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SPECTROCOLORIMETRIC STUDY OF GINGIVAL MICROVASCULAR REACTIVITY DURING PROSTHODONTIC TREATMENT USING FIXED DENTAL PROSTHESES

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Objective optical monitoring may reveal gingival microvascular dysfunction and inflammatory chromatic changes that are not fully captured by visual examination. ***The purpose of the study*** *was to evaluate longitudinal changes in gingival microvascular reactivity to a standardized masticatory load and the iodine-associated spectrocolorimetric response during implant-supported and tooth-supported fixed prosthetic rehabilitation, and to determine whether adjunctive multicomponent support was associated with more favorable six-month optical outcomes than basic care alone.* ***Materials and methods.*** *This longitudinal, nonrandomized comparative study included 76 adults aged 18–30 years with a bounded single-tooth edentulous space. Diagnostic stratification determined rehabilitation with two-stage implants (group 1.1, adjunctive regimen, n=20; group 1.2, basic care, n=17) or three-unit metal–ceramic fixed dental prostheses supported by two teeth (group 2.1, adjunctive regimen, n=22; group 2.2, basic care, n=17). An automated spectrocolorimeter recorded gingival reflectance-derived CIE X, Y, and Z tristimulus coordinates before and after a protocol-defined masticatory load and before and after Schiller–Pisarev iodine staining. Measurements were obtained at baseline, after preliminary therapy in the intervention groups, and 1 and 6 months after surgery or prosthesis fixation Statistical analysis was performed in STATISTICA 6.1 using Student's t-test (p < 0.01).* ***Research results.*** *At baseline, the implant-stratified groups showed a positive optical microvascular response to loading, whereas the bridge-stratified groups showed a negative response. At 1 month, load reactivity was attenuated or negative in all groups. By 6 months, group 1.1 demonstrated increases of +3.5, +2.5, and +2.7 units in X, Y, and Z after loading, while group 1.2 showed negligible changes (−0.1, +0.1, and +0.1). Group 2.1 shifted toward a positive response (+0.3, +0.3, and +0.4), whereas group 2.2 retained a negative response (−2.0 for each coordinate). At 6 months, the relative iodine-associated coordinate changes were 5.3–6.5% in group 1.1 versus 14.2–15.5% in group 1.2, and 16.2–17.9% in group 2.1 versus 25.9–27.8% in group 2.2 (p<0.001 for each adjunctive-versus-comparison contrast).* ***Conclusions.*** *Within each rehabilitation stratum, adjunctive multicomponent support was associated with more favorable recovery of the gingival optical response to functional loading and a smaller iodine-associated chromatic shift at 6 months. These findings support standardized optical monitoring as a complementary method for longitudinal assessment of peri-prosthetic soft tissues, while the nonrandomized design precludes direct causal comparison of implants and bridges.*

Key words: *gingival microcirculation, spectrocolorimetry, dental implants; fixed dental prosthesis, masticatory load, Schiller–Pisarev test, gingival inflammation, health care.*

СПЕКТРОКОЛОРИМЕТРИЧНЕ ДОСЛІДЖЕННЯ РЕАКТИВНОСТІ МІКРОЦИРКУЛЯТОРНОГО РУСЛА ЯСЕН У ПРОЦЕСІ ОРТОПЕДИЧНОГО ЛІКУВАННЯ НЕЗНІМНИМИ КОНСТРУКЦІЯМИ

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Об'єктивний оптичний моніторинг може виявляти порушення мікроциркуляції ясен і запальні хроматичні зміни, які не повною мірою визначаються під час візуального огляду. ***Мета дослідження.*** *Оцінити поздовжні зміни реактивності мікроциркуляторного русла ясен у відповідь на стандартизоване жувальне навантаження та йод-асоційовану спектроколориметричну реакцію під час незнімної ортопедичної реабілітації з опорою на імплантати й зуби, а також визначити, чи був додатковий багатокомпонентний супровід пов'язаний зі сприятливішими оптичними результатами через шість місяців порівняно із застосуванням лише базової терапії.* ***Матеріали та методи.*** *До цього поздовжнього нерандомізованого порівняльного дослідження було залучено 76 пацієнтів віком 18–30 років із включеним одиничним дефектом зубного ряду. На підставі діагностичної стратифікації здійснювали ортопедичну реабілітацію із застосуванням двоетапних імплантатів (група 1.1 − додатковий лікувально-профілактичний комплекс, n=20; група 1.2 − базова терапія, n=17) або трьохдиничних металокерамічних незнімних зубних протезів з опорою на два зуби (група 2.1 − додатковий лікувально-профілактичний комплекс, n=22; група 2.2 − базова терапія, n=17). За допомогою автоматичного спектроколориметра реєстрували отримані на підставі спектрів відбиття ясен тристимульні координати CIE X, Y і Z до та після регламентованого протоколом жувального навантаження, а також до і після йодного забарвлення за Шиллером–Писарєвим. Вимірювання проводили у вихідному стані, після попередньої терапії в основних групах, а також через 1 і 6 місяців після хірургічного втручання або фіксації зубного протеза. Статистичний аналіз виконували у програмі STATISTICA 6.1 із застосуванням t-критерію Стьюдента (p<0,01).* ***Результати дослідження.*** *У вихідному стані в групах, стратифікованих для реабілітації з опорою на імплантати, спостерігали позитивну оптичну реакцію мікроциркуляторного русла на навантаження, тоді як у групах, стратифікованих для мостоподібного протезування, реєстрували негативну реакцію. Через 1 місяць реактивність у відповідь на навантаження була послабленою або негативною в усіх групах. Через 6 місяців у групі 1.1 після навантаження було встановлено збільшення координат X, Y і Z відповідно на +3,5, +2,5 і +2,7 одиниці, тоді як у групі 1.2 зміни були мінімальними (−0,1, +0,1 і +0,1 відповідно). У групі 2.1 відзначено зміщення у напрямі позитивної реакції (+0,3, +0,3 і +0,4), натомість у групі 2.2 зберігалася* *негативна реакція (−2,0 для кожної координати). Через 6 місяців відносні йод-асоційовані зміни координат становили 5,3–6,5% у групі 1.1 порівняно з 14,2–15,5% у групі 1.2 та 16,2–17,9% у групі 2.1 порівняно з 25,9–27,8% у групі 2.2 (p<0,001 для кожного порівняння групи додаткового супров***оду з відповідною групою базової терапії). Висновки.*** *У межах кожної страти ортопедичної реабілітації додатковий багатокомпонентний супровід був пов'язаний зі сприятливішим відновленням оптичної реакції ясен на функціональне навантаження та менш вираженим йод-асоційованим хроматичним зсувом через 6 місяців. Отримані результати обґрунтовують застосування стандартизованого оптичного моніторингу як додаткового методу поздовжнього оцінювання стану м'яких тканин у ділянці ортопедичних конструкцій. Водночас нерандомізований дизайн дослідження не дає змоги здійснювати пряме причинно-наслідкове порівняння реабілітації з використанням імплантатів і мостоподібних протезів.*

Ключові слова: *мікроциркуляція ясен, спектроколориметрія, дентальні імплантати, незнімний зубний протез, жувальне навантаження, проба Шиллера–Писарєва, запалення ясен, охорона здоров'я.*

The long-term biological acceptability of fixed prosthetic rehabilitation depends not only on mechanical stability but also on preservation of a healthy soft-tissue interface. Restoration contours, emergence profiles, marginal configuration, surface characteristics, and plaque-retentive factors can modify local periodontal conditions and complicate maintenance. The current periodontal classification therefore treats dental prostheses and tooth-related factors as clinically relevant modifiers of plaque-induced gingival inflammation and attachment loss [1]. This principle applies to tooth-supported restorations and, with appropriate biological distinctions, to peri-implant mucosa.

Microvascular perfusion is central to gingival homeostasis because it supports oxygen delivery, metabolite exchange, inflammatory-cell trafficking, and tissue repair. The gingival microcirculation can respond rapidly to inflammation, surgical trauma, mechanical compression, and functional loading, potentially before gross morphological changes become apparent. Contemporary optical work has demonstrated that laser speckle contrast imaging can quantify gingival blood-flow dynamics after periodontal surgery, provide reproducible repeated measurements in healthy gingiva, and reveal functionally relevant collateral perfusion patterns [2–4]. Anatomical studies further emphasize that vascular density and vessel orientation vary by site, tissue thickness, and proximity to the mucogingival junction, making standardized measurement geometry essential [8].

Objective color measurement provides a complementary window on the same tissue interface. Gingival color is a composite phenotype determined by perfusion, hemoglobin concentration and oxygenation, epithelial thickness and keratinization, melanin, tissue hydration, and optical scattering. In vivo spectrophotometric studies have documented substantial interindividual variation and have proposed instrumental shade systems that reduce the subjectivity inherent in visual assessment [5,6]. Validation studies nevertheless show that reproducibility depends on the measuring device, acquisition protocol, tissue location, and color-space definition [9]. CIE tristimulus coordinates should therefore be interpreted as standardized optical descriptors rather than disease-specific biomarkers in isolation.

The clinical feasibility of perfusion-sensitive optical monitoring has expanded during the past decade. Laser Doppler flowmetry combined with tissue spectrophotometry has been used to define baseline oral mucosal perfusion, discriminate inflamed from clinically healthy gingiva, and characterize perfusion at reconstructed or augmented peri-implant sites [7, 10, 11]. Recent systematic reviews conclude that non-invasive blood-flow methods are promising for longitudinal periodontal and oral-soft-tissue assessment, while also highlighting heterogeneity in devices, probe stabilization, test sites, physiological confounders, and outcome definitions [12, 13]. Functional challenge testing may be particularly informative because it evaluates vascular reserve rather than a single resting measurement.

An iodine-based chromatic challenge can add another dimension to optical assessment. The Schiller–Pisarev reaction produces staining related to epithelial glycogen and inflammatory alteration; quantifying the resulting coordinate shift may reduce observer dependence. However, the response remains an operational optical surrogate and should not be equated with direct histological measurement of epithelial permeability. Few longitudinal studies have combined a standardized masticatory challenge with quantitative iodine-associated colorimetry during different fixed rehabilitation pathways, and evidence is especially limited for diagnostic stratification coupled with an adjunctive preventive regimen.

The aim of this study was to evaluate longitudinal changes in gingival microvascular reactivity to a standardized masticatory load and the iodine-associated spectrocolorimetric response during implant-supported and tooth-supported fixed prosthetic rehabilitation, and to determine whether adjunctive multicomponent support was associated with more favorable six-month optical outcomes than basic care alone.

Materials and methods. This longitudinal, non-randomized comparative clinical study included 76 young adults aged 18–30 years with bounded single-tooth edentulous spaces. All participants underwent a comprehensive pretreatment assessment of bone quality, gingival microvascular function and inflammatory status, salivary biochemical and biophysical characteristics, mobility of prospective abutment teeth, and selected genetic indicators of bone resorption and inflammation.

Treatment allocation was diagnostic rather than random. Cohort 1 comprised participants with a preserved gingival microvascular response to masticatory loading, normal densitometric and echo-osteometric indices without evidence of osteopenia or osteoporosis, and salivary biochemical values close to physiological reference levels. All participants in this cohort received two-stage implants manufactured by Alpha Dent Implants Ltd. They were subdivided into group 1.1 (adjunctive regimen plus basic care; n=20) and group 1.2 (basic care alone; n=17). Cohort 2 comprised participants who did not meet the diagnostic profile of cohort 1. They received three-unit metal–ceramic fixed dental prostheses supported by two adjacent teeth and were subdivided into group 2.1 (adjunctive regimen plus basic care; n=22) and group 2.2 (basic care alone; n=17). Because the rehabilitation modality was determined by baseline diagnostic status, implant and bridge cohorts were not treated as randomized alternatives and were not compared causally. The prespecified clinically relevant contrasts were group 1.1 versus 1.2 and group 2.1 versus 2.2.

Basic care consisted of oral sanitation and professional oral hygiene. The adjunctive protocol was multicomponent and was administered in addition to basic care. The original protocol did not permit attribution of any observed effect to an individual component.

For implant rehabilitation (group 1.1), the regimen comprised Esmin, one tablet once daily for 1 month before surgery; 40% Carniton (L-carnitine), 17 drops once daily for 1 month before surgery; Adaptol, 100 mg (two tablets), on the evening before surgery and on the morning of surgery; Lysomucoid, two teaspoons diluted in one-quarter glass of water for 1 week after surgery; “Grape” oral elixir, two teaspoons diluted in one-quarter glass of water and used as a postprandial rinse with an exposure period for 1 month; Lacalut Phytoformula toothpaste each morning for 1 month; and Lacalut Fluor toothpaste each evening for 1 month. The course was repeated every 6 months during the first year.

For tooth-supported bridge rehabilitation (group 2.1), the regimen comprised Esmin, one tablet twice daily for 1 month before prosthesis fixation; 40% Carniton (L-carnitine), 17 drops twice daily for 1 month before fixation; Adaptol, 100 mg (two tablets), on the day before fixation and on the morning of fixation; “Grape” oral elixir prepared and used as described above for 1 month after fixation; Lacalut Phytoformula toothpaste each morning for 1 month; and Lacalut Fluor toothpaste each evening for 1 month. This course was likewise repeated every 6 months during the first year. Product names and doses are reported as documented in the original clinical protocol.

Gingival light-reflectance spectra were recorded with an automated spectrocolorimeter and converted to the associated CIE X, Y, and Z tristimulus coordinates. Measurements were obtained under protocol-standardized conditions at baseline, after the preliminary course of therapy in groups 1.1 and 2.1, and at 1 and 6 months after implant surgery or bridge fixation.

Functional microvascular reactivity was assessed by recording the coordinates immediately before and after a protocol-defined standardized masticatory load. An increase in coordinate values after loading was classified operationally as a positive optical microvascular response, corresponding to the “positive hyperemia” terminology used in the source study. A decrease was classified as a negative optical response. The coordinate change was interpreted as a composite reflectance response associated with altered gingival blood filling, not as a direct volumetric measurement of flow.

The iodine-associated chromatic response was assessed with the Schiller–Pisarev test. The difference between coordinates recorded before and after iodine staining was calculated as ΔX, ΔY, and ΔZ and was also expressed relative to the prestaining value. Larger negative shifts indicated a stronger iodine-associated optical response. In the source protocol this measure was used to characterize gingival inflammation and barrier alteration; in the present interpretation it is treated as an operational surrogate because no paired histological validation was performed.

Data are presented as arithmetic mean ± standard error (M ± m). A 95% confidence level was used. Differences between group means and longitudinal observations were evaluated with a Student-type comparison-of-means procedure. [7].

Results of the study and their discussion. At baseline, the two implant-stratified groups had similar resting coordinate values and showed a clear positive optical response to masticatory loading. In group 1.1, X, Y, and Z increased from 15.3, 13.9, and 13.9 to 18.5, 15.7, and 16.1, respectively; the corresponding values in group 1.2 increased from 15.5, 14.1, and 14.0 to 18.6, 15.6, and 15.9. By contrast, both bridge-stratified groups showed small post-load decreases at baseline. In group 2.1, coordinates changed from 17.5, 16.3, and 16.4 to 17.1, 16.0, and 16.0; in group 2.2, they changed from 17.3, 16.5, and 16.6 to 16.9, 16.1, and 16.1 (Table 1).

The preliminary adjunctive course did not materially alter the already positive response in group 1.1: post-load increments were +3.5 for X, +2.1 for Y, and +2.5 for Z. In group 2.1, the direction of the response shifted modestly toward positive values (+0.7, +0.4, and +0.4). No post-preliminary-treatment measurement was available for the basic-care groups because they did not receive the preliminary adjunctive course.

At 1 month, the response to masticatory loading was attenuated or negative in all four groups. The most pronounced decreases occurred in the basic-care groups: group 1.2 showed changes of −3.1, −2.1, and −2.0 for X, Y, and Z, whereas group 2.2 showed changes of −4.2, −2.6, and −2.7. At 6 months, the optical response had recovered in group 1.1, with increments of +3.5, +2.5, and +2.7. Group 1.2 showed almost no response (−0.1, +0.1, and +0.1). Group 2.1 demonstrated a small positive response (+0.3, +0.3, and +0.4), while group 2.2 retained a uniformly negative response of −2.0 for each coordinate.

Table 1

Gingival CIE X, Y, and Z coordinates before and after the standardized masticatory load (M±m)

Time point	Load	Group 1.1 Implant + adjunctive (n=20)	Group 1.2 Implant + basic care (n=17)	Group 2.1 Bridge + adjunctive (n=22)	Group 2.2 Bridge + basic care (n=17)
Baseline	Pre-load	X15.3±0.7 Y13.9±0.9 Z13.9±0.9 $p_1>0.1$	X15.5±0.9 Y14.1±0.8 Z14.0±0.8	X17.5±0.9 Y16.3±0.9 Z16.4±0.8 $p_1>0.1$	X17.3±0.8 Y16.5±0.8 Z16.6±0.7
	Post-load	X18.5±1.0 Y15.7±0.9 Z16.1±0.9 $p_1>0.01$	X18.6±1.0 Y15.6±1.0 Z15.9±0.9	X17.1±1.0 Y16.0±0.9 Z16.0±1.0 $p_1>0.01$	X16.9±0.9 Y16.1±0.8 Z16.1±1.9
After preliminary therapy	Pre-load	X15.1±0.9 Y13.8±0.9 Z13.8±0.9 $p>0.1$	–	X17.1±0.9 Y15.9±1.0 Z15.9±1.0 $p>0.1$	–
	Post-load	X18.6±0.8 Y15.9±0.9 Z16.3±0.7 $p>0.1$	–	X17.8±1.0 Y16.3±1.0 Z16.3±0.9 $p>0.1$	–
1 month	Pre-load	X17.7±0.8 Y15.1±0.9 Z15.1±0.9 $p<0.05$ $p_1<0.1$	X19.3±0.7 Y17.2±0.8 Z17.1±0.8 $p<0.01$	X18.1±0.8 Y15.9±0.9 Z15.8±0.8 $p>0.1$ $p_1<0.05$	X20.3±0.9 Y17.1±0.8 Z17.0±0.8 $p<0.012$
	Post-load	X17.6±1.0 Y15.3±0.9 Z15.3±1.0 $p>0.1$ $p_1>0.1$	X16.2±0.7 Y15.1±0.7 Z15.1±0.9 $p>0.1$	X17.1±0.8 Y15.7±0.9 Z15.8±0.7 $p>0.1$ $p_1>0.1$	X16.1±0.7 Y14.5±0.8 Z14.3±0.7 $p>0.1$
6 months	Pre-load	X15.1±0.8 Y13.5±0.7 Z13.5±0.7 $p>0.1$ $p_1>0.1$	X17.1±0.7 Y15.3±0.6 Z15.2±0.6 $p>0.1$	X17.3±0.9 Y16.1±0.8 Z16.0±0.7 $p>0.1$ $p_1>0.1$	X18.1±0.9 Y17.2±0.9 Z17.1±0.8 $p>0.1$
	Post-load	X18.6±0.8 Y16.0±0.6 Z16.2±0.7 $p>0.1$ $p_1>0.1$	X17.0±0.7 Y15.4±0.6 Z15.3±0.6 $p>0.1$	X17.6±0.7 Y16.4±0.8 Z16.4±0.7 $p>0.1$ $p_1>0.1$	X16.1±0.9 Y15.2±0.8 Z15.1±0.9 $p>0.1$

Note. p, comparison with the corresponding baseline value; p_1, comparison with the respective basic-care group. "–", not assessed because the basic-care groups did not receive preliminary adjunctive therapy.

At baseline, the iodine-associated relative changes in the implant-stratified groups were 8.4–11.8%, whereas the bridge-stratified groups showed substantially larger shifts of 20.2–24.7% (Table 2). The between-stratum difference was approximately 12–13 percentage points, consistent with the diagnostic stratification applied before treatment.

After preliminary therapy, relative coordinate changes decreased to 7.1–8.4% in group 1.1 and to 14.2–16.8% in group 2.1. At 1 month, the iodine-associated response increased in every group, but the magnitude remained lower with adjunctive support: 12.3–13.6% in group 1.1 versus 16.2–18.8% in group 1.2, and 22.0–25.2% in group 2.1 versus 25.9–27.75% in group 2.2.

By 6 months, group 1.1 demonstrated the smallest shifts observed during follow-up (5.3–6.5%), approximately 2.5-fold lower than group 1.2 (14.2–15.5%). Group 2.1 also improved to 16.2–17.9%, whereas group 2.2 remained at 25.9–27.8%. The adjunctive-versus-basic-care contrast was significant within each rehabilitation stratum ($p<0.001$).

The principal finding was that adjunctive multicomponent support was associated with a more favorable six-month optical phenotype within both rehabilitation strata. Participants receiving implant-supported rehabilitation plus adjunctive support regained a clear positive coordinate response to masticatory loading, whereas the corresponding basic-care group showed essentially no functional response. Among participants receiving tooth-supported bridges, the adjunctive group shifted from a negative baseline pattern to a small positive response, while the basic-care group retained a marked negative pattern. The parallel reduction in iodine-associated chromatic shifts strengthens the internal coherence of the observations: better recovery of functional reactivity coincided with a smaller optical response to the inflammatory staining challenge.

The transient deterioration at 1 month is biologically plausible in the context of surgery, prosthesis fixation, altered local loading, and early soft-tissue adaptation. Optical techniques are sensitive to perfusion changes following periodontal procedures [2], and functional reserve may remain disturbed even when resting appearance is clinically acceptable. The six-month trajectory is therefore more informative than a single postoperative value. Nevertheless, the measured X, Y, and Z changes represent composite tissue reflectance; they cannot be assigned exclusively to blood-flow velocity, vascular volume, or oxygen saturation.

The baseline difference between rehabilitation strata reflects the study's diagnostic algorithm rather than an effect of the rehabilitation modality. Participants with preserved microvascular reactivity and more favorable bone and salivary indices were selected for implant treatment, whereas those outside that profile received tooth-supported bridges. Direct comparison of groups 1 and 2 would therefore be confounded by indication. The appropriate inference is restricted to the adjunctive-versus-basic-care contrast within each modality. This distinction is important because restoration-related periodontal risk depends on both the prosthetic environment and pre-existing tissue susceptibility [1].

The present findings align conceptually with modern optical studies showing that gingival perfusion can be quantified non-invasively and that inflamed tissues exhibit distinguishable perfusion character-

Table 2

Changes in gingival CIE coordinates after Schiller–Pisarev iodine staining (M±m)

Time point	Group 1.1 Implant + adjunctive (n=20)	Group 1.2 Implant + basic care (n=17)	Group 2.1 Bridge + adjunctive (n=22)	Group 2.2 Bridge + basic care (n=17)
Baseline	ΔX−1.3±0.1(8.4%) ΔY−1.6±0.1(10.4%) ΔZ−1.8±0.1(11.7%)	ΔX−1.3±0.1(8.5%) ΔY−1.7±0.1(10.5%) ΔZ−1.85±0.1(11.8%)	ΔX−3.1±0.2(20.2%) ΔY−3.6±0.2(23.3%) ΔZ−3.8±0.2(24.6%)	ΔX−3.0±0.2(20.3%) ΔY−3.5±0.2(23.5%) ΔZ−3.8±0.2(24.7%)
After preliminary therapy	ΔX−1.1±0.1(7.1%) ΔY−1.3±0.1(8.4%) ΔZ−1.3±0.1(8.4%)	–	ΔX−2.2±0.1(14.2%) ΔY−2.5±0.1(16.2%) ΔZ−2.6±0.1(16.8%)	–
1 month	ΔX−1.9±0.1*(12.3%) ΔY−2.0±0.1*(13.0%) ΔZ−2.1±0.1*(13.6%)	ΔX−2.5±0.1(16.2%) ΔY−2.8±0.1(18.1%) ΔZ−2.9±0.1(18.8%)	ΔX−3.4±0.1*(22.0%) ΔY−3.7±0.1*(23.9%) ΔZ−3.9±0.1*(25.2%)	ΔX−4.0±0.2(25.9%) ΔY−4.3±0.2(27.5%) ΔZ−4.5±0.2(27.75%)
6 months	ΔX−0.8±0.1*(5.3%) ΔY−0.9±0.1*(5.7%) ΔZ−1.0±0.1*(6.5%)	ΔX−2.2±0.1(14.2%) ΔY−2.4±0.1(15.5%) ΔZ−2.4±0.1(15.5%)	ΔX−2.5±0.1*(16.2%) ΔY−2.8±0.1*(17.9%) ΔZ−2.8±0.1*(17.9%)	ΔX−4.0±0.2(25.9%) ΔY−4.2±0.2(27.1%) ΔZ−4.3±0.2(27.8%)

*Note. Relative change is shown in parentheses. Negative signs indicate a decrease in the corresponding coordinate after iodine staining. *p<0.001 versus the respective basic-care group. "–", not assessed.*

istics [7, 10]. They also support the use of dynamic rather than purely static assessment. Laser speckle studies have shown acceptable repeatability under standardized conditions and have identified local vascular networks capable of redistributing flow [3, 4]. Gingival vascular anatomy is heterogeneous, however, and both probe position and tissue thickness can influence the signal [8]. The same caution applies to spectrocolorimetry: natural gingival color varies considerably among individuals [5, 6], and method-comparison work indicates that instrument and protocol affect reproducibility [9]. Longitudinal paired measurements at a fixed site are therefore more defensible than universal thresholds derived from raw coordinate values.

The iodine challenge was used here to amplify optical differences associated with epithelial glycogen and inflammatory alteration. Its quantitative expression as ΔX, ΔY, and ΔZ is preferable to an uncalibrated visual judgement, but it remains a surrogate endpoint. The lower six-month response in the adjunctive groups may indicate a less pronounced inflammatory-associated chromatic reaction and improved barrier status, as proposed in the original protocol; confirmation with standardized clinical periodontal indices, biomarkers, or histological correlates would be required to establish the underlying tissue mechanism.

The multicomponent nature of the adjunctive protocol is both a pragmatic feature and an interpretive limitation. The regimen combined systemic products, perioperative anxiolytic administration, oral rinses, and toothpastes, with schedules differing between implant and bridge pathways. Any association may therefore reflect additive effects, improved hygiene behavior, adherence, or unmeasured differences in supportive care. The data do not identify an active component and should not be used to recommend a specific product independently of contemporary safety evaluation and regulatory guidance.

Recent systematic reviews characterize non-invasive oral microcirculatory methods as promising but not yet fully standardized [12, 13]. The present data contribute a functional-challenge and longitudinal perspective, but several limitations restrict generalization. Allocation was nonrandomized and baseline-stratified; the cohort was limited to adults aged 18–30 years; sample sizes were modest; sex-specific results were unavailable; the archived study records available for this analysis did not provide the spectrocolorimeter model, calibration procedure, exact chewing-load parameters, or participant-level data; multiple coordinate comparisons were reported without a modern multiplicity strategy; and the complete optical follow-up analyzed here extended to 6 months. In addition, the absence of a single-component comparator prevents mechanistic attribution. Future studies should use randomized or carefully matched designs within a single rehabilitation modality, preregistered endpoints, standardized device calibration and probe geometry, paired clinical periodontal outcomes, and mixed-effects longitudinal models.

Conclusions:

1. Within the implant-supported and tooth-supported rehabilitation strata, adjunctive multicomponent support was associated with better recovery of the gingival optical response to standardized masticatory loading at 6 months than basic care alone.

2. The adjunctive groups also demonstrated smaller Schiller–Pisarev iodine-associated changes in CIE X, Y, and Z coordinates, consistent with a less pronounced inflammatory chromatic response.

3. Automated spectrocolorimetry with functional and staining challenges may complement clinical monitoring of peri-prosthetic gingiva, provided that acquisition conditions are standardized and results are interpreted as longitudinal optical surrogates rather than standalone diagnostic or causal measures.

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