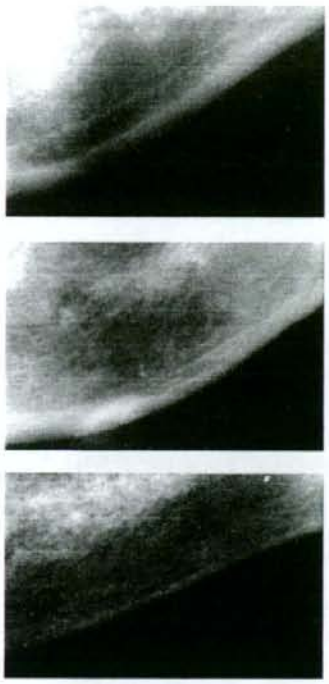

Figure 1 Mandibular inferior cortex classification (MIC) on dental panoramic radiographs

First-, second- and third percentiles were computed. S-OC, S-BAP, and U-DPD were evaluated by analysis of covariance (ANCOVA) adjusted for smoking habit (0: no, 1: past or current). In addition, correlations among S-OC, S-BAP, U-DPD, mean PPD, mean CAL and 6+ mm CAL were evaluated using partial correlation coefficients adjusted for gender. Finally, the multiple linear regression analysis was used to identify independent predictors of 6+ mm CAL. Gender (0: males, 1: females), the number of remaining teeth, S-OC, smoking habit (0: no, 1: past or current), MIC (C1, reference), MIC (C2, dummy), and MIC (C3, dummy) were used as independent variables. In this analysis, S-OC, S-BAP, and U-PD are strongly correlated with each other. Therefore, we selected S-OC because S-OC is most strongly correlated in the percentage of sites with 6+ mm CAL.

All calculations and statistical analyses were performed using the STATA™ software package (StataCorp., College Station, TX, USA). A P-value <0.050 was considered statistically significant.

Results

The percentage of subjects with MIC C1, C2, and C3 were 65.8%, 32.9%, and 1.3% for males and 11.3%, 54.8%, and 33.9% for females, respectively. The percentage of subjects with C2 and C3 was significantly higher in females than in males ($P < 0.001$, Fisher's exact probability test).

Characteristics of subjects are shown in Table 1. S-OC had significantly higher (males: $P = 0.038$, females: $P = 0.041$) tendency for MIC Class (ANOVA). Table 2 shows differences in the distribution of bone turnover markers according to the percentage of sites with 6+ mm CAL per person. S-OC was significantly lower in the third tertile than in the first and second tertile adjusted for smoking habit (males: $P = 0.007$, females: $P = 0.042$, ANCOVA).

Partial correlation coefficients among bone metabolism markers and periodontal disease markers are shown in Table 3. There was a significant negative relationship between mean CAL and S-OC ($r = -0.26$, $P = 0.002$).

Table 1 Comparison of selected characteristics according to MIC of each gender

	Males (n = 79)							*Females (n = 69)*						
	MIC Class							*MIC Class*						
	C1 (n = 52)		*C2 (n = 26)*		*C3 (n = 1)*			*C1 (n = 7)*		*C2 (n = 34)*		*C3 (n = 21)*		
Variables	*Mean or %*	*s.d.*	*Mean or %*	*s.d.*	*Mean or %*	*s.d.*	P *value*[a]	*Mean or %*	*s.d.*	*Mean or %*	*s.d.*	*Mean or %*	*s.d.*	P *value*[a]
% of sites with >6 mmCAL	10.8	13.2	13.7	14.1	–		0.340	3.9	5.2	10.7	17.0	5.8	7.2	0.673
CAL (mm)	3.7	1.0	3.8	0.9	–		0.620	2.7	0.7	3.4	1.1	3.4	0.8	0.246
PPD (mm)	2.2	0.5	2.2	0.4	–		0.781	2.0	0.4	2.3	0.6	2.1	0.5	0.908
Number of remaining teeth	19.5	7.8	15.5	7.9	–		0.059	21.7	7.6	18.7	8.1	16.9	10.1	0.146
Smoking habit (%)	82.0		80.0		–		0.807	0.0		3.3		5.0		0.473
S-OC (ng/ml)	6.3	2.8	7.8	3.3	–		0.038	8.0	1.2	9.3	3.2	10.3	2.8	0.041
S-BAP (U/l)	21.3	5.6	24.3	8.2	–		0.059	25.7	6.9	27.5	10.5	30.9	10.7	0.172
U-DPD (nM/nM*Cr)	4.3	1.2	4.5	0.9	–		0.496	6.3	0.8	6.5	1.4	6.8	1.8	0.307

CAL, mean clinical attachment level; PPD, mean probing pocket dept; S-OC, serum osteocalcin; S-BAP, serum bone-specific alkaline phosphatase; U-DPD, urinary deoxypyridinoline; MIC Class, Mandibular inferior cortex classification.
[a] P value was obtained by ANOVA.

Table 2 Bone markers of subjects according to attachment level

	Males (% of sites with 6 mm attachment level)				*Females (% of sites with 6 mm attachment level)*			
	First (n = 16)	*Second (n = 31)*	*Third (n = 29)*	P *value*[a]	*First (n = 28)*	*Second (n = 14)*	*Third (n = 16)*	P *value*[a]
Mean (SD)	0.5 (0.6)	4.3 (2.1)	25.1 (12.5)		0.3 (0.5)	4.3 (2.4)	24.7 (15.4)	
S-OC (ng/ml)	8.5 (4.5)	6.8 (2.7)	5.7 (1.8)	0.007	9.9 (2.8)	9.3 (2.4)	9.1 (3.5)	0.042
S-BAP (U/l)	22.2 (5.9)	23.3 (7.4)	21.1 (6.2)	0.212	29.3 (10.8)	28.9 (8.1)	27.4 (11.2)	0.752
U-DPD (nM/nM*Cr)	4.8 (1.0)	4.4 (1.2)	4.0 (1.0)	0.055	6.6 (1.4)	6.8 (1.4)	6.3 (1.7)	0.664

S-OC, serum osteocalcin; S-BAP, serum bone-specific alkaline phosphatase; U-DPD, urinary deoxypyridinoline.
[a]ANCOVA adjusted for smoking habit.

Table 3 Correlation of S-OC, S-BAP, U-DPD and periodontal disease markers using partial correlation coefficient adjusted for gender

	PPD	*CAL*	*% of sites with 6 mm attachment level*	*S-OC*	*S-BAP*	*U-DPD*
PPD						
r^a	1.00					
P value						
CAL						
r^a	0.51	1.00				
P value	< 0.001					
% of sites with ≥ 6 mm attachment level						
r^a	0.52	0.85	1.00			
P value	< 0.001	< 0.001				
S-OC						
r^a	−0.05	−0.26	−0.29	1.00		
P value	0.581	0.002	< 0.001			
S-BAP						
r^a	−0.03	−0.14	−0.17	0.49	1.00	
P value	0.701	0.108	0.052	< 0.001		
U-DPD						
r^a	0.02	−0.17	−0.22	0.56	0.58	1.00
P value	0.800	0.057	0.011	< 0.001	< 0.001	

PPD, mean probing pocket depth; CAL, mean clinical attachment level; S-OC, serum osteocalcin; S-BAP, serum bone-specific alkaline phosphatase; U-DPD, urinary deoxypyridinoline.
[a]Partial correlation coefficient adjusted for gender.

Table 4 The relationship between % of sites with >6 mm attachment level and confounding factors by multiple regression analysis

	Dependent variable (% of sites with 6 mm attachment level)					
Independent variables	*Coef.*	*s.e.*	P *value*	*95% CI*		*Beta*
Number of remaining teeth	−0.71	0.12	< 0.001	−0.95	−0.47	−0.46
S-OC (ng/ml)	−1.11	0.35	0.002	−1.81	−0.41	−0.28
Smoking habit (0: no, 1: past or current)	−2.60	3.22	0.420	−8.97	3.77	−0.10
Gender (0: males, 1: females)	2.92	3.74	0.435	−4.47	10.32	0.11
MIC						
C1 (Reference)	3.16	2.49	0.206	−1.76	8.08	0.12
C2 (Dummy)	−3.12	3.70	0.401	−10.46	4.21	−0.09
C3 (Dummy)	30.82	4.28	< 0.001	22.34	39.29	–
Constant					R^2 = 0.322, P < 0.001	

S-OC, serum osteocalcin; MIC, mandibular inferior cortex classification.

The percentage of sites with 6+ mm CAL had a significant negative association with S-OC ($r = -0.29$, $P < 0.001$) and U-DPD ($r = -0.22$, $P = 0.011$). There was a significant positive relationship among bone metabolism markers, that is, S-OC, S-BAP, and U-DPD ($r = 0.49$–0.58, $P < 0.001$).

Multiple linear regression results showed that the number of remaining teeth and S-OC were negatively associated with the percentage of sites with 6+ mm CAL ($R^2 = 0.322$, $P < 0.001$). Coefficients and betas were −0.71, −0.46 ($P < 0.001$) and −1.11, −0.28 ($P = 0.002$), respectively (Table 4).

Discussion

We can confirm a weak but clear relationship between the percentage of sites with 6+ mm CAL and bone metabolism markers, especially S-OC. A significant association remained after adjustment for demographic variables. Furthermore, S-OC was associated with MIC. Lower concentrations of S-OC might reflect a lower level of general bone metabolism, especially in an elderly population. S-OC is presently considered a valid marker of bone turnover when resorption and formation are coupled (Giannobile *et al*, 2003).

When we evaluate the general bone condition, serum and urinary markers may be appropriate. Indeed, periodontal disease is characterized by the absorption of alveolar bone. Some studies reported the efficacy of serum and urinary markers to evaluate periodontal disease (Gibert *et al*, 2003; Takaishi *et al*, 2005). However, the mechanism between periodontal disease and bone metabolism markers might be so complicated in elderly because bone resorption and formation are balanced to maintain stable bone mass. It has been assumed that bone formation and bone resorption are mechanistically linked during bone remodeling. Bone formation markers and bone resorption markers are positively correlated. High bone metabolism involves both high formation and resorption (Iki *et al*, 2004). Previous study has demonstrated a consistent relationship between biochemical markers and bone loss. Periodontitis patients have been reported to have lower S-OC values than healthy subjects (Vardar-Sengül *et al*, 2006).

On the other hand, the percentage of subjects with MIC C2 and MIC C3 was significantly higher in females than in males (Table 1). It has been speculated that estrogen deficiency and osteopenia/osteoporosis play a role in the progression of oral bone loss following menopause. Various reports also have linked estrogen deficiency and osteopenia/osteoporosis to increased oral bone resorption, attachment loss, and tooth loss (Paganini-Hill, 1995; Grodstein *et al*, 1996).

Furthermore, there was positive relationship between MIC and S-OC (Table 1). The subjects with MIC C1 had lower level of S-OC and more teeth than the subjects with MIC C2 or C3. According to another large cohort study (Bauer *et al*, 1999), higher levels of S-OC were associated with greater average rates of total hip bone loss. In our previous studies, we found the relationship between general bone metabolism and periodontal condition (Yoshihara *et al*, 2007) or mandibular inferior cortex (Deguchi *et al*, 2008). We hypothesized that general bone metabolism affected both alveolar bone and mandibular inferior cortex.

The relationship between CAL and MIC was obscure according to Tables 1 and 4. However, the findings in our study did not deny the positive relationship between MIC class and CAL even if it was not significant. In our previous study, we confirmed the significant relationship between osteopenia and periodontal disease progression (Yoshihara *et al*, 2004).

There might be an indirect association between CAL and MIC, which is complicated. CAL is influenced by not only general bone metabolism but also local factors such as gingival crevicular fluid. Bone turnover profiles from periodontal bone surfaces and gingival crevicular fluid differed from systemic (serum) bone turnover profiles (Wilson *et al*, 2003). Osteocalcin levels in gingival crevicular fluid correlates with periodontal but not with osteoporosis status (Bullon *et al*, 2005). Unfortunately, it was impossible to show concrete connection based on the findings of our study. We could not measure bone turnover markers in gingival crevicular fluid.

In terms of the relationship between oral bone mass and systemic bone mineral density, Kribbs *et al* (1983) reported that the bone mass of the mandible and alveolar bone was related to radial and systemic bone mineral density in postmenopausal women; this was followed by reports on mandibular bone mass by many researchers. Southard *et al* (2000) reported correlations between maxillary alveolar bone mineral density and bone mineral density in other parts of the body including the mandibular alveolar bone. Furthermore, some reports suggest that osteoporosis in postmenopausal women accelerates the progression of periodontal disease and increases the risk of early tooth loss (von Wowern *et al*, 1994; Inagaki *et al*, 2001; Mohammad *et al*, 2003). According to our study, jaw bone status was significantly associated with markers of bone turnover.

This study had some limitations. The cross-sectional nature of the study limits its ability to make causal relationships, and the findings should be confirmed by a longitudinal study. In addition, we selected 148 of 600 possible subjects. Although we excluded subjects for justifiable reasons, it is possible that selection bias occurred. Generalization of our results to other populations should thus be made with caution.

In conclusion, this study suggests that there is a significant relation of bone turnover markers to periodontal disease and jaw bone morphology in elderly Japanese subjects.

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高齢者の嚥下障害

Dysphagia in the elderly

診断の指針 / 治療の指針

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はじめに

本邦では，高齢化が急速に進んでいる．平成18年度厚生労働白書によると1970年には65歳以上人口は739万人，総人口に占める割合(高齢化率)は7.1%であった．しかし，2005年には65歳以上人口は2,682万人，高齢化率は21%となっている．今後さらに高齢者数と高齢化率は増加し，2020年には65歳以上人口は3,334万人，高齢化率は26.9%になると予想されている．これに伴い，障害をもつ高齢者も増加の一途をたどり2000年では280万人，2025年には520万人に達する見込みといわれている．

摂食・嚥下障害の主要な原疾患は脳卒中であり，脳卒中は高齢者に好発する．その他の摂食・嚥下障害をきたす疾患も，そのほとんどが高齢者に多く認めるものである．したがって摂食・嚥下障害を有する患者の著しい増加も予測される．また，本邦の死因の第4位である肺炎は高齢者に多く，その原因として誤嚥が重要視されている．このように摂食・嚥下障害は社会的に大きな影響を及ぼすと考えられ，これらに関して知識を持つことは重要である．

1. 高齢者の嚥下動態の特徴

高齢者は加齢をはじめとする種々の要因により摂食・嚥下障害を呈しやすい．以下に高齢者によく認められる嚥下機能に関する問題をあげる．

う蝕や歯周病により残存歯数は減少し，咀嚼機能が低下する傾向にある．嚥下反射の惹起性が低下し，反射開始が遅延する．また，嚥下反射運動の速度が低下する．さらに，液体の嚥下時および固形物の咀嚼を伴う嚥下時に，嚥下反射前に食物が下咽頭に到達する例が増加する．これらは，嚥下反射そのものの安全性を損なう．その他に，呼吸と嚥下の協調性にも影響が出る．本来，嚥下時は無呼吸となるが，嚥下時に吸気が生じたり，嚥下後に吸気で再開したりする例が増える．気道防御機構である咳嗽反射の低下が起こる．

また，内服薬剤の中には副作用として，嚥下機能に悪影響を与えるものがある．新たな薬剤の処方，処方量の調節によって摂食・嚥下障害が増悪することは少なくない．したがって，処方薬剤の確認は重要である．嚥下機能に悪影響を及ぼす主な薬剤を**表1**に示す．

表1 嚥下機能に悪影響を与える薬剤とその作用

薬剤の種類	摂食・嚥下機能に対する作用
トランキライザー(メジャー・マイナーともに) (抗精神病薬・抗うつ薬・抗不安薬)	錐体外路異常・パーキンソン症状の出現 精神活動や意識・注意レベルの低下 口腔内乾燥 ドパミン抑制薬として働きサブスタンスP放出を抑制し，咳・嚥下反射が低下する
制吐薬・消化性潰瘍薬	錐体外路系の副作用
抗コリン薬	唾液分泌低下し口腔内乾燥，食道内圧低下
ステロイド	ステロイドミオパチーで筋力低下
筋弛緩薬	筋の過度の弛緩，精神活動の低下
抗がん剤	口腔内乾燥・味覚障害・食欲低下・易感染性
抗てんかん薬・抗ヒスタミン薬	精神活動の低下・口腔内乾燥
利尿薬・交感神経抑制薬・抗不整脈薬	口腔内乾燥

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Key words 高齢者 摂食・嚥下障害 誤嚥性肺炎

2. 摂食・嚥下障害の診断・評価

飲み込みにくい，むせる，のどに詰まった感じがする，などが典型的な主訴となる．その他に食事に関連する咳嗽の存在，発熱，体重減少，食事嗜好の変化などに気をつける．全身状態としては意識レベルや呼吸状態に注意する．意識障害が存在する場合は嚥下機能も低下する．呼吸状態が不良である場合，とくに，咳による喀出が弱い場合や，湿性ラ音をはじめとする肺雑音を聴取する場合には，十分注意する必要がある．

口腔所見としてはまず，口腔の衛生状態を観察する．高齢者の口腔衛生状態は不良である場合が多い．口腔の不衛生は誤嚥性肺炎のリスクを増加させる．そして，義歯の適合を確認することも忘れないようにしたい．咽頭所見としては，下部脳神経とくに三叉，顔面，舌咽，迷走，舌下神経の機能が重要である．舌偏位，口蓋垂偏位，カーテン徴候，口腔・咽頭感覚の低下，gag 反射の左右差が認められるときは嚥下機能低下が疑わしい．気息性嗄声，湿性嗄声の存在にも留意する．

嚥下機能を診るために有用なスクリーニングとして，反復唾液嚥下テスト，改訂水飲みテストなどがある．これらは安全性が高いため広く利用できる．頸部聴診法による嚥下音や呼吸音の聴診，経皮的酸素飽和度モニタも有用な補助手段である．

誤嚥していても咳嗽が出現しない状態，すなわち不顕性誤嚥(silent aspiration)が摂食・嚥下障害者の約3割に存在する．したがって，身体所見やスクリーニングだけでは誤嚥の有無を診断することは困難である．臨床的に誤嚥の存在が強く疑われる場合には，専門機関での嚥下造影や嚥下内視鏡検査の施行が必要となる．

3. 注意すべき合併症

1)低栄養，脱水

摂食・嚥下障害者は，咀嚼・嚥下機能の低下，食欲の減退，偏った食材による調整食の摂取，認知障害など種々の問題により低栄養，脱水となるリスクが高い．1日に必要な栄養量の目安は体重1kgあたり30カロリー，日常生活活動が全介助の状態でも25カロリーは必要である．同様に1日に必要な水分量の目安は，簡易的な計算で体重1kgあたり30mlとなる．発熱，下痢などの消耗の著しいときは栄養，水分とも増量する必要がある．

2)誤嚥性肺炎

高齢者における肺炎の7割が誤嚥性肺炎である．嚥下後の湿性嗄声，食事中・食事後のむせや咳嗽の出現，喀痰の増加，食後の呼吸困難感の出現などは誤嚥の存在を強く疑わせる徴候であり，注意を要する．また，睡眠中に唾液を誤嚥し，高齢者本人が自覚しない誤嚥による肺炎もある．

高齢者では上記のような典型的な症状を呈さずに，発動性の低下，食事時間の延長，覚醒度の低下，失禁の増加といった非特異的な徴候を呈することがある．

誤嚥性肺炎の予防としては，良好な栄養状態，誤嚥しにくい食物形態，姿勢といった摂食・嚥下障害者への一般的な対応をはじめとして，口腔内衛生を保つための口腔ケアの徹底，胃食道逆流防止目的の食後の頭位挙上姿勢などがあげられる．

3)窒　　息

窒息は上気道の異物による完全閉塞を指し，急速，かつ重篤な呼吸障害であり，迅速な対応を要する．摂食・嚥下障害の合併症において最も致死的である．

高齢者および摂食・嚥下障害者が変形性に乏しい食物，たとえば肉片，餅，芋類などの摂取した時に起こりうる．よって，固形物を咀嚼して摂食しているような軽症の嚥下障害者にこそ注意が必要となる．重症の嚥下障害者もまた，ごく多量の誤嚥，粘稠性の高い痰の喀出困難によって窒息が起こりうる．

日常から同居者に対して窒息のリスクと徴候，ならびに背部叩打，ハイムリッヒといった窒息が起こったときの対応法を教育する必要がある．