previous studies reported that xerostomia leads to oral dysfunction, including swallowing, mastication and speaking difficulties.<sup>13,33</sup> Saliva plays an important role in maintaining oral health status because of its antibacterial, buffering and moistening functions.<sup>35</sup> Therefore, xerostomia affects quality of life and activities of daily living, and likely influences self-rated oral health as well. It is necessary for oral health professionals to consider xerostomic problems when managing oral health for older people.

In the present study, there was no significant association between depressive symptoms and poor self-rated oral health. Previous reports had suggested that self-rated oral health was related to psychological well-being, including such variables as depressive symptoms, chronic stress and life satisfaction.<sup>1,6,25,36,37</sup> In contrast, the decline of cognitive function was independently associated with self-rated oral health. Cognitive impairment can be an early sign of clinical dementia,<sup>38</sup> and it influences disability<sup>39</sup> and mortality.<sup>40</sup> Okamoto *et al.* reported that tooth loss was related to cognitive function among community-dwelling older Japanese.<sup>41</sup> However, few studies have investigated the association between cognitive function and self-rated oral health among the independent older population, so the evidence remains insufficient. Previous studies reported the association between cognitive impairment and depression,<sup>42</sup> so we tested the correlation coefficient between the dependent variables in order to avoid multicollinearity before carrying out the multiple logistic regression analysis. The correlation coefficient between cognitive function evaluated by the MoCA-J and depressive condition evaluated by the SDS was just  $-0.174$  (data not shown). Thus, cognitive function and depressive symptoms were not potential confounding factors for self-rated oral health. This was the first population-based study that investigated both depressive symptoms and cognitive function, so the results offer new information. It appears that cognitive function is an important issue for promoting oral health among the older population of Japan.

The present study suggested that reduction in frequency of leaving the house was an independent risk factor of poor oral health. We speculated that this is because a lower frequency of leaving the house would affect the regularity of dental clinic visits. Dental disease is easily managed or prevented through proper daily care and regular use of professional dental services. However, older persons face many challenges in accessing such dental services.<sup>43</sup> Thus, oral healthcare providers should pay special attention to preventive care for older people with functional disabilities and decreasing frequency of leaving the house.

**Table 3** Bivariate analyses between self-rated oral health and selected predictor variables

Predictor variables	Good/rather good ( <i>n</i> = 529)		Rather poor /poor ( <i>n</i> = 368)		<i>P</i> -value
	Mean	SD	Mean	SD	
Continuous variables					
Age (years)	73.5	5.0	73.5	5.0	0.977 <sup>†</sup>
No. present teeth	21.7	8.9	16.5	8.9	<i>P</i> < 0.001 <sup>‡</sup>
No. functional teeth	27.2	3.3	26.0	4.3	<i>P</i> < 0.001 <sup>‡</sup>
Occlusal force (N)	582.4	365.5	375.9	258.6	<i>P</i> < 0.001 <sup>‡</sup>
MoCA-J total points	23.4	3.6	23.0	3.7	0.139 <sup>‡</sup>
TMIG-IC total points	12.5	1.2	12.2	1.4	<i>P</i> < 0.001 <sup>‡</sup>
SDS total points	33.2	8.6	36.1	9.4	<i>P</i> < 0.001 <sup>‡</sup>
Amount of resting saliva (g)	0.28	0.19	0.28	0.22	0.514 <sup>‡</sup>
Categorical variables	<i>n</i>	%	<i>n</i>	%	
Sex					
Male	220	41.6	137	37.2	0.107 <sup>§</sup>
Female	309	58.4	231	62.8	
Smoking habit (% yes)					<i>P</i> < 0.001 <sup>§</sup>
Reduction in frequency of leaving the house (% yes)	81	15.3	116	31.5	<i>P</i> < 0.001 <sup>§</sup>
Hospitalization in the last one year (% yes)	64	12.1	41	11.1	0.371 <sup>§</sup>
Experience of fall in the last one year (% yes)	103	19.5	102	27.7	0.003 <sup>§</sup>
Difficulty in mastication (% yes)	61	11.6	154	41.8	<i>P</i> < 0.001 <sup>§</sup>
Difficulty in swallowing (% yes)	96	18.2	90	24.5	0.013 <sup>§</sup>
Xerostomia (% yes)	150	28.4	162	44.0	<i>P</i> < 0.001 <sup>§</sup>

<sup>†</sup>Student's *t*-test; <sup>‡</sup>Mann-Whitney *U*-test; <sup>§</sup> $\chi^2$ -test. MoCA-J, Japanese version of Montreal Cognitive Assessment; SD, standard deviation; SDS, Self-rated Depression Scale.; TMIG-IC, Tokyo Metropolitan Institute of Gerontology index of competence.

**Table 4** Multiple logistic regression analysis of associated factors with poor self-rated oral health

	Adjusted OR	95% CI	<i>P</i> -value
No. present teeth	0.97	(0.95–0.99)	0.008
No. functional teeth	0.98	(0.94–1.03)	0.553
Occlusal force (N)	1.00	(1.00–1.00)	<i>P</i> < 0.001
Difficulty in mastication (for yes)	3.20	(2.18–4.70)	<i>P</i> < 0.001
Difficulty in swallowing (for yes)	1.05	(0.72–1.55)	0.792
Xerostomia (for yes)	1.43	(1.02–2.01)	0.036
Smoking habit (for yes)	0.61	(0.36–1.03)	0.063
MoCA-J total points	1.06	(1.01–1.11)	0.018
SDS total points	1.02	(1.00–1.03)	0.111
TMIG-IC total points	0.97	(0.84–1.11)	0.644
Reduction in frequency of leaving the house (for yes)	1.64	(1.12–2.41)	0.012
Experience of fall in the last one year (for yes)	1.32	(0.92–1.91)	0.136

Forced entry, *P*-values are adjusted for sex. 95% CI, 95% confidence interval; MoCA-J, Japanese version of Montreal Cognitive Assessment; OR, odds ratio; SD, standard deviation; SDS, Self-rated Depression Scale; TMIG-IC, Tokyo Metropolitan Institute of Gerontology index of competence.

Although approximately one-quarter of Japanese young adults report poor oral health, it is a more important public health issue for the older population, who tend to experience more oral disease and functional decline.<sup>7</sup> The present study is one of the few reports that investigated the factors associated with self-rated oral health focused particularly in the Japanese community-dwelling older population. The present results suggested that various factors, such as dental clinical condition, as well as psychosocial factors, were associated with poor oral health in the older population. Self-rated oral health is a key factor impacting on well-being and quality of life.<sup>5</sup> In order to prevent impairment of oral function and well-being at an early stage, oral health professionals should assess these multiple factors.

There were some limitations in the present study. First, we cannot infer any causal relationship between poor self-rated oral health and associated factors because of the cross-sectional study design. Second, the participants in the present study were independently living individuals who volunteered to participate in the health examination; therefore, it is likely that they represented a healthier portion of the general elderly population. Further investigation including a longitudinal study would be necessary to confirm and expand these findings.

In conclusion, the present study showed that poor self-rated oral health was significantly and independently related to masticatory function, the presence of xerostomia, number of present teeth, cognitive function and reduction in frequency of leaving the house in community-dwelling older Japanese adults, after adjusting for confounding variables.

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## Disclosure statement

The authors declare no conflict of interest.

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ORIGINAL ARTICLE: EPIDEMIOLOGY,  
CLINICAL PRACTICE AND HEALTH**Relationship between chewing ability and sarcopenia in Japanese community-dwelling older adults**Masaharu Murakami,<sup>1</sup> Hirohiko Hirano,<sup>2</sup> Yutaka Watanabe,<sup>3</sup> Katsuhiko Sakai,<sup>1</sup> Hunkyoung Kim<sup>2</sup> and Akira Katakura<sup>1</sup><sup>1</sup>Department of Oral Medicine, Oral and Maxillofacial Surgery, Tokyo Dental College, <sup>2</sup>Research Team for Promoting Independence of the Elderly, Tokyo Metropolitan Institute of Gerontology, Tokyo, and <sup>3</sup>Oral Diseases Research, Department of Advanced Medicine, Division of Oral and Dental Surgery, National Center for Geriatrics and Gerontology, Aichi, Japan

**Aim:** It has been reported that if nutrient intake is unbalanced, muscle mass, muscle strength and physical performance declines, and therefore it is important to maintain chewing ability to keep a balanced nutrient intake. However, the relationship between chewing ability and sarcopenia has not been previously reported. Therefore, the present study investigated the relationship between chewing ability and sarcopenia in addition to known sarcopenia-related factors.

**Methods:** We examined 761 participants (average age  $73.0 \pm 5.1$  years), who lived in the Itabashi city of Tokyo. Our research was designed to examine the relationship between chewing ability and sarcopenia. We carried out regression analysis to analyze the relationship with sarcopenia-related factors with consideration of the age of the participants.

**Results:** The 761 participants were divided into two groups in terms of the stage of sarcopenia according to whether there was a deterioration of muscle strength or physical performance. Furthermore, we carried out logistic regression analyses on the value as a dependent variable, including known sarcopenia-related factors. There were significant correlations of sarcopenia with age (odds ratio 2.37, 95% confidence interval 1.52–3.70), body mass index (odds ratio 0.75, 95% confidence interval 0.69–0.81) and chewing ability (odds ratio 2.18, 95% confidence interval 1.21–3.93).

**Conclusions:** The present study shows that chewing ability is related to sarcopenia, which is equal to the relationship with the known factor of age by odds ratio. **Geriatr Gerontol Int 2015; 15: 1007–1012.**

**Keywords:** chewing ability, color-changeable gum, community, elderly, sarcopenia.

**Introduction**

Sarcopenia, defined as the degenerative loss of skeletal muscle mass, has recently been considered to result from a decline in muscular strength.<sup>1,2</sup> It has been reported that the age-related loss of skeletal muscle mass leads to a decline in activities of daily living (ADL) in older adults, leading to difficulties in maintaining their quality of life (QOL). Studies have shown that if nutrient intake is unbalanced, muscle mass, muscle strength and physical performance declines,<sup>3</sup> and it is important to maintain chewing ability to keep a balanced nutrient intake.<sup>4,5</sup> Enjoying meals is one of the

most important factors to support the QOL of senile older adults, and it is also important to maintain and promote their health.<sup>6,7</sup>

Several studies have reported on the relationship between chewing ability and grip strength/physical performance,<sup>8,9</sup> and on the relationship between tongue muscle thickness and sarcopenia,<sup>10</sup> but there have been no reports addressing the possible relationship between chewing ability and sarcopenia.

Therefore, we carried out this research on Japanese community-dwelling older adults, and investigated the relationship between chewing ability and sarcopenia in addition to known sarcopenia-related factors.

**Methods****Participants**

The Tokyo Metropolitan Institute of Gerontology (TMIG) sent invitations for a comprehensive geriatric

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health examination for early detection and early care of geriatric syndrome to 7015 male and female older adults aged from 65 to 85 years who lived within nine towns in Itabashi city (Tokyo, Japan), excluding nursing home residents and those who had participated in our previous interventional research studies. Among them, 1325 people offered to attend and 835 people actually attended. Excluding withdrawals due to the terms of our research, and also exclusions of missing values due to people with heart pacemakers and/or walking difficulties, the data of 761 participants were analyzed in the present study.

This research was carried out at the TMIG from 25 September 2012 to 5 October 2012. The participants attended by walking, driving or being driven by family members, or by using public transportation, and furthermore, they were able to understand and follow our instructions. We received written informed consent from each participant individually. This research was carried out with permission of the TMIG Ethics Committee (Issue #.23–1253 in 2011).

### **Stages of sarcopenia**

The guidelines of the European Working Group on Sarcopenia in Older People (EWGSOP) were used to classify the severity of sarcopenia (stage of sarcopenia [SSp]) according to muscle mass (skeletal muscle mass measured by bioelectrical impedance analysis [BIA]), muscle strength (grip strength) and physical performance (usual walking speed).<sup>11</sup> In addition, participants were classified by SSp into a healthy and presarcopenia group in which declines in muscle strength or physical performance were not observed (maintenance group [MG]), or into a sarcopenia and severe sarcopenia group in which declines in muscle strength or physical performance were significant (decline group [DG]). The cut-off value was according to the method established by the Asian Working Group for Sarcopenia (AWGS).<sup>12</sup>

### **General evaluation**

#### *Height*

Each participant was advised to keep their heels, buttocks, back and head touching the stadiometer. Making sure that their neck, waist and knees were straight, their height was measured per 0.1 cm.

#### *Weight*

Each participant was advised to stand on a weight scale quietly, and the stable value of their weight was measured per 0.1 kg.

### *Skeletal muscle mass index*

Body composition was measured with BIA using an InBody720 (Bio Space, Seoul, Korea), and extremity muscle mass (kg) was determined from the sum of the upper and lower extremities. We divided the measured extremity muscle mass by the squared height (m conversion), and the adjusted extremity muscle mass was used as the skeletal muscle mass index (SMI). We used the standard value set by the AWGS, which is less than 7.0 kg/m<sup>2</sup> for men and less than 5.7 kg/m<sup>2</sup> for women for the SMI cut-off value of sarcopenia.<sup>12</sup>

### *Nutrition evaluation*

The body mass index (BMI) was measured as an indicator of the nutritional status of each participant. We divided the measured extremity height (m), and the weight was used as the BMI.

### *Physical function evaluation*

Physical function was measured following the functional improvement manual issued by the Ministry of Health, Labor and Welfare.<sup>13</sup>

#### *Grip strength*

Grip strength was used as an indicator of muscle strength, and was measured using a Smedley dynamometer (As one, Osaka, Japan). Measurements were carried out twice, and the higher value was used.<sup>14,15</sup> The cut-off value of grip strength was set as the lowest of quartile value, according to the method of the AWGS, which is less than 26.0 kg for men and less than 18.0 kg for women.<sup>12</sup>

#### *Usual walking speed (walking ability)*

Participants walked along a walking path with a 3-m acceleration zone, a 5-m measurement zone and a 3-m deceleration zone, and the time each participant's feet were in the swing phase (the foot apart from the ground) was measured from the start-point of the measurement zone to the end-point of the measurement zone. Measurements were taken twice, and the faster time was used in the analysis. The cut-off value of the walking speed was set as the lowest of quartile value, according to the method of the AWGS, which is less than 1.0 m/s.<sup>12</sup>

### *Oral examination*

Oral examinations were carried out by two dentists and five dental hygienists who had standardized their methods before the study.

**Table 1** Basic attributes of Japanese community-dwelling older adults

		Total (n = 761) Mean ± SD	Male (n = 314) Mean ± SD	Female (n = 447) Mean ± SD	P-value
Age (years)		73.0 ± 5.1	73.7 ± 5.5	72.6 ± 4.9	0.011 (u)
BMI (kg/m <sup>2</sup> )		22.9 ± 3.3	23.7 ± 3.1	22.4 ± 3.3	<0.001 (u)
SMI (kg/m <sup>2</sup> )		6.5 ± 1.0	7.3 ± 0.9	5.9 ± 0.6	<0.001 (u)
Grip strength (kg)		24.3 ± 8.2	31.2 ± 7.1	19.4 ± 4.7	<0.001 (u)
Usual walking speed (m/s)		1.4 ± 0.2	1.4 ± 0.2	1.4 ± 0.3	0.689 (u)
No. existing teeth		19.9 ± 8.9	19.0 ± 9.4	20.5 ± 8.6	0.040 (u)
No. functional teeth		27.0 ± 3.0	26.8 ± 3.5	27.1 ± 2.6	0.386 (u)
Occlusal force (N)		529 ± 342	576 ± 383	497 ± 305	0.011 (u)
Chewing ability	Good	85.8 = 653/761	87.6 = 275/314	84.6 = 378/447	0.241 (χ <sup>2</sup> )
	Poor	14.2 = 108/761	12.4 = 39/314	15.4 = 69/447	
Stages of sarcopenia	MG	84.8 = 645/761	86.0 = 270/314	83.9 = 375/447	0.429 (χ <sup>2</sup> )
	DG	15.2 = 116/761	14.0 = 44/314	16.1 = 72/447	

Values are mean ± standard deviation. Chewing ability (divided the color changes of color-changeable gum into 5 stages, 1 and 2 with less color change into "Poor," and 3, 4 and 5 with more color change into "Good"). χ<sup>2</sup>, χ<sup>2</sup>-test; BMI, body mass index; DG, decline group; MG, maintenance group; SD, standard deviation; SMI, skeletal muscle mass index; u, Mann-Whitney U-test.

#### Chewing ability

A color-changeable chewing gum (masticatory performance evaluating gum Xylitol; Lotte, Saitama, Japan) was used to examine chewing ability. After chewing the gum for 1 min, the participant spat the gum on a piece of white paper, and the gum was analyzed with a color chart into five levels by testers.<sup>16</sup> Levels 1 and 2, which were approximately the lowest of quartile value, were classified as "poor," and levels 3, 4 and 5 were classified as "good".

#### Number of existing teeth

The number of existing intraoral erupted teeth was counted, excluding the residual roots.

#### Number of functional teeth

The number of prosthetic treatment bridges, plate dentures (removal dentures), implants (artificial roots) of defect sites and the number of existing teeth were counted.

#### Occlusal force

An occlusal force measurement system film was used, Dental Prescale 50H Type R (Fuji Photo Film, Tokyo, Japan) and an Occuluser (Fuji Photo Film). Following the method of Matsui *et al.*,<sup>17</sup> each participant sat on a chair, making sure that the Frankfurt horizontal plane and the floor were as parallel as possible, and then was asked to bite down on the prescale at the intercuspal position as hard as possible.<sup>17</sup> Occlusal force was measured in newtons (N).

#### Statistical analysis

The Mann-Whitney U-test was carried out to assess differences between continuous variables in the two groups. For the categorical variable, the χ<sup>2</sup>-test was used. Logistic regression analysis was used for the purpose of researching factors related to DG. All statistical analyses were carried out using SPSS20.0J for Windows (IBM, Armonk, NY, USA), and a risk ratio of less than 5% was considered a significant difference.

### Results

#### Basic attributes of the participants

The basic attributes of the participants in the present study are shown in Table 1. There were 761 participants (mean age 73.0 ± 5.1 years), 314 men (mean age 73.7 ± 5.5 years) and 447 women (mean age 72.6 ± 4.9 years). Women had higher values for the number of existing teeth (P = 0.040). Men had higher values for age (P = 0.011), BMI (P < 0.001), SMI (P < 0.001), grip strength (P < 0.001) and occlusal force (P = 0.011).

The rate of MG and DG of SSp was: men 14.0% and women 16.1%. However, the percentage of DG was not significantly different between men and women.

#### SSp comparisons

Comparisons of each variable between MG and DG of SSp are shown in Table 2. The ages of the participants were higher with DG (P < 0.001). BMI (P < 0.001), SMI (P < 0.001), grip strength (P < 0.001), usual walking speed (P < 0.001), number of existing teeth (P < 0.001), occlusal force (P < 0.001) and chewing ability

**Table 2** Comparison between stage of sarcopenia and each factor

	MG		DG		P-value
	Men (270) Mean ± SD	Women (375) Mean ± SD	Men (44) Mean ± SD	Women (72) Mean ± SD	
<i>n</i> = 761					
Age (years)	72.6 ± 5.0	72.3 ± 4.8	75.7 ± 5.2	74.4 ± 4.9	<0.001 (u)
Early elderly	64.2 = 414/645	66.4 = 249/375	42.2 = 49/116	55.6 = 40/72	<0.001 (χ <sup>2</sup> )
Late elderly	35.8 = 231/645	33.6 = 126/375	57.8 = 67/116	44.4 = 32/72	
BMI (kg/m <sup>2</sup> )	23.3 ± 3.2	22.8 ± 3.3	20.9 ± 2.7	20.4 ± 2.9	<0.001 (u)
SMI (kg/m <sup>2</sup> )	6.6 ± 1.0	6.0 ± 0.6	5.7 ± 0.7	5.2 ± 0.4	<0.001 (u)
Grip strength (kg)	25.6 ± 8.1	20.3 ± 4.4	17.1 ± 4.5	14.7 ± 3.0	<0.001 (u)
Usual walking speed (m/s)	1.4 ± 0.2	1.4 ± 0.2	1.2 ± 0.3	1.2 ± 0.3	<0.001 (u)
No. existing teeth	20.3 ± 8.8	20.7 ± 8.5	17.5 ± 9.4	19.8 ± 8.9	<0.001 (u)
No. functional teeth	27.0 ± 2.9	27.1 ± 2.4	26.7 ± 3.6	26.9 ± 3.4	0.693 (u)
Occlusal force (N)	551 ± 347	509 ± 308	407 ± 280	431 ± 282	<0.001 (u)
Chewing ability	88.7 = 572/645	86.9 = 326/375	69.8 = 81/116	27.8 = 20/72	<0.001 (χ <sup>2</sup> )
	11.3 = 73/645	13.1 = 49/375	30.2 = 35/116	72.2 = 52/72	

Value are mean ± standard deviation. Early elderly aged less than 75 years; late elderly aged more than 75 years; chewing ability (divided the color changes of color-changeable gum into 5 stages, 1 and 2 with less color change into "poor," and 3, 4 and 5 with more color change into "good"). χ<sup>2</sup>, χ<sup>2</sup>-test; BMI, body mass index; DG, decline group; MG, maintenance group; SD, standard deviation; SMI, skeletal muscle mass index; u, Mann-Whitney *U*-test.

**Table 3** Examination of relationship between various items and Sarcopenia

	OR	95% CI	P-value
Age (early elderly = 0, late elderly = 1)	2.37	(1.52–3.70)	<0.001
BMI (/kg/m <sup>2</sup> )	0.75	(0.69–0.81)	<0.001
No. existing teeth (/tooth)	1.01	(0.98–1.04)	0.523
Occlusal force (/N)	1.00	(1.00–1.00)	0.007
Chewing ability (good = 0, poor = 1)	2.18	(1.21–3.93)	0.010

Logistic regression analysis dependent variable: cut-off stage of sarcopenia at maintenance group and decline group. Independent variable: Age, BMI, number of existing teeth, Occlusal force and Chewing ability. Early elderly aged less than 75 years; late elderly aged more than 75 years. BMI, body mass index.

(*P* < 0.001) declined in participants with DG. Among patients aged less than 75 years, 10.6% had DG. Among participants aged more than 75 years, 22.5% had DG (*P* < 0.001).

### Logistic regression analysis

The results of the logistic regression analysis are shown in Table 3. The dependent variable was 0 for MG and 1 for DG. As a result, age, BMI, number of existing teeth, occlusal force and chewing ability were selected as independent variables. Age (OR 2.37, 95% CI 1.52–3.70), BMI (OR 0.75, 95% CI 0.69–0.81) and chewing ability (OR 2.18, 95% CI 1.21–3.93) were significant factors of sarcopenia.

### Discussion

There have been many reports about sarcopenia, regarding the concept of the frail model proposed by Fried *et al.*<sup>18</sup> It has been reported that sarcopenia decreases the ADL of older adults, makes it difficult to maintain their QOL,<sup>1,2</sup> and it is important to intake a good balance of nutrition to prevent a decline in muscle mass, muscle strength and physical performance.<sup>3</sup> It has been reported that it is essential to maintain the ability to chew to keep a good balance of nutrient intake.<sup>4,5</sup> From these understandings, a strong relationship between chewing ability and sarcopenia has been inferred, but this hypothesis has not been previously tested. Thus, in the present study, we examined the relationship between chewing ability and sarcopenia in addition to known sarcopenia-related factors.

The prevalence of severe sarcopenia in the present study was 5.6% (42 participants), 12.8% (96 participants) had sarcopenia and 22.5% (169 participants) had presarcopenia. Three factors of EWGSOP, muscle mass, muscle strength and physical performance, were