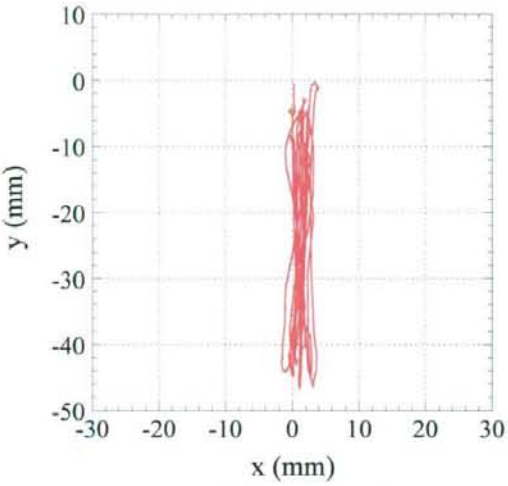
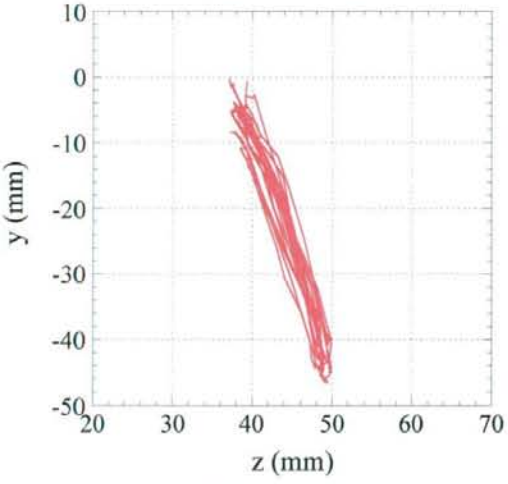


(a) 正面からの軌跡



(b) 側面からの軌跡

図６　顎運動モデル計測結果

厚生労働科学研究費補助金（長寿科学総合研究事業）
Ⅱ－4　分担研究報告書

積層アモルファスを用いた生体用 LC 共振型ワイヤレス磁気マーカの開発に関する研究

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【研究要旨】
口腔内への適用を考慮して、LC マーカの主要構成部品である磁気コアの小型・薄型化による LC マーカの薄型化の検討を行った。その結果、厚さ 20μm 程度のアモルファスリボンを絶縁積層した磁気コアを用いることで、LC マーカ全体の厚みを 1mm 以下に抑えるための知見が得られた。

A. 研究目的

被験者の口腔内において、ストレスフリーで貼付可能なサイズを実現しつつ、高精度な位置の計測が可能な LC 共振型磁気マーカの開発を目的とした。具体的には、マーカを構成する磁気コア材の見直しと小型・薄型化について検討を行った。

B. 薄型 LC マーカの設計・試作

被験者の口腔内で違和感のないサイズの目安として、縦・横 5mm、厚さ 1mm 程度を目標とした。磁心材として、厚さ 0.5mm のフェライト板と、厚さ 23μm のアモルファスリボンを絶縁積層した磁心を用いてマーカの小型・薄型化に関する検討を行った。以下にその手順の詳細を述べる。

まず寸法 5×4mm、厚さ 0.5mm の板状の Ni-Zn フェライト磁心に銅線を 100 回巻きマーカ用コイルとした。次に高周波域でも高透磁率を示す金属磁性材料として日立金属社製 Co 系アモルファスリボン(Metglas 2705M, 表 2 参照)を用意した。アモルファスリボンを積層する際に、厚さ 10μm の極薄両面テープ（寺岡製作所製、7070w）を接着・絶縁層に使用した(図 1 参照)。両面テープで絶縁することにより、層間を流れる渦電流を抑制することができる。またアモルファスリボンについては、誘導磁気異方性の制御による使用周波数帯域での磁気特性向上化について検討を行うため、未熱処理の状態で積層したコアと、3kOe の静磁界中熱処理を施したリボンを用いた積層コアについて評価した。リボン材を 5mm×4mm のサイズに切り出した後、積層する前に 200℃から 50℃毎に 350℃までの範囲で熱処理を行った。個々のリボン材の磁気特性を最適化することで、位置検出時の S/N 比の向上が期待できる。

未熱処理および熱処理を施したリボンを、2 枚刻みで 16 枚まで積層させたコアを作製した。次に、コアを非磁性のプラスチック板で出来たコイル枠（100 回巻き、図 2 参照）に挿入し、ベクトルネットワークアナライザで周波数特性を測定しコイルの Q 値を算出した。

図 1　アモルファスリボン積層磁心の作製の流れ

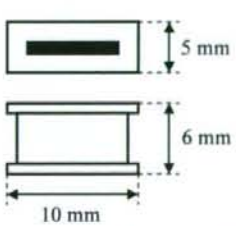
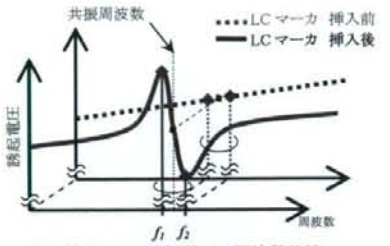
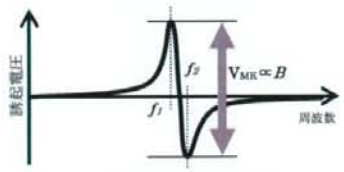


図 2　プラスチック製コイル枠の概略図



(1) 検出コイル誘起電圧の周波数特性



(2) LC マーカから発生した磁界の誘起電圧への寄与分

図 3 LC マーカが発した磁界による誘起電圧の計測

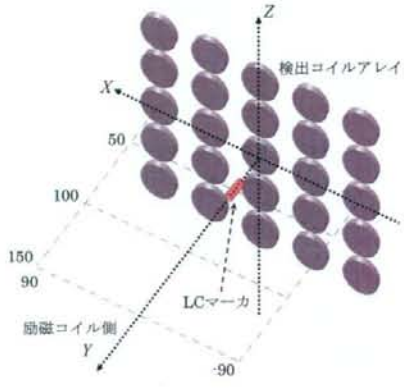


図 4　LC マーカと検出コイルの配置図

Q 値を上げるためには、アモルファスリボンの積層枚数を増やすか、コイルの銅線の巻き数を増やす 2 通りがあるが、目安としたマーカサイズ程度にするため、ここではコイル部の積層枚数と銅線の巻き数の最適条件を考える。5mm 幅に巻ける銅線は 1 層あたり 40 巻き程度であり、1 層巻くと線径 0.1mm×2 程度の厚みが増すことになる。本検討では 16 枚の積層コアに銅線を直接 100 回巻いたところ、厚さは 1.1mm となった。

マーカの共振周波数設定にあたって、各マーカコイルの Q 値が最も高くなる周波数帯域を考慮しつつ、全てのマーカができるだけ同じ帯域に共振周波数を設定できるようにチップコンデンサを選んだ。これによりほぼ同じ条件でマーカの性能を評価可能となる。

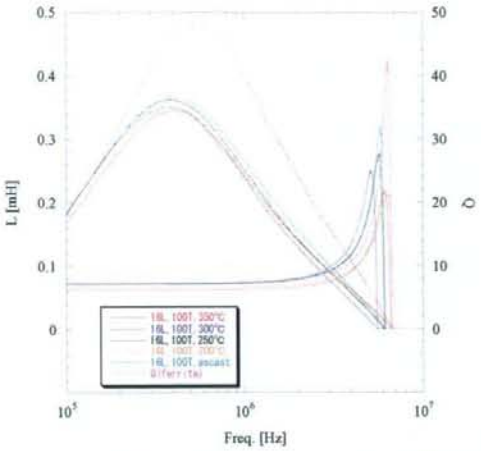


図 5 マーカ用コイルのインダクタンスおよび Q 値の周波数特性

表 1 試作した LC マーカのパラメータ

	ascast	200℃	250℃	300℃	350℃	ferrite
L [mH]	0.0737	0.0662	0.0723	0.0714	0.0617	0.0713
C [pF]	2300	2590	2350	2350	2590	2350
共振周波数	398	402	399	399	406	401
Q値	36.8	34.8	36.1	34.9	34.3	46.5
V_{mk} [mV]	0.0639	0.0694	0.0589	0.0627	0.0646	0.0648

次に、励磁波の測定周波数を決定するため、マーカの発する誘導磁界による寄与電圧の計測を行った。それぞれのマーカの共振周波数域において励磁界の周波数を 0.1 kHz 刻みで掃引し、バックグランド電圧を取得し後、LC マーカを挿入し、誘起電圧の周波数特性を測定した。これらの電圧データの差分を取って、マーカ寄与電圧の周波数特性を算出し、マーカ寄与電圧が極大および極小になる周波数を調べた（図 3 参照）。その際、図 4 に示すように、LC マーカは座標 (0, 50, 0) にそのマーカの中心軸が励磁コイル軸および検出コイル軸に対し平行になるように配置した（$\theta = 90°$, $\phi = 90°$ ）。このとき原点(検出コイルアレイの中心に配置されたコイル)に発生した誘起電圧を計測して測定周波数を決定した。

C. 試作した LC マーカの性能評価および考察

C-1) マーカ用コイルの周波数特性

図 5 にフェライト薄板コアおよびアモルファス積層コアについて、インダクタンス L と Q 値の周波数特性の測定結果を示す。また各マーカのパラメータを表 1

に示す。図5および表1によると、フェライト薄板コアマーカが500kHzにおいて最も高いQ値（約48）を示していることがわかる。それに対し、アモルファス積層コアは熱処理の有無に関わらず400kHzで36程度となっている。これはセラミックス材であるフェライトに比べアモルファスリボンは電気抵抗率の金属材であり、コア材自体に流れる渦電流による磁気損失が大きくなるためである。積層コアの各層間を絶縁しているにも関わらず、渦電流の影響を受けるのは、数百kHz帯ではリボン材の厚み（20μm）による見かけの比抵抗が小さく渦電流の抑制効果が小さいためである。

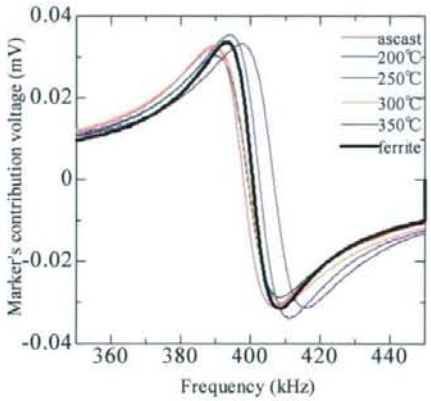


図6 試作したLCマーカの寄与電圧測定結果

しかしながらインダクタンスに注目してみると、アモルファス材、フェライト材に関係なく0.07mH程度となっており、マーカ寄与電圧の差はほとんどないことが予測される。

C-2)薄型LCマーカの誘起電圧測定

インダクタンス及びQ値の測定結果より、アモルファス積層コアにおいては、Q値のピークを示す周波数帯が400kHz程度であることから、共振周波数を400kHzとした。またフェライト薄板コアにおいては、500kHz付近がピークを示すが、アモルファス積層コアと同じ条件でひかくするため、こちらも共振周波数を400kHzとしたが、Q値は45程度とアモルファス積層コアに比べ十分に高い値を示している。

それぞれ適切な値のチップコンデンサをコイルの両端に接続してLCマーカとし、出力特性（誘起電圧特性）の測定を行った。25個の検出コイルアレイの中心に配置された検出コイルの中心軸上から、50mmの距離に薄型LCマーカを配置して誘起電圧の測定を行った。結果を図6にそれぞれ示す。いずれもピーク－ピーク電圧値で60μV_{p-p}～70μV_{p-p}でありインダクタンスの値と同様、それほど大きな差は見られなかった。これより、作製したマーカにおいて、寄与電圧の値はQ値よりもインダクタンスや磁性材コアの形状や体積が支配的であると考えられる。アモルファス積層コアとフェライト薄板コアについて、その体積を比較してみると、0.5mm厚のフェライト板に対して、アモルファス積層コアの厚み約0.49mmの内、磁性材分の厚みは0.34mmであり、フェライト薄板コアの70%程度しかない。またセラミックス材であるフェライトは薄くなると破損しやすく取り扱いに注意が必要となるが、アモルファスリボン材は柔軟であるため扱いが容易である。これらはアモルファスリボン積層コアの有利な点である。

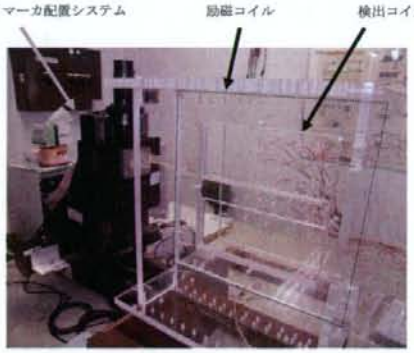


図7 三次元LCマーカ配置システムと励磁コイル・検出コイルアレイ

表2 繰り返し位置計測時のばらつき

位置精度

1 mm立方以下		座標
	ascast	～(0,50,0)
	200 ℃	～(0,50,0)
	ferrite	～(0,50,0)

2 mm立方以下		座標
	ascast	～(0,70,0)
	200 ℃	～(0,80,0)
	ferrite	～(0,70,0)

5 mm立方以下		座標
	ascast	～(0,100,0)
	200 ℃	～(0,100,0)
	ferrite	～(0,100,0)

C-3) LCマーカの性能評価

LCマーカの移動には、図7に示すようにレーザ変位

計と三軸ステージを組み合わせたシステムを用いた。この位置決めシステムは、LCマーカを移動精度0.1 mm以下での移動が可能である。座標（0, 50, 0）からy軸方向へ10mm刻みで（0, 150, 0）までLCマーカを移動させ（図4参照）、各座標においてそれぞれ10回の位置検出を行った。その際、励磁コイルには6Vで印加した。励磁コイルのインピーダンスを考慮すると、電流値は約0.03A低度である。

図8に各LCマーカを用いた位置検出システムによる評価結果を示す。検出コイルからの距離が大きくなるにしたがって検出位置のばらつきが大きくなっていく傾向にあることがわかる。詳細な評価のためにアモルファスリボン積層コアの未熱処理、200℃熱処理、フェライト薄板コアの3つのLCマーカについて比較検討を行った。

それぞれのLCマーカの繰り返し位置計測時のばらつき範囲について表2にまとめた。ばらつきの範囲が1mm以下となるのは、いずれのLCマーカも（0, 50, 0）までであるが、2mm以下となる座標は200℃熱処理を施した積層リボンコアのLCマーカがもっとも遠く（0, 80, 0）までであった。しかしながら、5mm以下で評価するといずれも（0, 100, 0）となり同程度であることがわかる。これは図6の寄与電圧の測定結果が全てのLCマーカで同程度であることから、測定時のシステムのノイズが一定であるため、S/N比は同程度となることから説明される。今回、励磁界発生に増幅器は使用しておらず、発振器の最大出力である6Vを印加して評価を行ったが、低ノイズの増幅器を用いることでS/N比の向上が期待でき、検出位置精度の更なる改善が可能であると考えられる。

またリボン積層コアについて、積層前の磁場中熱処理による磁気異方性の制御といった面では明確な効果を確認することはできなかった。

D. 結論

口腔内に貼付する際に違和感を低減可能なLCマーカのサイズとして、5mm角、厚さ1mm程度を目安として、厚みが0.5mmのフェライト薄板コア、厚さ21 μmのアモルファスリボンを16枚絶縁積層させたコアを用いて所望のサイズのLCマーカを作製した。またリボン積層コアについては、積層前に磁場中熱処理を施し磁気異方性の誘導効果について検討を行った。

フェライト薄板コアおよびリボン積層コアからなる

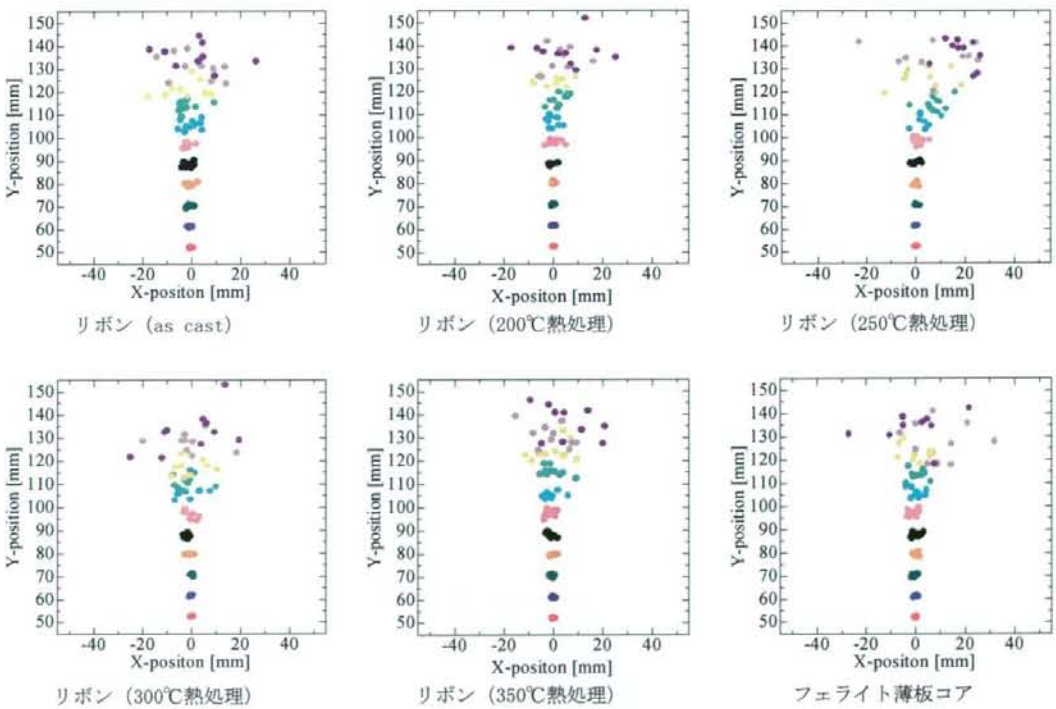


図8 試作したLCマーカを用いた位置検出評価結果

LC マーカの位置検出システムによる性能評価を行った結果、検出コイルアレイから 50mm 程度の範囲で検出位置のばらつき 1mm 立方以下と、同程度の結果を示した。励磁系に低ノイズの増幅器を用いることで、1mm 立方以下の位置精度を維持できる空間を拡大できるものと思われる。

しかしながら、コア全体に占める磁性材の割合やこのサイズにおけるフェライト磁心の破損しやすさを考慮すると、アモルファスリボン積層コアは LC マーカのコア材として適用可能である。

また、アモルファスリボンを絶縁積層した磁心を用いたマーカについて、磁場中熱処理を施す前後およびその温度で明確な性能の差は確認されなかった。

E. 研究発表

1．論文発表

[1] S. Hashi, M. Ohya, M. Uchiyama, S. Yabukami, H. Kanetaka, K. Ishiyama, Y. Okazaki and K. I. Arai: "Study on downsizing of LC markers for a wireless magnetic motion capture system," Sensor Letters, (2009) in press.

[2] S. Hashi, S. Yabukami, H. Kanetaka, K. Ishiyama Member, and K. I. Arai: "Numerical Study on the Improvement of Detection Accuracy for a Wireless Motion Capture System," IEEE Transactions on Magnetics, (2009) in press.

2．学会発表

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F．知的財産権の出願・登録状況

なし

Ⅲ．研究成果の刊行に関する一覧表

書籍

著者氏名	論文タイトル名	書籍全体の編集者名	書　籍　名	出版社名	出版地	出版年	ページ

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
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Hashi S, Ohya M, Uchiyama M, Yabukami S, Kanetaka H, Ishiyama K, Okazaki Y, Arai I K	Study on downsizing of LC markers for a wireless magnetic motion capture system	Sensor Letters			2009 in press 印刷中のため別刷が用意できていません
Hashi S, Yabukami S, Kanetaka H, Ishiyama K, Arai I K	Numerical Study on the Improvement of Detection Accuracy for a Wireless Motion Capture System	IEEE Transactions on Magnetics			2009 in press 印刷中のため別刷が用意できていません

Ⅳ. 研究成果の刊行物・別刷

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Beneficial Effects of Orthodontic Treatment on Quality of Life in Patients with Malocclusion

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Patients with malocclusion, especially those in need of surgical correction, have lower health related quality of life (HRQOL) and higher anxiety. We investigated the changes of HRQOL and psychological status following jaw surgery in the patients with facial deformities. Thirty-one adult orthodontic patients admitted to Tohoku University Hospital and diagnosed as malocclusion requiring jaw surgery were recruited for the study. The severity of malocclusion was assessed by Severity Score (SS) which is based on their cephalometric radiographs. They were divided into three groups according to the severity of malocclusion, i.e. Low-SS, Moderate-SS and High-SS. The subjects also completed a generic HRQOL (entire body health) instrument, and three disease-specific oral HRQOL instruments. HRQOL and psychological status of the patients were assessed before (T1) and at debonding of multibracketed appliances after surgery (T2). SS in each group significantly decreased to normal occlusion level (SS = 0~1). Oral function significantly improved from 11.8 ± 5.4 to 5.9 ± 4.3 in the Low-SS ($p < 0.01$), from 13.7 ± 6.5 to 8.8 ± 5.1 in the Moderate-SS ($p < 0.05$), and from 14.7 ± 6.7 to 7.8 ± 5.7 in the High-SS ($p < 0.01$). The patients after the surgical correction had improved disease-specific HRQOL and state anxiety irrespective of the severity before surgery, although the generic HRQOL, trait anxiety and depression were equal to that before the surgery. Furthermore, both postoperative anxiety and HRQOL were estimated by the preoperative anxiety and HRQOL. These results indicated that jaw surgery markedly improved the disease-specific HRQOL and psychological status in the present patients. We therefore suggest that assessments of the HRQOL and psychological status before treatment might predict the HRQOL and psychological status after the treatment to a certain extent. ——— psychological status; malocclusion; surgical correction; SF-36; severity score.

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Oral diseases and disorders are highly prevalent and give rise to not only physical, but also economic, social, and psychological problems. They impair health related quality of life (HRQOL) and affect various aspects of life including function, appearance, and interpersonal relationships in a large number of individuals (Gift and Redford 1992).

In the past, oral HRQOL research was primarily directed at the assessment of the experiences of elderly patients who often suffer periodontal disease, tooth loss or inadequate dentures (Locker and Jokovic 1996; Inglehart and Bagramian 2002). Recently, oral HRQOL in children and adolescents has received considerable interest (Broder et al. 2002; Jokovic et al. 2002). Moreover, HRQOL assessments made by patients provide a view of dentofacial disharmony and surgical outcome that can inform clinicians in important ways (Bennett and Phillips 1999).

The patients' satisfaction with the orthodontic intervention is likely to be high when their initial dentofacial deformity is severe and have lower HRQOL and psychological status. We have recently reported that the patients with malocclusions especially in need of surgical correction had lower disease-specific HRQOL (Tajima et al. 2007). However, even after orthodontic treatment by the expert dentists, patients show large variations in the level of satisfaction (Kiyak et al. 1982; Flanary et al. 1990; Enomoto et al. 2000; Cunningham et al. 2002). Although preoperative HRQOL and phychological status of the patients might affect the level of satisfaction, prospective cohort study with the viewpoint has not been reported. Moreover, the predictors of HRQOL and psychological status after the treatment have not been elucidated. Therefore, in this study, we demonstrated the effects of orthodontic treatment on HRQOL and psychological status in the patients with facial deformities and also elucidated the predictors of better postoperative HRQOL and psychological status in the patients with facial deformities.

Material and Methods

Subjects

Eighty-one consecutive patients who had deformities in the maxilla and the mandible and had combined surgical-orthodontic treatment at the Tohoku University Hospital between April 2003 and December 2005 were included in the study. All of them filled in a questionnaire preoperatively and were asked to participate in the present study. The patients with any other co-morbidity or those who did not finish the treatment were excluded from the study. Exclusion criteria were the following : (1) any surgery performed in the previous days, (2) previous temporomandibular joint arthrotomies, (3) fewer than 20 teeth total or fewer than 10 teeth in each arch, (4) unstable residence or travel restrictions, (5) periodontal disease judged to be severe by the surgeon, (6) pregnancy, (7) previous mandibular surgery, and (8) inability to follow instructions or the study protocol. Finally, thirty-one patients who consented and finished the treatment were all analyzed in the study. All of them had single jaw or bimaxillary operations. Their ages ranged from 17.3 ~ 42.5 years with a mean age of 25.4. Approval for the study was given by the regional research ethics committee.

Persons with normal occlusion had good maxillomandibular relation, especially good bilateral canine relations and molar relations, and had adequate dental axis, overjet and overbite, and had no arch length discrepancy (ALD) or minor ALD (< 2 mm). To assess the patients' morphological deformities, we set up a Severity Score (SS) for each patient based on their cephalometric radiographs which were traced and lined, and the angular and plaster model measurements were assessed. The Severity Scores were used to assess the patients' dentofacial deformities, and defined in Table 1 (Tajima et al. 2007).

The characteristics of the subjects are shown in Table 2. The patients were divided into three groups according to the severity of malocclusion, i.e., Low-SS (SS 2 ~ 4; n = 13), Moderate-SS (SS 5; n = 11), and High-SS (SS 6 ~ 9; n = 7). There was no significant difference in gender and age among these three groups. Ability to speak and oral function of Low-SS were comparatively high in comparison with other groups and High-SS showed a tendency to be low. Generic HRQOL was assessed using The Short Form-36. Disease-specific HRQOL was evaluated with The Subjective Oral Health Status Indicators (SOHSI), The Orthognathic Quality of Life Questionnaire (OQLQ), and The Recognition and

TABLE 1. Definition of the severity score.

Dental	Arch length discrepancy (ALD)	0 : Deficiency ≦ 7-8 mm 1 : Deficiency > 7-8 mm (7-8 mm: patient' own premolar size)
Skeletal	Anteroposterior jaw discrepancy (AD)	0 : Discrepancy ≦ 1 S.D. 1 : 1 S.D. < Discrepancy ≦ 2 S.D. 2 : 2 S.D. < Discrepancy ≦ 3 S.D. 3 : Discrepancy > 3 S.D.
Skeletal	Vertical jaw discrepancy (VD)	0 : Discrepancy ≦ 1 S.D. 1 : 1 S.D. < Discrepancy ≦ 2 S.D. 2 : 2 S.D. < Discrepancy ≦ 3 S.D. 3 : Discrepancy > 3 S.D.
Skeletal	Transversal jaw discrepancy (TD)	0 : Symmetry 1 : Asymmetry ≦ 5 mm 2 : Asymmetry > 5 mm
	SS = Σ (ALD + AD + VD + TD)	(Minimum: 0, Maximum: 9) Normal occlusion: SS = 0~1

TABLE 2. Sample characteristics.

	Low-SS	Moderate-SS	High-SS
	(SS 2 ~ 4)	(SS 5)	(SS 6 ~ 9)
N (M, F)	13 (1, 12)	11 (3, 8)	7 (2, 7)
Mean age	26.1	26	24.3
(range)	(18.2 – 42.5)	(17.3 - 38.1)	(19.1 - 35.0)
Preoperative mean SS	3.4	5	6.4
Postoperative mean SS	0	0	0.4

SS, Severity Score; M, Male; F, Female.

Satisfaction scale modified (RSS-M) of surgical correction. In addition, anxiety and depression were assessed using STAI (Spielberger's State-Trait Anxiety Inventory Questionnaire) and SRQ-D (The Self-Rating Questionnaire for Depression), respectively. It took about 15-20 minutes for the patients to answer the questionnaire and no assistants helped them to answer the questionnaire. These generic and disease-specific HRQOL, anxiety and depression in patients were assessed just before surgery (T1) and after surgery involving debonding of multibracketed appliances (T2). The results compared the changes between pre and post intervention, and across three severity groups.

In addition, the patients were also analyzed in two groups, split according to degree of anxiety (High-anxiety, n = 16; Low-anxiety, n = 15) and depression (High-depression, n = 14; Low-depression, n = 17) scores before the intervention. The Anxiety and depression level between T1 and T2 were compared between the two groups.

The MOS Short Form-36 (SF-36)

The MOS Short Form-36 (SF-36) is a generic health status measure, and has been widely used (Ware and Sherbourne 1992; Garratt et al. 1996). The instrument consists of 36 items divided into eight subscales, namely:

physical functioning (PH), social functioning (SF), role physical (RP), role emotional (RE), vitality (VT), mental health (MH), bodily pain (BP) and general health (GH). Each scale is scored 0-100 where 0 is the worst possible and 100 the best possible health. There is good evidence for the validity, reliability, and responsiveness of SF-36 in different populations (Jenkinson et al. 1993; Garratt et al. 1994, 1996; Brazier et al. 1993).

Spielberger's State-Trait Anxiety Inventory Questionnaire (STAI)

The anxiety status was measured by Spielberger's State-Trait Anxiety Inventory Questionnaire (STAI) (Spielberger et al. 1970). Items for anxiety were selected for their ability to discriminate between stress and non-stress conditions. The state anxiety score (STAI-I) consists of 20 statements on a 4-point scale covering apprehension, tension, nervousness, and worry, which evaluates how the subjects feeling 'at this moment'. The trait anxiety score (STAI-II) consists of 20 statements on a 4-point scale pertaining to how the subjects generally feel. Both scales are designed to contain anxiety present and anxiety absent factors. The 20 responses for each scale are summed (Shumaker et al. 1990) and the total score for both ranges from 20 to 80, with a lower score reflecting a better psychological state.

The Self-Rating Questionnaire for Depression (SRQ-D)

The depression status was measured by the Self-Rating Questionnaire for Depression (SRQ-D) (Tsutsui 1993), which evaluates mild and more severe depressive conditions. The subjects tested have a choice of 4 answers to each question: seldom or never, some of time, quite often or almost always. For any one questions, these answers are scored 0, 1, 2 and 3, respectively. In scoring a completed questionnaire, the control items (6 items) are crossed out (Rockliff 1969) and the score ranges from 0 to 36, with a score of 11-16 representing borderline depression and a score above 16 representing depression (Tsutsui 1993). The reliability and validity of the questionnaires have been established and they have been used in a variety of clinical populations including patients with cardiac disease (Shumaker et al. 1990; Tsutsui 1993).

The Subjective Oral Health Status Indicators (SOHSI)

Disease specific HRQOL was measured by the Subjective Oral Health Indicators (SOHSI). The SOHSI takes as its theoretical basis Locker's conceptual model of oral health (Locker 1988). SOHSI is useful for descriptive oral health surveys of general populations. The instrument comprises the following scales: "Ability to chew (AC)" "Ability to speak (AS)" "Oral and facial pain symptoms (OFPS)" "Other oral symptoms (OOS)" "Eating impact scale (EIS)" "Communication/social relations impact scale (CSIS)" "Activities of daily living impact scale (ADIS)" and "Worry/concern impact scale (WCIS)". The response format varies with each scale. The scales "AC", "AS", "OFPC" and "OOS" all have a yes/no response format for their items. The "EIS", "ADIS" and the "WCIS" all have 5-point rating scales for the frequency of occurrence of each item with categories: all the time (scored 5), very often (scored 4), fairly often (scored 3), sometimes (scored 2) and never (scored 1). The measure has been shown to be reliable and valid in samples, both in Canada and UK (Locker 1997). All questions were administered as a self-complete questionnaire.

The Orthognathic Quality of Life Questionnaire (OQLQ)

Disease specific HRQOL was also measured by Orthognathic Quality of Life Questionnaire (OQLQ) (Cunningham et al. 2000). The instrument was developed for the orthognathic patients and consists of 22 statements marked on a 4-point scale according to how much the issue covered by the statement bothers the respondent. The 22 items contribute to four dimensions: "social aspects of dentofacial deformity (SA)" "facial aesthetics (FA)" "oral function (OF)" "awareness of dentofacial aesthetics (ADFA)". OQLQ dimensions are scored so that lower scores indicate a better quality of life and higher scores signify a poorer quality of life. The 100 mm visual analogue scale (VAS) is marked from 0 to 10; the respondents were asked to rate how they felt about their dental and facial appearance and oral function, with 0 being "no problem at all" and 10 being "the worst problem imaginable". The OQLQ showed good reliability (Cunningham et al. 2000), validity and responsiveness (Cunningham et al. 2002).

The Recognition and Satisfaction scale modified (RSS-M)

Patients' self-evaluation of their own facial parts was measured by the Recognition and Satisfaction Scale (RSS) (Enomoto et al. 2000). RSS consists of five domains. I used the following two domains: "recognition of facial deformity" and "self-evaluation of facial components". These two scales have 5-point rating scales of the degree of deformity or satisfaction of each item with

categories: much (scored 5), considerable (scored 4), mildly (scored 3), few (scored 2) and very little (scored 1). This measure showed good evidence of validity and responsiveness (Enomoto et al. 2000).

Data analysis

The results were expressed as the mean ± S.E.M. For statistical analysis, HRQOL data were analyzed by Wilcoxon signed rank test between T1 and T2. Comparisons among the 3 groups according to SS were performed using two-way factorial ANOVA. Comparisons between the groups were performed using Wilcoxon signed rank test. Logistic regression analysis was performed with the psychological status and the disease-specific HRQOL after surgery. A backward elimination procedure was used with a significance level of $\alpha = 0.05$ for staying in the model. The following variables obtained at T1 were entered as possible explanatory variables: "STAI-I", "STAI-II", "SRQ-D", "SA", "DFA", "OF", "ADFA", "Recognition", "Satisfaction", "Gender" and "Age". Females showed lower self-esteem and reduced satisfaction with body image (Kiyak et al. 1981). "Gender" was binary variables, and was therefore allocated values of 1 or 0 for male or female. Satisfaction with facial body image decreased with age (Cunningham et al. 2000). "Age" was treated as a continuous variable. Macintosh statistical package software, StatView 4.5 (Abacus Concepts, Inc., Berkeley, CA, USA) was used. $P < 0.05$ was considered statistically significant.

The study protocol was approved by the ethical committee of Tohoku University and all the subjects gave informed consent.

Results

Comparisons of HRQOL and psychological status among Low-SS, Moderate-SS, and High-SS

All patients' SS were improved almost completely (SS 0-SS 1) after the surgery (Table 2). Generic HRQOL measured by SF-36 is shown in Tables 3 and 4. There was no significant difference in any subscale scores of SF-36 between T1 and T2. Moreover, there was no significant difference in any subscale scores of SF-36 among Low-SS, Moderate-SS, and High-SS. Furthermore, there are data of the Japanese standard value under 29 years old of SF-36. There were no significant differences between the value of the subjects (T1 and T2) and the Japanese standard value (Table 3).

The psychological status measured by "STAI" and "SRQ-D" is shown in Table 3 and Table 4. In "STAI-I", there were significant differences between T1 and T2, ($p < 0.01$), however no significant differences were found in "STAI-II". There was no interaction among the SS groups. Moreover, no significant difference in "SRQ-D" was found. There was no interaction among the SS groups. When logistic regression was applied (Table 5), the predictor of postoperative "STAI-I" was preoperative "STAI-I" and "STAI-II" (53.6%, $p < 0.001$). The predictor of postoperative "SRQ-D" was preoperative "SRQ-D" and "STAI-I" (31.6%, $p < 0.01$). In contrast, it was difficult to predict the postoperative "STAI-I" by the preoperative anxiety and disease-specific HRQOL.

The disease-specific HRQOL measured by "SOHSI" is shown in Table 3 and Table 4. There were significant differences between T1 and T2, in "AC", "AS", "EIS (%) (sum)", "CSIS (%) (sum)", "ADIS (%) (sum)" and "WCIS (%) (sum)" of "SOHSI" ($p < 0.01$ or 0.05). However, there was no interaction among the three groups.

The disease-specific HRQOL measured by OQLQ is also shown in Tables 3, 4 and Fig. 1. There were significant differences between T1 and T2 in 3 out of 4 domains of OQLQ: "SA", "FA" and "OF". In contrast, there were no significant differences in "ADFA". There was interaction among the three groups. When logistic regression was applied (Table 5), the predictor of postoperative "SA" was the preoperative "SA" (28.5%, $p < 0.01$). The predictor of postoperative "FA" was the preoperative "OF", "SA", "STAI-I" and "STAI-II" (32.1%, $p < 0.01$). The predictor of postoperative "OF" was the preoperative "STAI-I", "STAI-II" and "gender" (35.0%, $p < 0.01$). The predictor of postoperative "ADFA" was the preoperative "STAI-I" (34.5%, $p < 0.01$).

The result of RSS-M is shown in Tables 3 and 4. Both in the domains of "Recognition" and "Satisfaction" there were significant differences between T1 and T2 ($p < 0.001$). There was no interaction among the groups. When logistic

TABLE 3. Comparisons of QOL and psychological status between T1 and T2.

Measure	Domain	T1	T2	Japanese standard (≦ 29y)
SF-36	Physical functioning (PF)	95.3 ± 8.50	96.4 ± 6.20	94.4 ± 9.40
	Role physical (RP)	89.5 ± 26.4	95.9 ± 18.3	91.9 ± 20.8
	Bodily pain (BP)	83.0 ± 21.4	86.0 ± 15.5	79.8 ± 21.2
	Social functioning (SF)	87.3 ± 15.5	84.9 ± 15.3	86.5 ± 18.9
	General health (GH)	57.9 ± 15.2	64.0 ± 16.5	71.3 ± 18.2
	Vitality (VT)	86.9 ± 15.6	84.4 ± 15.3	64.9 ± 19.6
	Role emotional (RE)	86.9 ± 25.4	84.8 ± 25.7	84.3 ± 27.5
	Mental health (MH)	68.1 ± 14.6	70.5 ± 15.1	70.5 ± 18.3
STAI & SRQ-D	State anxiety (STAI-I)	47.4 ± 8.80	39.4 ± 6.2**	
	Trait anxiety (STAI-II)	46.8 ± 8.50	45.0 ± 9.9	
	Depression (SRQ-D)	10.1 ± 3.80	9.5 ± 4.8	
SOHSI	Ability to chew (AC)	13.4 ± 16.8	5.9 ± 11.0*	
	Ability to speak (AS)	51.6 ± 42.0	22.5 ± 33.7*	
	Oral and facial pain symptoms (OFPS)	16.1 ± 18.3	18.4 ± 14.8	
	Other oral symptoms (OOS)	17.7 ± 11.7	15.8 ± 12.0	
	Eating impact scale (EIS) %	67.7 ± 37.0	38.7 ± 35.5**	
	Eating impact scale (EIS) sum	11.4 ± 2.75	13.2 ± 2.18**	
	Communication/social relations impact scale (CSIS) %	49.1 ± 30.6	22.5 ± 25.2**	
	Communication/social relations impact scale (CSIS) sum	16.4 ± 2.79	18.8 ± 1.63**	
	Activities daily living impact scale (ADIS) %	28.4 ± 32.5	12.3 ± 25.0*	
	Activities daily living impact scale (ADIS) sum	27.6 ± 3.00	29.1 ± 1.66*	
	Worry/concern impact scale (WCIS) %	90.3 ± 20.0	59.6 ± 35.1**	
	Worry/concern impact scale (WCIS) sum	5.87 ± 2.24	8.32 ± 1.70**	
OQLQ	Social aspects of dentofacial deformity (SA)	11.5 ± 8.8	4.5 ± 5.0**	
	Facial aesthetics (FA)	9.9 ± 5.1	3.0 ± 3.2**	
	Oral-function (OF)	13.1 ± 6.0	7.3 ± 4.9**	
	Awareness of dentofacial aesthetics (ADFA)	7.1 ± 4.4	5.2 ± 4.3	
RSS-M	Recognition	23.9 ± 5.7	13.2 ± 6.6**	
	Satisfaction	17.3 ± 5.3	30.5 ± 6.5**	

Generic quality of life was measured by SF-36 (The MOS Short Form-36). Psychological status was measured by STAI (State-Trait Anxiety Inventory Questionnaire) and SRQ-D (Self-Rating Questionnaire for Depression). Disease specific quality of life was measured by SOHSI (The Subjective Oral Health Indicators), OQLQ (The Orthognathic Quality of Life Questionnaire), and RSS-M (The Recognition and Satisfaction scale Modified). T1: before surgery, T2: after debonding of multibracket appliance. Results expressed as mean ± standard error (S.E.M.). *Significantly different from T1 by Wilcoxon signed rank test; $p < 0.05$. **Significantly different from T1 by Wilcoxon signed rank test; $p < 0.01$.

TABLE 4. Comparisons of QOL and psychological status among Low-SS, Moderate-SS and High-SS.

Measure	Domain	Low-SS (n = 13)		Moderate-SS (n = 11)		High-SS (n = 7)		Interaction
		T1	T2	T1	T2	T1	T2	P
SF-36	Physical functioning (PF)	95.0 ± 8.10	96.5 ± 4.2	96.3 ± 8.90	96.3 ± 8.9	94.2 ± 9.7	95.0 ± 7.6	0.98
	Role physical (RP)	90.3 ± 16.2	92.3 ± 27.7	90.9 ± 30.1	97.7 ± 7.5	85.7 ± 37.7	100 ± 0	0.72
	Bodily pain (BP)	87.3 ± 15.9	85.8 ± 15.3	81.7 ± 23.0	89.0 ± 14.4	77.0 ± 28.3	81.7 ± 18.7	0.71
	Social functioning (SF)	87.3 ± 13.5	85.3 ± 14.4	88.5 ± 19.8	81.6 ± 14.2	85.4 ± 13.4	89.2 ± 19.6	0.61
	General health (GH)	58.7 ± 16.4	68.8 ± 15.4	56.7 ± 12.1	58.8 ± 16.9	58.4 ± 20.2	63.2 ± 18.1	0.69
	Vitality (VT)	87.3 ± 13.5	85.3 ± 14.4	88.5 ± 19.8	81.6 ± 14.2	83.0 ± 12.9	87.5 ± 20.9	0.60
	Role emotional (RE)	86.9 ± 21.2	81.9 ± 29.4	84.7 ± 31.2	81.6 ± 27.5	85.5 ± 26.4	95.1 ± 12.8	0.61
	Mental health (MH)	70.4 ± 11.3	70.4 ± 14.0	67.6 ± 17.4	72.7 ± 15.0	64.5 ± 16.7	67.4 ± 18.8	0.84
STAI & SRQ-D	State anxiety (STAI-I)	48.0 ± 10.2	39.6 ± 6.7*	46.5 ± 9.6	38.9 ± 5.7	48.0 ± 5.1	40.1 ± 7.1##	0.99
	Trait anxiety (STAI-II)	45.0 ± 8.00	42.2 ± 9.3	48.5 ± 9.2	47.2 ± 10.4	47.2 ± 8.9	46.5 ± 10.6	0.93
	Depression (SRQ-D)	10.1 ± 4.00	10.5 ± 5.2	11.1 ± 3.9	9.0 ± 5.3	8.7 ± 3.0	8.2 ± 3.0	0.62
SOHSI	Ability to chew (AC)	15.3 ± 19.7	6.4 ± 8.4	10.6 ± 15.4	3.0 ± 6.7	14.2 ± 14.9	9.5 ± 18.8	0.91
	Ability to speak (AS)	58.9 ± 38.8	17.9 ± 32.2	51.5 ± 45.6	18.1 ± 22.9	38.0 ± 44.8	38.0 ± 48.7	0.27
	Oral and facial pain symptoms (OFPS)	16.4 ± 20.9	13.1 ± 13.6	18.1 ± 14.4	22.0 ± 16.1	12.2 ± 20.9	22.4 ± 13.9	0.47
	Other oral symptoms (OOS)	15.3 ± 14.5	16.1 ± 12.6	20.0 ± 8.9	16.3 ± 12.0	18.5 ± 10.6	14.2 ± 12.7	0.76
	Eating impact scale (EIS) (%)	67.7 ± 37.0	38.7 ± 35.5*	66.6 ± 42.1	36.3 ± 37.8	61.9 ± 40.4	38.0 ± 35.6	0.96
	Eating impact scale (EIS) (sum)	11.0 ± 3.0	13.4 ± 1.5**	11.5 ± 2.9	13.6 ± 1.4+	12.1 ± 1.7	12.1 ± 2.8	0.32
	Communication/social relations impact scale (CSIS) (%)	48.0 ± 27.8	25.0 ± 22.8**	52.2 ± 3.9	13.6 ± 20.5+	46.4 ± 22.4	32.1 ± 34.5	0.43
	Communication/social relations impact scale (CSIS) (sum)	16.9 ± 2.30	18.6 ± 1.8	15.9 ± 3.6	19.3 ± 1.0+	16.4 ± 2.2	18.4 ± 1.9#	0.41
	Activities daily living impact scale (ADIS) (%)	30.7 ± 33.9	19.2 ± 34.5	27.2 ± 36.7	4.5 ± 10.7	26.1 ± 26.9	11.9 ± 18.5	0.80
	Activities daily living impact scale (ADIS) (sum)	27.2 ± 3.10	28.7 ± 2.2*	27.8 ± 3.1	29.7 ± 0.6	28.1 ± 2.3	29.1 ± 1.4	0.87
	Worry/concern impact scale (WCIS) (%)	96.1 ± 13.8	50.0 ± 28.8*	81.8 ± 25.2	63.6 ± 45.2	92.8 ± 18.8	71.4 ± 26.7	0.20
	Worry/concern impact scale (WCIS) (sum)	6.00 ± 1.70	9.0 ± 0.5**	5.60 ± 2.9	8.0 ± 1.9+	5.8 ± 2.1	7.4 ± 2.2	0.60
OQLQ	Social aspects of dentofacial deformity (SA)	10.0 ± 6.6	3.4 ± 4.3*	12.4 ± 10.0	4.7 ± 5.4+	13.1 ± 11.1	6.2 ± 5.7	0.96
	Facial aesthetics (FA)	9.10 ± 5.0	2.5 ± 2.9*	11.2 ± 5.1	3.1 ± 3.4++	9.2 ± 5.5	3.8 ± 3.9	0.66
	Oral function (OF)	11.8 ± 5.4	5.9 ± 4.3*	13.7 ± 6.5	8.8 ± 5.1+	14.7 ± 6.7	7.8 ± 5.7#	0.87
	Awareness of dentofacial aesthetics (ADFA)	7.20 ± 3.6	4.6 ± 3.9	7.50 ± 5.5	6.0 ± 5.4	6.2 ± 4.6	5.0 ± 3.4	0.89
RSS-M	Recognition	22.1 ± 4.6	10.8 ± 4.5**	25.6 ± 7.1	14.7 ± 7.7++	24.7 ± 4.9	15.4 ± 7.7#	0.88
	Satisfacion	18.7 ± 4.2	30.6 ± 7.5**	15.5 ± 6.0	30.3 ± 6.4++	17.7 ± 5.9	30.4 ± 5.5#	0.71

Generic quality of life was measured by SF-36 (The MOS Short Form-36). Psychological status was measured by STAI (State-Trait Anxiety Inventory Questionnaire) and SRQ-D (Self-Rating Questionnaire for Depression). Disease specific quality of life was measured by SOHSI (The Subjective Oral Health Indicators), OQLQ (The Orthognathic Quality of Life Questionnaire), and RSS-M (The Recognition and Satisfaction scale Modified). T1: before surgery, T2: after debonding of multibracket appliance. SS: Severity score. Low-SS: SS 2-4, Moderate-SS: SS 5, High-SS: SS 6-7. Results expressed as mean ± standard error (median). *Significantly different from T1 two-way factorial ANOVA; $p < 0.05$. **Significantly different from T1 by two-way factorial ANOVA; $p < 0.01$. +Significantly different from Moderate-SS (T1) by two-way factorial ANOVA; $p < 0.05$. ++Significantly different from Moderate-SS (T1) by two-way factorial ANOVA; $p < 0.01$. #Significantly different from High-SS (T1) by two-way factorial ANOVA; $p < 0.05$. ##Significantly different from High-SS (T1) by two-way factorial ANOVA; $p < 0.01$.

TABLE 5. Variables related to QOL scales in a stepwise logistic regression.

	C-R^2 (%)	p	Variables entered in equation	F
STAI-I (T2)	1.0	0.2652	ADFA (T1)	1.291
STAI-II (T2)	53.6	< 0.0001	STAI-II (T1)	34.649
			STAI-I (T1)	7.236
SRQ-D (T2)	31.6	0.0019	SRQ-D (T1)	14.388
			STAI-I (T1)	4.75
SA (T2)	28.5	0.0012	SA (T1)	12.963
FA (T2)	32.1	0.0064	OF (T1)	11.007
			SA (T1)	6.012
			STAI-I (T1)	4.801
			STAI-II (T1)	4.448
OF (T2)	35.0	0.0021	STAI-I (T1)	9.108
			STAI-II (T1)	8.538
			Gender	6.812
ADFA (T2)	34.5	0.001	ADFA (T1)	10.609
			STAI-I (T1)	6.441
Recognition (T2)	10.1	0.0456	Recognition (T1)	4.365
Satisfaction (T2)	25.1	0.0066	Age	8.681
			Recognition (T1)	4.647

Logistic regression analysis was performed with the psychological status and the disease-specific QOL after surgery. Psychological status was measured by STAI (State-Trait Anxiety Inventory Questionnaire) and SRQ-D (Self-Rating Questionnaire for Depression). Disease specific quality of life was measured by OQLQ (The Orthognathic Quality of Life Questionnaire), and RSS-M (The Recognition and Satisfaction scale Modified). T1: before surgery, T2: after debonding of multibracket appliance. STAI-I; state anxiety, STAI-II; trait anxiety, SRQ-D; depression, SA; social aspects of dentofacial deformity, FA; facial aesthetics, OF; oral function, ADFA; awareness of dentofacial aesthetics.

regression was applied (Table 5), the predictor of postoperative "Recognition" was the preoperative "Recognition" (10.1%, $p < 0.05$), and the predictor of postoperative "Satisfaction" was the preoperative age and "Recognition" (25.1%, $p < 0.01$).

Comparisons of HRQOL and psychological status in High-anxiety and Low-anxiety

The HRQOL and psychological status of patients divided into two groups according to the anxiety level is shown Fig. 2. There was no interaction between the groups in any of the domains. "STAI-I" improved significantly after the treatment in both groups. However, "STAI-II" did not change significantly.

Comparisons of HRQOL and psychological status in High-depression and Low-depression level

The HRQOL and psychological status of patients divided into two groups according to the depression level is shown in Fig. 3. There was no interaction. "SRQ-D" did not improve significantly after the treatment in the two groups.

DISCUSSION

In the present study, the improvement of disease-specific HRQOL and psychological status of patients with malocclusion after the surgical correction was demonstrated irrespective of the severity before surgery. In contrast, no change was recognized in generic HRQOL after the treat-

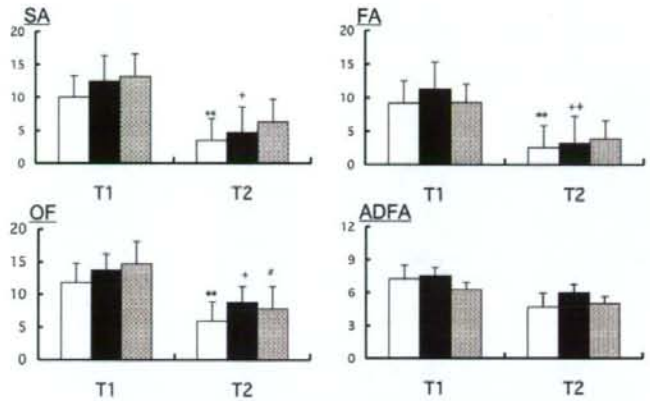

Fig. 1. Comparisons of disease specific quality of life measured by OQLQ among Low-SS, Moderate-SS and High-SS.
Results expressed as mean ± standard error (S.E.M.). □, Low-SS; ■, Moderate-SS, ▨, High-SS. Disease specific quality of life was measured by OQLQ (The Orthognathic Quality of Life Questionnaire). T1: before surgery, T2: after debonding of multibracket appliance. Results expressed as mean ± standard error (S.E.M.). SA, social aspects of dentofacial deformity; FA, facial aesthetics; OF, oral function; ADFA, awareness of dentofacial aesthetics.
**Significantly different from Low-SS (T1) by two-way factorial ANOVA; $p < 0.01$.
+Significantly different from Moderate-SS (T1) by two-way factorial ANOVA; $p < 0.05$.
++Significantly different from Moderate-SS (T1) by two-way factorial ANOVA; $p < 0.01$.
#Significantly different from High-SS (T1) by two-way factorial ANOVA; $p < 0.05$.

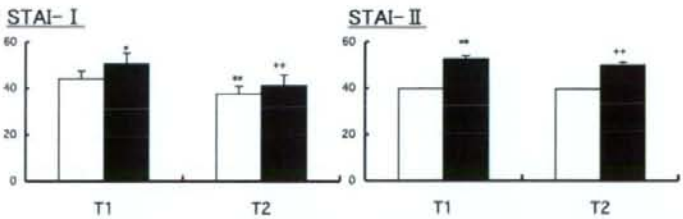

Fig. 2. Comparisons of anxiety level measured by STAI among Low-anxiety and High-anxiety.
Results expressed as mean ± standard error (S.E.M.). □, Low-anxiety; $n = 15$, anxiety score 30-46, ■, High-anxiety; $n = 16$, anxiety score 47-67. Psychological status was measured by STAI (State-Trait Anxiety Inventory Questionnaire). T1: before surgery, T2: after debonding of multibracket appliance. Results expressed as mean ± standard error (S.E.M.). STAI- I; state anxiety, STAI- II; trait anxiety.
*Significantly different from Low-anxiety (T1) by two-way factorial ANOVA; $p < 0.05$.
**Significantly different from Low-anxiety (T1) by two-way factorial ANOVA; $p < 0.01$.
++Significantly different from High-anxiety (T1) by two-way factorial ANOVA; $p < 0.01$.

ment. The patients' state anxiety improved after the treatment irrespective of their individual anxiety and depression level before surgery. In contrast, trait anxiety and depression were unchanged. Moreover, both postoperative anxiety and HRQOL were determined to a certain extent by the preoperative anxiety and HRQOL.

This is the first report addressing the

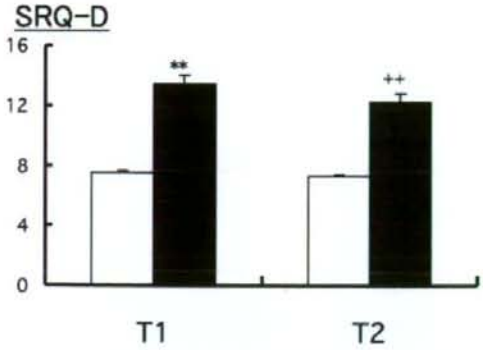

Fig. 3. Comparisons of depression level measured by SRQ-D among Low-depression and High-depression.
Results expressed as mean ± standard error (S.E.M.). □, Low-depression; $n = 17$, depression score 11-18, ■, High-depression; $n = 14$, depression score 2-10. Psychological status was measured by Self-Rating Questionnaire for Depression (SRQ-D). T1: before surgery, T2: after debonding of multibracket appliance. Results expressed as mean ± standard error (S.E.M.).
**Significantly different from low-depression (T1) by two-way factorial ANOVA; $p < 0.01$.
++Significantly different from High-depression (T1) by two-way factorial ANOVA; $p < 0.01$.

HRQOL and psychological status of adult patients with various severity levels of malocclusions before and after surgical correction. The disease-specific HRQOL and psychological status improved after the surgery irrespective of the severity of SS or the psychological status before the surgery.

The reason why the degree of improvement of HRQOL was not in parallel with the degree of improvement of the dentofacial deformity was not fully clarified in the present study. It may have been due to the timing of the assessments affecting the measurements. The patients may not have had time to adjust to their new appearance and facial frames immediately after the treatment, and some further improvement in HRQOL and psychological status could be expected. A longer follow up period is needed to establish the maximum effect that the treatment can offer the patients in terms of HRQOL and psychological status.

The postoperative "STAI-II" and "SRQ-D" were specified as 53.6% and 31.6%, the prespectively by preoperative "STAI-I", "STAI-II" and "SRQ-D". Although the individual transient emotional condition improved, the trait anxiety or depression did not improve after the treatment. Therefore, it is considered that trait anxiety is not determined only by either the tooth or face frame, since trait anxiety or depression did not improve even when the patients gained normal occlusion after treatment.

The generic HRQOL of orthognathic surgery patients measured by SF-36 in England prior to surgery and after removal of the orthodontic appliances (Cunningham et al. 2002) showed levels similar to those of the present study. There was no significant difference in any scale scores of SF-36 between T1 and T2 in each group. The reason why the levels of generic HRQOL measured by SF-36 were matched might be because they had no other major problems except dental ones.

Compared with the level of trait anxiety of temporomandibular joint patients with anterior openbite prior to surgery in London (Aghabeigi et al. 2001), the level of STAI-II was slightly higher in the present patients at T1. Additionally, compared with the levels of STAI-I and STAI-II of patients before third molar extraction in Japan (Yusa et al. 2004), both levels of trait and state anxiety were slightly higher in the present patients at T1. The differences might be due to differences in the dentofacial deformity prior to orthognathic treatment, racial differences in the reactions to anxiety, and the influence of age although detailed analysis remains to be further investigated.

Compared with the levels of disease-specific HRQOL measured by SOHSI in an 18-29 age group of the general population of New York (Locker and Miller 1994), the level of disease specific HRQOL measured by SOHSI was lower in the present patients at T1, except for the domains of oral and facial pain symptoms and other oral symptoms. The reason why the patients with malocclusion had lower HRQOL in this study may be that firstly, the difference in the age

range, i.e. 17-42 at T1 (32% of patients were over the age of 30), and secondly, the various ranges of dentofacial deformity. It is interesting to note that the patients with malocclusions had fewer problems with chewing, oral and facial pain and other symptoms compared with the older people in New York with tooth loss and pain or symptoms of periodontal disease (Locker and Miller 1994).

The disease-specific HRQOL measured by OQLQ in the orthognathic surgery patients in England showed the same degree of improvement by treatment in disease-specific HRQOL patients in the present study. (Cunningham et al. 2002) The research moment was matched, and the mean age of the orthognathic surgery patients in England prior to treatment and the patients of the present study were quite similar. The disease-specific HRQOL measured by RSS in orthognathic surgery patients prior to surgery in Japan showed the same mean levels of disease-specific HRQOL measured by RSS-1 as the patients in the present study at T1 (Enomoto et al. 2000).

The present study had a few limitations. It can be said that there are validity and reliability in Japanese reason version of SF-36, STAI and SRQ-D. On the other hand, though it had checked with Japanese SOHSI and OQLQ, validity and reliability are not being checked, and it is a future subject. Moreover, HRQOL and psychological status were measured just before surgery and after debonding of the multibracketed appliances. Therefore, fear of the impending surgery may have affected the HRQOL and psychological status before surgery, although the patients had similar preoperative data of OQLQ and RSS-1 as reported in other studies (Enomoto et al. 2000; Cunningham et al. 2002). A longer follow up period may be needed to have had time to adjust to their new appearance and facial frames and to elucidate the maximum effect of the treatment on HRQOL and psychological status. Moreover, further investigation is needed to increase the number of subjects more and to compare the degree of the improvement in HRQOL between patients treated with jaw surgery and those with non-surgical correction. There could have been a bias in the validity and reliability. The validity and reliability of the Japanese version of SF-36, STAI, SRQ-D were established, however those of the Japanese version of SOHSI and OQLQ have not been established and need further study. Another limitation was the relatively small number of the patients. The number of new patients to our hospital was less than we expected during the scheduled period. Although our findings were significant, still the supportive reports by the future studies will be needed.

In summary, an improvement in the disease-specific HRQOL and state anxiety of patients with malocclusion after surgical correction was demonstrated irrespective of the severity before surgery. Both postoperative anxiety and HRQOL were determined by the preoperative anxiety and HRQOL. These results indicated that jaw surgery markedly improved the disease-specific HRQOL and psychological status in the present patients. Moreover, they suggest that assessments of the HRQOL and psychological status before treatment might predict the HRQOL and psychological status after the treatment to a certain extent. This may help to do mental care and explain the outcome of the surgery beforehand, which leads to establish better doctor-patient relationships.

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