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THE INFLUENCE OF HAND DOMINANCE ON THE EFFECTIVENESS OF ORAL HYGIENE - LITERATURE REVIEW

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ABSTRACT

Introduction: The Human Microbiome Project (HMP) has advanced our understanding of the microbiome's role in health and disease. The oral cavity hosts a complex microbiome, comprising over 750 microbial species, including bacteria, archaea, viruses, and fungi. Bacteria, forming dental plaque biofilm, are the primary cause of caries and periodontal diseases. Factors such as oral hygiene and diet influence oral health, with handedness potentially affecting plaque removal efficiency.

Methodology: This review, sourced from PubMed, Scopus, and Google Scholar, analyzes hand lateralization's impact on dental plaque removal and neuroplastic changes linked to motor skill acquisition, using fMRI and mirror neuron studies. Keywords: oral hygiene, handedness, dental plaque, motor skills, oral microbiome.

Discussion: Handedness subtly influences dental plaque removal, with right-handers showing better upper left quadrant cleaning and left-handers favoring right quadrants. However, standardized training minimizes these differences, emphasizing technique and education over hand dominance.

Conclusions: Handedness has a minor impact on dental plaque removal, with quadrant-specific differences due to accessibility and brushing dynamics. Proper instruction reduces these disparities, emphasizing technique, dexterity, and motivation. Neural plasticity supports non-dominant hand improvement. Future research should explore motor learning and behavioral factors to optimize oral hygiene.

KEYWORDS

Oral Hygiene, Handedness, Lateralization, Dexterity

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Introduction:

The Human Microbiome Project (HMP) introduced the concept of the microbiome, enabling a better understanding of the relationship between health and disease. The oral cavity harbors a highly complex microbiome, including archaea, protozoa, bacteria, viruses, and fungi, with over 750 microbial species identified to date. Bacteria within this ecosystem are the main etiological factor in caries and periodontal diseases, colonizing tooth surfaces as dental plaque biofilm. Poor oral hygiene and dietary habits contribute to disease, while commensal microorganisms also support oral health by preventing pathogen adhesion. Oral microorganisms colonize both hard surfaces - teeth - and soft tissues - mucosa- with distinct microbial communities depending on the substrate. The tongue represents the primary microbial reservoir, hosting up to 30% of oral bacteria with high density and diversity. Saliva, containing up to 10^9 microorganisms/mL, plays a key role in recolonization of oral surfaces, though its mechanical cleaning effect is limited [1]. Due to constant exposure to external factors, the oral microbiome is highly dynamic compared with other microbial communities. The oral cavity also serves as the gateway to both the digestive and respiratory tracts, making it especially vulnerable to infection [2]. Effective plaque control - regular mechanical removal of biofilm - is essential for periodontal therapy and prevention of gingivitis. Its success depends on thorough cleaning, interdental care, and patient motivation, underlining the importance of education. Natural forces such as chewing, tongue, and cheek movement aid cleaning, while saliva provides antimicrobial proteins [3]. Brushing for 2 minutes is optimal, with no additional benefit beyond 3 minutes. Both manual and electric toothbrushes are effective if properly used, while fluoride-containing agents support caries prevention. Habit formation plays a major role: occasional missed brushing does not disrupt the routine, but irregularity significantly reduces effectiveness. Interdental cleaning is less automated and requires greater effort and external aids, such as floss and mirrors [4].

Handedness, also known as laterality or hand dominance, is one of the most common functional asymmetries in the human population, occurring in approximately 96% of society [5]. Manual dexterity is crucial for maintaining hygiene and motivating patients. Manual skills and hand preference are related to the

lateralization of brain functions, neuromuscular structure, and genetic factors. Initially, although it was thought that human brain hemispheres showed no significant asymmetry, anatomical asymmetry was identified. With this asymmetrical distribution in the left or right hemisphere, it was noted that the right hemisphere is responsible for spatial abilities, while the left hemisphere is responsible solely for verbal abilities [6]. The term "dexterity" originates from the Latin *dexter*, meaning "right," indicating that the right hand is typically dominant and more adept in most people. Only few can use both hands equally effectively, which is particularly noticeable among individuals requiring precision, physical skill, and creativity [7].

There is limited evidence, obtained indirectly and from clinical experiments, regarding differences in plaque indices in different quadrants of the oral cavity between right-handed and left-handed individuals. The effectiveness of tooth brushing is significantly influenced by whether an individual is right- or left-handed, as well as their ability to access dental plaque. Tooth wear was more commonly observed in the upper teeth than in the lower ones, and more frequently on the left side of the mouth compared to the right. It seems that both accessibility and handedness may impact the degree of tooth wear and plaque buildup [8].

Materials and methods:

This review was based on articles sourced from PubMed, Scopus and Google Scholar databases, with a particular focus on the latest systematic reviews and meta-analyses concerning the impact of hand lateralization on the effectiveness of dental plaque removal in specific quadrants. Additionally, the review emphasized studies exploring neuroplastic changes in the brain associated with motor skill acquisition and hand lateralization, particularly those involving functional magnetic resonance imaging (fMRI) and mirror neuron system activation. The review incorporated original research articles, review articles, case reports, and guidelines. The literature search was conducted using the following keywords: oral hygiene, non-dominant hand, handedness, ambidexterity, dental plaque, tooth brushing, cerebellum, motor imagery, motor skills, mirror therapy, mirror neurons, cross education, parietal cortex, oral microbiome, dental plaque, biofilm, periodontal disease, dental caries, oral hygiene, saliva, tongue microbiota.

Results (Analysis of literature):

Brain plasticity and hand lateralization in motor skill acquisition

Neuronal Activation Depending on the Dominant and Non-Dominant Hand:

The fMRI study conducted by Crotti et al. investigated the influence of handedness on the neural basis of motor imagery (MI) and motor execution (ME) in 26 right-handed and 25 left-handed individuals. Participants performed tasks involving imagining and actually squeezing a ball with their dominant, non-dominant, or both hands. The results revealed statistically significant differences ($p < 0.05$) in brain activation between groups at both cortical and subcortical levels. During ME tasks, more bilateral activation of neural networks was observed in left-handers, whereas right-handers exhibited stronger lateralization. In MI tasks, both groups showed bilateral cortical activation for the dominant hand; however, at the subcortical level, only right-handers engaged the posterior cerebellum, with no similar activity observed in left-handers. Partial overlap of activation areas for MI and ME was noted in the motor, premotor, sensory cortices, and cerebellum. These findings indicate differences in the functional organization of motor areas between right- and left-handed individuals, supporting the hypothesis that MI is modulated by habitual motor patterns. The differences in activation may stem from long-term motor experience, consistent with the simulation hypothesis, which posits that MI engages the same neural networks as actual movements. The potential of these findings for planning rehabilitation tailored to individual handedness was highlighted [9]. Additionally, an EEG study on 31 participants (left- and right-handed) examined brain oscillatory activity during imagery and execution of upper limb movements, indicating that handedness influences ERD/ERS patterns in the alpha and beta bands over sensorimotor areas. More bilateral activation was observed in left-handers, with stronger ERD during MI than ME, suggesting greater neural engagement in simulation for this group [10]. Similarly, EEG evaluation of 40 participants revealed reduced asymmetry in sensorimotor rhythm desynchronization in left-handers, particularly in alpha/beta bands, with ERD patterns shaped by imagery perspective and motor experience under kinesthetic (KMI) and visual-motor (VMI) conditions [11]. An fMRI study from 2023, focused on right-handers, decoded distinct neural representations of hand movement direction in the presupplementary motor area (pre-SMA) during MI and ME, with partial overlap in the motor and premotor cortices but differing patterns between modalities, reinforcing the simulation hypothesis and the role of long-term experience in modulating MI networks [12]. A randomized controlled trial from 2025, utilizing EEG, investigated the neural

foundations of motor skill learning and interlimb transfer in 47 right-handed individuals trained on simple or complex tasks with one hand. Task complexity and the trained hand significantly influenced skill acquisition and transfer. Complex tasks enhanced coherence in the alpha and theta bands in motor and sensorimotor areas, indicating shared neural mechanisms for skill learning and interlimb transfer, modulated by hand dominance [13]. Additionally, a 2025 study compared neural and behavioral outcomes in grasping tasks among 20 right-handed adults under fixed and free conditions. No differences were found in synergy indices, EEG beta-band power, or EEG-EMG coherence between hands, although differences were observed between task conditions. This equivalence suggests comparable cortical and motor control mechanisms regardless of dominance in tasks requiring steady-state force maintenance [14]. These studies collectively highlight handedness-related differences in cortical and subcortical organization, with implications for personalized rehabilitation strategies in motor skill acquisition and recovery.

Training of the Non-Dominant Hand and Changes in RSFC

A study utilizing functional magnetic resonance imaging (fMRI) analyzed changes in resting-state functional connectivity (RSFC) associated with short-term motor learning of chopstick use with the left hand in right-handed individuals. The experiment involved 40 healthy adults, equally divided into an experimental and a control group. The experimental group practiced using chopsticks with their left hand, while the control group only held chopsticks without developing skills. Both groups completed 9 cycles of 30-second tasks and rest periods. Analysis showed improved task performance post-session in both groups, with greater progress in the training group. In the experimental group, increased RSFC was observed in two neural networks. The first network showed enhanced connectivity between the right primary motor cortex (M1) and the right cerebellar region (Crus I), which positively correlated with post-task performance. The second network involved connectivity between the right M1 and the left cerebellar region (Crus II), associated with skill improvement from the start to the end of the session. These findings suggest that strengthened RSFC in these networks supports early motor learning of the non-dominant hand [15]. Complementarily, a randomized controlled trial with 100 healthy adults demonstrated that fine-motor training with chopsticks using a mirror improves coordination and dexterity of the non-dominant hand, with significant improvements in the Chopsticks Manipulation Test and Purdue Pegboard Test ($p < 0.01$), though without between-group differences (mirror training vs. direct training); these effects were attributed to activation of brain regions associated with the non-dominant hand, including the motor cortex and cerebellum [16]. Similarly, gPPI fMRI analysis in right-handed participants revealed increased interhemispheric functional connectivity in motor areas such as the supplementary motor area (SMA), precentral gyrus, and cerebellum during left-hand (non-dominant) movements, without analogous changes for the dominant hand; BOLD activation was symmetrical but with larger clusters in the dominant hand, highlighting adaptation of cortico-cerebellar networks in precise motor tasks [17]. Furthermore, an fNIRS study on 14 right-handed individuals after 8 weeks of chopstick training with the left hand showed a decrease in RSFC between the parietal cortex, sensorimotor cortex, and cerebellum, indicating neuronal reorganization in cortico-cerebellar networks during long-term learning of precise motor skills with the non-dominant hand [18]. These results reinforce the significance of RSFC changes for learning non-dominant hand skills, with implications for rehabilitation and motor training.

Mirror Training and Mirror Neurons

Mirror training (MT), leveraging visual feedback, enhances brain plasticity by increasing cortical activity associated with the non-dominant hand. Initially developed for treating phantom limb pain following limb amputations, it involves observing the dominant hand's movement in a mirror, which supports functional recovery of the non-dominant hand. This method is applied in stroke rehabilitation and in treating musculoskeletal injuries in athletes. The mirror neuron system plays a critical role in imitation-based learning. Research indicates that this system activates the inferior parietal cortex and ventral premotor cortex during observation of novel, unpracticed movements, essential for early motor learning stages. Additionally, fMRI studies demonstrate that mirror reflection of the unaffected hand's movement provides visual feedback, activating the ipsilateral primary motor cortex and extracerebral regions, thereby aiding motor function recovery. An fMRI study observed activation of the right superior temporal and occipital gyri during a mirror-induced illusion of non-dominant hand movement, despite its immobility, suggesting that mirror images generate visual stimuli akin to actual movements. In the experiment, the experimental group, without directly using the non-dominant hand, showed significant improvements in coordination and dexterity, highlighting brain plasticity in the context of asymmetric motor learning. Observing and imagining movement activate

mirror neurons, enhancing primary motor cortex excitability, which underscores the importance of mirror training in developing hand lateralization and acquiring new motor skills [19][16]. Furthermore, systematic reviews and meta-analyses indicate that MT improves upper limb motor recovery and activities of daily living after stroke, with potential neural correlates such as the primary motor cortex (M1), precuneus, and posterior cingulate cortex, particularly in the subacute phase. Clinical studies confirm that additional MT leads to greater improvements in Fugl-Meyer Assessment for upper extremities (FMA-UE) and instrumental activities of daily living (IADL), without significant heterogeneity depending on age, stroke type, lesion side, or clinical stage, suggesting the universality of this method in rehabilitation for asymmetric motor learning [20][21]. Mirror neuron-based rehabilitation in Parkinson's disease (PD), utilizing action observation (AO) and motor imagery (MI), was investigated in a 2024 scoping study. Five studies demonstrated that AO and MI techniques, leveraging mirror neuron activation, improved gait, balance, and quality of life in PD patients, suggesting their potential for integration into standard physiotherapy [22]. Additionally, mirror therapy in stroke rehabilitation was analyzed in a 2020 study, emphasizing its role in activating mirror neurons to promote cortical reorganization and motor recovery in the upper limb. MT proved effective across acute, subacute, and chronic stroke phases, with benefits in motor and sensory function, though its impact on activities of daily living (ADL) requires further investigation [23]. These findings underscore the potential of mirror neuron-based interventions, yet further research is required to thoroughly evaluate their long-term efficacy and impact on functional outcomes.

Cross-Training and Skill Transfer

Cross-training, involving the exercise of one limb to enhance the function of another, supports the transfer of motor skills through brain plasticity. Studies indicate that unilateral upper limb training increases cortical excitability in the contralateral cerebral hemisphere, leading to improved function of the non-dominant hand. This mechanism relies on a hierarchical cortical network, including the frontal lobes involved in movement planning and execution, and connections via the corpus callosum, which facilitate the transfer of motor learning between hemispheres. In the experimental study, participants in the training group achieved significant improvements in coordination and dexterity without directly engaging the non-dominant hand, due to mirror training with the dominant hand, highlighting the efficacy of cross-training in asymmetric motor learning. Furthermore, observing movements in a mirror activates the mirror neuron system, enhancing primary motor cortex excitability and supporting skill transfer [16]. Unilateral strength training boosts motor unit recruitment in the non-dominant limb through neural adaptations in the motor cortex, as shown in a 2024 study. An 8-week program increased strength in the untrained biceps brachii by 11% after four weeks and 19% after eight weeks, with lower motor unit recruitment thresholds and enhanced corticospinal output, indicating cortical and spinal adaptations without significant hypertrophy [24]. Cross-education in post-stroke rehabilitation enhances strength and function in the paretic limb through neural plasticity. Unilateral training of the less-affected limb improves motor performance in the affected limb through transcallosal communication and bilateral cortical activation, proving effective across stroke phases for patients with severe paresis [25]. Additionally, training in motor skills, such as precise movements, induces changes in the motor cortex and cerebellum, supporting transfer in complex tasks like chopstick use. These effects underscore the role of cross-training in developing hand lateralization and acquiring new motor skills [26].

Parietal Cortex Mechanisms in Lateralized Motor Skill Acquisition

Studies on neuronal activity in the inferior parietal lobule (IPL), particularly in area 7a, revealed significant variations associated with visuospatial signals, eye movements, and hand positioning and movement during visuomotor tasks. When performing actions with the upper limb contralateral to the recorded brain hemisphere, the combined neuronal response showed two main temporal peaks: one synchronized with the visual instruction signal and another with movement onset, with the latter being more prominent in tasks requiring eye-hand coordination. Combinatorial neurons in area 7a, including those primarily responsive to the eye (33.2%), hand (9.6%), or both limbs (33.8%), exhibited increased activity for hand movements directed toward the fixation point, underscoring this region's critical role in integrating spatial attention with motor planning. Comparisons with the superior parietal lobule (SPL, including areas PEc and V6A) highlighted differences in cortical reorganization: IPL primarily integrates eye and hand signals, whereas SPL focuses on hand-related motor behaviors, with earlier activity peaks (235 ms compared to 387 ms in IPL). These findings suggest that contralateral lateralization enhances plasticity by selectively encoding hand position relative to attended locations, supporting motor adaptation [27]. Concerning sensorimotor adaptation, functional MRI

studies revealed that changes in cortical activity patterns reflect dynamic learning processes. During the early adaptation phase, parietal and premotor areas showed contraction along the cortical manifold, linked to increased covariance with associative regions, including the default mode and frontoparietal networks. In the later phase, expansion of the visual cortex was associated with reduced visuomotor errors, decreased covariance with associative areas, and enhanced internal connectivity. Individuals who learned faster exhibited greater covariance between sensorimotor and associative regions in the early phase, indicating plasticity driven by the integration and segregation of neuronal activity in unimodal and associative networks [28]. Analyses using deep neural network models and explainable artificial intelligence identified specific cortical regions responsible for processing movement kinematics in reaching tasks. The parietal cortex played a central role in encoding acceleration, velocity, and position, with neuronal activity strongly linked to motor coordination. Shared regions included bilateral supramarginal gyri and superior parietal lobules, associated with movement goals and sensory integration, while distinct regions for each kinematic parameter (contralateral motor cortex for acceleration, contralateral parieto-frontal network for velocity, and bilateral visuomotor areas for position) were mutually exclusive. These findings highlight that lateralization in the parieto-frontal network supports plasticity by transforming sensory information into movement plans [29]. Investigations into neuronal activity in the V6A region of the posterior parietal cortex revealed consistent reference frameworks for visuospatial and motor representation in three-dimensional tasks. Neurons encoded target locations regardless of the effector used, with mixed body/hand coordinate systems dominating over purely body- or hand-based systems. As tasks progressed, the influence of hand position on neuronal activity grew stronger than that of target location, with body-centered coding observed only in a subset of neurons active in the early phase. Similar patterns were observed in fixation-reaching tasks, suggesting consistent reference frameworks across spatial and nonspatial motor responses, which supports the integration of spatial awareness with movement control [30]. Assessments of neuronal synchronization in the posterior parietal cortex during visual tasks revealed modulations specific to cell types within the multiregional framework. Spike-field synchronization in the beta frequency range was higher for presumed pyramidal neurons compared to inhibitory interneurons, with one underlying factor reflecting shared excitability across distributed groups. Variations in power within the multiregional framework corresponded to pyramidal neuron activity, suggesting their role in inter-regional communication, which supports plasticity in procedural networks without direct connections to hand lateralization [31]. Regarding information flow in the posterior parietal cortex, inferred interactions between the PRR and LIP regions showed an asymmetric pattern during eye-hand movement preparation. Information primarily flowed from PRR to LIP across various reaching tasks, with minimal influence from LIP on PRR, ruling out LIP as a general hub for spatial processing. These regions operate simultaneously for planning arm and eye movements, with asymmetric interactions supporting eye-hand coordination, which underscores plasticity in skill transfer under lateralization conditions [32]. To conclude, the evidence suggests that hand lateralization enhances brain plasticity through activation of the opposite side in parietal and motor areas, bilateral representations in sequential learning, and dynamic changes in visuomotor circuits. These mechanisms, connected to prior findings on neuronal activation, functional connections, mirror neurons, and skill transfer, support effective adaptation and improvement in motor skill development.

Impact of Handedness on Dental Plaque Removal

Quadrant-Specific Differences in Plaque Removal

Kadkhodazadeh and colleagues carried out a two-phase clinical study assessing plaque index (PI) values before and after brushing. Their findings revealed noticeable asymmetries between right- and left-handed individuals:

Right-handed participants tended to accumulate more plaque on the upper left side compared to the upper right before brushing. After brushing, these individuals removed plaque more effectively from the left side of the upper jaw, indicating that their dominant hand allowed easier access to these areas. In the lower jaw, plaque was slightly higher on the right side before brushing, but differences were not statistically significant.

Left-handed participants generally showed more uniform plaque removal across quadrants. Although not statistically significant, they demonstrated a slight trend toward better cleaning in the upper left (UL) and lower right (LR) quadrants.

Between-group comparison showed that right-handed individuals achieved greater plaque reduction on the upper left quadrant, while left-handed participants tended to be more effective on the right-side surfaces of both jaws. Importantly, right-handed subjects showed stronger improvements between the first and second phases of the study, suggesting they adapted more efficiently to the brushing technique after instruction [33].

Long-Term Effects of Handedness on Oral Hygiene

Tezel and co-authors investigated the influence of handedness on oral hygiene over a longer time frame. Plaque and gingival indices were measured at baseline, and again one and three months after standardized oral hygiene instruction. Their results showed no consistent differences in plaque removal effectiveness between left- and right-handed groups. Both groups improved significantly in plaque and gingival indices when they followed correct brushing instructions. This suggests that brushing technique and compliance with oral hygiene practices may have a greater impact on plaque removal than the dominant hand itself [6].

Influence of Dexterity, Technique, and Motivation

Other studies underline the role of manual dexterity, patient motivation, and brushing method in plaque removal, beyond handedness. Research shows that effective plaque control depends largely on how consistently and accurately patients brush, particularly in difficult-to-reach quadrants. For right-handed individuals, the left side of the upper jaw may be more accessible, whereas left-handed individuals may find right-sided quadrants easier. This explains some of the asymmetry seen in quadrant-specific studies [33]. However, findings are not uniform across all studies. For example, Tezel et al. found that when individuals received proper oral hygiene instruction, handedness did not significantly alter outcomes. This suggests that education and training can minimize natural differences caused by hand dominance. Supports the conclusion that while handedness may slightly affect plaque removal in specific quadrants, the key determinants of success are brushing technique, mechanical control of plaque, and patient motivation to maintain oral hygiene routines [34][35][36][37][38].

Non-dominant Hand Performance

A study by Malik et al. ("The Effectiveness of Non-dominant Hand in Performing Oral Hygiene Care," Malaysian Journal of Medicine and Health Sciences, 2020) further explored the influence of hand dominance by testing plaque removal efficiency when participants used their non-dominant hand. The study involved dental students - most of whom were right-handed - and assessed plaque scores using the Turesky modification of the Quigley-Hein index before and after brushing. Results showed a significant increase in plaque index when participants brushed with their non-dominant hand ($p < 0.01$), particularly among left-handed individuals, who demonstrated less control and coordination when switching hands. A significant difference was also found between right- and left-handed groups in the buccal area of the first quadrant ($p < 0.05$).

Malik et al. emphasized that effective plaque removal depends not only on hand dominance but also on brushing time, frequency, and the use of auxiliary cleaning aids (such as floss or electric toothbrushes). They concluded that brushing with the non-dominant hand is less effective overall, especially for left-handed individuals, reinforcing the idea that dexterity and practice are crucial factors for optimal oral hygiene outcomes. [39]

Discussion

Handedness influences neural patterns in motor imagery (MI) and execution (ME). Functional MRI reveals that left-handers show more balanced activation across cortical and subcortical regions, unlike the stronger hemispheric dominance in right-handers. EEG data indicate left-handers exhibit broader alpha/beta desynchronization during MI, reflecting increased neural effort in mental simulation. These patterns support the idea that MI engages motor, premotor, and cerebellar areas similarly to physical actions. Task complexity and hand dominance shape skill transfer, with alpha-theta coherence in motor regions suggesting shared learning pathways. Grasping tasks show similar control mechanisms across hands, though task conditions add variability.

Training the non-dominant hand strengthens resting-state connectivity between the contralateral motor cortex and cerebellar regions, linked to improved performance. Mirror-based training enhances dexterity, with no clear advantage over direct methods. Extended training reduces connectivity among parietal, sensorimotor,

and cerebellar areas, indicating neural reorganization for precision tasks. These changes highlight cortico-cerebellar networks' role in non-dominant skill learning.

Mirror training (MT) uses visual feedback to promote plasticity, engaging mirror neurons in parietal and premotor regions during action observation. fMRI shows activation in ipsilateral motor cortex and visual areas, aiding recovery in stroke and injury rehabilitation. MT improves limb function across stroke stages and enhances mobility in Parkinson's disease through action observation and MI.

Cross-training boosts non-dominant limb function through contralateral cortical activation and interhemispheric connections. Mirror-based dominant-hand training improves non-dominant coordination, driven by mirror neuron activity in the motor cortex. Unilateral strength training enhances untrained limb performance through neural adaptations.

The inferior parietal lobule integrates visuospatial and motor signals, with contralateral movements showing distinct neural responses tied to cues and action onset. The superior parietal lobule focuses on motor-specific tasks. Early sensorimotor learning involves parietal-premotor interactions, shifting to visual network expansion as errors decrease. Parietal regions process movement kinematics, supporting motor planning. Asymmetric information flow between parietal areas aids eye-hand coordination, enhancing plasticity in skill development.

The present analysis highlights the complex relationship between handedness and the effectiveness of dental plaque removal. While early hypotheses suggested that dominant-hand preference could lead to measurable asymmetries in oral hygiene outcomes, the reviewed studies demonstrate that these effects are generally modest and can be mitigated through proper brushing instruction and technique standardization.

Kadkhodazadeh et al. (2012) observed quadrant-specific variations in plaque removal related to handedness, with right-handed participants showing greater plaque reduction on the upper left side, and left-handed individuals demonstrating relatively more effective cleaning on the right quadrants. These findings support the notion that manual dominance influences accessibility and brushing dynamics in certain areas of the mouth. However, such differences were not always statistically significant, and appeared to diminish with repeated instruction, suggesting a learning or adaptation effect.

Similarly, Tezel et al. (2001) found no long-term differences in plaque control between right- and left-handed subjects when standardized oral hygiene training was provided. Both groups exhibited significant improvement in plaque and gingival indices, underscoring the critical role of education and technique over innate motor dominance. This aligns with previous reports indicating that mechanical control of plaque is primarily dependent on brushing consistency, dexterity, and motivation rather than handedness alone.

Taken together, these findings indicate that while handedness may influence plaque accumulation patterns - particularly in specific quadrants - the clinical relevance of this effect appears limited when adequate oral hygiene practices are established. The evidence supports an emphasis on individualized patient education and reinforcement of brushing technique rather than concerns regarding hand dominance.

Future studies should consider evaluating larger sample sizes, different brushing methods (manual vs. powered toothbrushes), and longitudinal follow-ups to further elucidate the interaction between handedness, dexterity, and plaque removal efficiency. Additionally, assessing the impact of cognitive and behavioral factors, such as motivation and adherence, may help clarify the broader determinants of successful oral hygiene maintenance.

Conclusions:

The collective evidence suggests that handedness exerts only a minor influence on the effectiveness of dental plaque removal, with any observed quadrant-specific differences largely attributable to variations in accessibility and brushing dynamics rather than inherent motor superiority of the dominant hand. While right- and left-handed individuals may initially demonstrate asymmetrical cleaning patterns, these disparities tend to diminish following proper instruction and practice, reflecting the adaptability of motor control and learning mechanisms.

Importantly, brushing technique, manual dexterity, motivation, and adherence to oral hygiene routines remain the primary determinants of effective plaque removal, surpassing the impact of hand dominance. Neural evidence from studies on motor imagery, execution, and cross-training further supports the concept that both hands share overlapping neural pathways and exhibit plasticity through training, suggesting that proficiency with the non-dominant hand can be enhanced through practice and feedback.

In clinical terms, these findings underscore the importance of personalized oral hygiene education and technique reinforcement over concerns about handedness. Future research should integrate neurophysiological and behavioral assessments to better understand how motor learning and cortical plasticity contribute to improved oral hygiene performance, particularly when employing training strategies that engage both hands or mirror-based feedback mechanisms.

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