

Restorative Dentistry

1. Principles for the Evaluation Criteria

This section of the quality guidelines deals with restorative dentistry, i.e. with the lesion-specific caries diagnostics as well as with all forms of caries therapy from reversible, non-invasive to irreversible, invasive.

Objectives of Restorative Dentistry

The objectives of restorative dentistry are as follows:

- Primarily, non-invasive elimination of caries using caries-inhibiting, remineralizing measures
- Prevention of caries therapy using non-invasive, yet irreversible measures (sealing of fissures and pits, sealing of caries-prone or carious enamel and dentin areas)
- Treatment of caries using minimally invasive, by the current state of the technique necessarily irreversible, measures with the following subgoals:
 - maintaining the vitality and protection of the dental pulp as well as preservation of the dental hard tissue structures
 - restitution of form and function of the single tooth
 - invisibility of the restoration at normal speaking distance, if this is requested by the patient

For a restorative dentistry as defined above the following prerequisites are to be fulfilled:

- Sophisticated diagnostics
- Clear definition of the restoration qualities, which can be achieved by the various restorative measures using adequate restorative materials

- Unambiguous treatment contract following a comprehensive patient information
- Availability of established clinical concepts and techniques, which permit a safe prediction regarding the immediate and long-term quality of the restoration

In dealing with restorations, it is convenient to distinguish three different restoration levels depending on the treatment goal. Any higher restoration level necessarily implies the fulfillment of the requirements of the lower level (Tab. I).

Restoration level 1 "preservation of dental hard tissue" is concerned with the preservation of the remaining dental hard tissue and the protection of the pulp following the inactivation or elimination of the caries. This essential minimum goal is aimed at by the atraumatic restorative technique (ART) developed for third-

world countries. The same applies to the simplest form of temporary fillings, which for the period of their use are to be caries-protective and pulp-stimulating.

On *restoration level 2 "form and function"* not only tooth structures have to be preserved, but in addition form and function of the restored tooth are to be reconstructed. With different expectations concerning the life span of the restoration, these objectives are influential for functional temporary fillings, amalgam fillings, and cast gold restorations.

On *restoration level 3 "invisible restoration"* preservation of dental hard tissue and restitution of form and function are prerequisites. In addition, the restoration has to be and to remain imperceptible at normal speaking distance. In discolored teeth, it is attempted to achieve this therapeutic goal with the aid of bleaching techniques in order to preserve as much dental hard tissue as possible.

Table I: Restoration levels and related objectives and restoration types

RESTORATION LEVEL	OBJECTIVE	RESTORATION TYPE
Level 1: preservation of tooth substance	Protection of the dental pulp Preservation of enamel and dentin	Filling compliant with atraumatic restorative technique (ART), non-functional temporary filling, sealing of caries
Level 2: preservation of tooth substance and in addition: form and function	Preservation of dental hard tissues including restitution of tooth form and tooth function (contour, interproximal contacts, and occlusion)	Functional temporary fillings, fillings in primary teeth, amalgam fillings, cast gold restorations
Level 3: preservation of tooth substance and in addition: form and function and in addition: esthetics	Invisible preservation of dental hard tissue including restitution of tooth form and tooth function	Adhesive tooth-colored restorations made of dental composite or ceramics; if required, use of tooth bleaching techniques

With respect to materials, especially the following products are applied:

- Composite materials utilized with clinically tested adhesive systems
- Ceramic restorations that are manufactured chairside or in a dental laboratory and employed using adequate, usually adhesive cementation techniques
- Amalgam fillings
- Cast gold fillings
- Glass ionomer cements
- Approved bleaching agents for external or internal tooth bleaching

In this context primarily the specifications “wear resistance like enamel”, “antagonist friendliness”, “dentin-like physical properties” and continuous margin upon loading of >90% in enamel and of >80% in dentin should be fulfilled.

Application Principles and Collection of Findings

Restorative dentistry is futile without accompanying prophylactic measures because, in this way, caries can only be eliminated temporarily. Restorative dentistry therefore has to be associated with preventive dentistry. This includes the determination of the individual caries risk, the assessment of other risk factors associated with the treatment outcome (e.g. erosion, abrasion, attrition), the motivation for and instruction of an adequate oral hygiene performed by the patient, as well as professional preventive care of the patient. Apart from the elimination of caries, periodontal health and impeccable restitution of tooth form and function have to be considered. Esthetics, i.e. the invisibility of the restoration at speaking distance, has to be weighted appropriately if requested by the patient.

For these reasons, in all cases, an initial comprehensive collection of findings with due regard to the patient’s general

health is indicated. Such an initial examination should not be focused on caries alone, but also comprise the periodontal health as well as the function of the dentition.

Treatment Planning

Based on the medical history of the patient primarily, their capability of and willingness for treatment have to be assessed. Treatment planning has to consider the following issues:

- Importance attached by the patient to oral and dental health
- Extent, intensity, and quality of the oral hygiene
- Degree of cooperation
- Economic considerations: Does the patient have to pay themselves for treatment or are they supported by third parties

In seeking to reduce the caries risk and, if necessary, to use the time until the caries risk can be reliably assessed, primarily all bacterial hiding places per se or at least their pathogenic impact have to be eliminated. Depending on the findings, carious lesions have thus to be treated using either temporary or permanent restorations. However, before major or multiple permanent restorations are made, the occlusion has to be checked; habitual maximum intercuspation as well as working and balancing contacts should be free from interferences.

The principle of minimally invasive therapy pertains. Upon the definite establishment of the treatment plan, which has to be reevaluated following a diagnostically clarifying pretreatment or in case of a change in influential parameters, due attention has to be paid to the indication quality. In order to spare as much dental hard tissue as possible, particularly repair fillings and bleaching techniques

have to be included in the planning as well. In cases of complex interventions, additional documents such as photographs and models are helpful.

Restorative Techniques

Restorative measures should be as sparing as possible regarding tooth hard tissues. Adhesive techniques should be preferred since these protect the remaining dental hard tissue and pulp better and weaken the remaining dental hard tissues to a lesser extent than conventional, retentively fixed restorations.

Materials

Based on the patients’ requests – following respective information –, the suitable restoration level (Tab. I) has to be determined. From here, ensue the adequate clinical concept, the selection of materials, and the appropriate operative technique. For the initial quality, the operator is primarily responsible; additional important factors are evident from Table II; Table III lists the factors affecting mainly the follow-up quality, i.e. the long-term quality of the restorations over the required life span.

Patient Care

Regular dental checkups customized to the individual risk, professional tooth cleaning as needed, re-instruction and motivation regarding oral hygiene and diet, as well as adequate restoration maintenance are decisive for the prevention of new carious lesions, for the mastery of further attachment loss due to periodontitis, and likewise for the life span of restorations and preservation of an interference-free function.

Table II: Factors determining the initial quality of a restoration

ASPECT	FACTORS
Dentist	Knowledge, skill, current physical condition, current capability, discipline in the application of the adequate operative technique
Practice	Facilities, equipment, personnel
Clinical concept	Clinical concept continuously adapted to the current state of knowledge
Materials	Clinically approved materials, instruments, and small equipment are controlled and re-evaluated (in particular performance control of the polymerization lamp)
Operative technique	Standardized treatment concepts; when placing adhesive restorations, in particular safe techniques for drying of the operation field
Patient	Capability of treatment, cooperation
Financial consideration	Application of the best restoration concept pertinent to the capabilities

Table III: Factors determining the long-term quality of a restoration

ASPECT	FACTORS
Patient	Self-care, diet, cooperation in the context of preventive care
Practice	Preventive care (frequency, intensity, extent), prophylaxis personnel (availability, educational level, work discipline)
Restoration	Initial quality, structural quality of the preserved dental hard tissue, size, shape, localization as well as normal functional and parafunctional loading of the restoration; biological, chemical, and physical properties of the restoration material
Dentist/prophylaxis team	Maintenance of filling

2. Evaluation Criteria for the Quality Levels A+ to C for all Types of Restorations

	CARIES Criterion #01	POSTOPERATIVE SENSITIVITY Criterion #02	VITALITY Criterion #03
A+	<ul style="list-style-type: none"> No indications of caries in the region of the interface restoration/dental hard tissue 	<ul style="list-style-type: none"> No increased sensitivity to various stimuli or occlusal loading 	<ul style="list-style-type: none"> Symptom-free pulp, adequate pulp protection
A	<ul style="list-style-type: none"> Marginal discoloration and imperfections indicate an increased caries risk in the region of the interface restoration/dental hard tissue. No penetration with the probe possible No caries detectable 	<ul style="list-style-type: none"> Sensitivity to various stimuli or occlusal loading, which appears shortly after placement of the filling and is not attributable to a pre-existing damage of the pulp (caries, trauma) or inadequate treatment Spontaneous remission, possibly following subsequent improvement of the restoration, can be expected 	<ul style="list-style-type: none"> As in A+
B	<ul style="list-style-type: none"> Suspected caries in the region of the interface restoration/dental hard tissue Penetration of the probe 	<ul style="list-style-type: none"> Sensitivity to various stimuli or occlusal loading Duration and prognosis unclear, even with later improvements 	<ul style="list-style-type: none"> Symptoms of pulpitis, no adequate pulp protection Prognosis unclear
C	<ul style="list-style-type: none"> Caries in the region of the interface restoration/dental hard tissue, which compromises the pulp and/or the preservation of the dental hard tissue Caries can be probed and/or seen on the radiograph. 	<ul style="list-style-type: none"> Pain caused by various stimuli or occlusal loading Attributable to inadequate treatment Pain treatment is urgent. 	<ul style="list-style-type: none"> Irreversible pulpitis and/or necrosis Undiagnosed non-vital tooth Attributable to inadequate treatment Treatment as a rule urgently required

	ANATOMICAL FORM AND WEAR Criterion #04	OCCUSION Criterion #05 (centric occlusion = habitual maximum intercuspation)
A+	<ul style="list-style-type: none"> ▪ Smooth transition tooth/restoration ▪ Normal interproximal contact ▪ The restoration contour is harmonically adapted to the anatomical form. ▪ The characteristic tooth shape including the texture is ideally and harmonically restored. 	<ul style="list-style-type: none"> ▪ Individually correct centric and functional contacts ▪ Restored occlusion-bearing cusps and fossae hold a Shimstock foil in centric occlusion. ▪ There are neither lateral sliding movements in centric occlusion nor functional interferences.
A	<ul style="list-style-type: none"> ▪ Slightly under- or overcontoured restoration ▪ Vertical loss of substance recognizable ▪ Weak or excessive interproximal contact ▪ Interproximal surface is slightly undercontoured. ▪ The restoration contour is adapted to the existing anatomical form. ▪ The characteristic tooth shape including the texture, partly with minor imperfections, is restored. 	<ul style="list-style-type: none"> ▪ Too strong or weak occlusal contact ▪ The centric occlusion is satisfactory. ▪ However, there are slight functional interferences. ▪ Pathologic findings and symptoms are absent. ▪ Grinding adjustments possible without great effort
B	<ul style="list-style-type: none"> ▪ Suspected caries in the region of the interface restoration/dental hard tissue ▪ Penetration of the probe 	<ul style="list-style-type: none"> ▪ Missing or reversibly traumatizing occlusal and/or functional contacts
C	<ul style="list-style-type: none"> ▪ Missing restoration or restoration parts ▪ Distinct structural damages in the region of occlusal contacts with significant vertical loss of substance ▪ Dentin or underfilling are exposed. ▪ Missing interproximal contact ▪ Interproximal overhang ▪ The restoration contour is not adapted to the existing anatomical form. ▪ The characteristic tooth shape including the texture is not restored. ▪ The restoration causes dental or periodontal pain. 	<ul style="list-style-type: none"> ▪ Chewing and/or speech disorders

	QUALITY OF MARGIN Criterion #06	COLOR QUALITY (Restoration level 3) Criterion #07	RESTORATION SURFACE Criterion #08
A+	<ul style="list-style-type: none"> Smooth, continuous transition 	<ul style="list-style-type: none"> Color, opacity, and/or translucency harmonically conform to the surrounding dental hard tissue. Even upon a close inspection, the restoration is hardly recognizable. 	<ul style="list-style-type: none"> Enamel-like restoration surface
A	<ul style="list-style-type: none"> Signs of material deficiency, overhangs, unevenness, or formation of grooves No disruptions of continuity at the transition restoration/dental hard tissue, which are visible or can be probed Imperfections easily repairable by finishing 	<ul style="list-style-type: none"> Color, opacity, and/or translucency – possibly following removal of any discoloration – reasonably conform to the surrounding dental hard tissue. The restoration is not recognizable at normal speaking distance. Possible slight color discrepancies are attributable to internal discoloration of the dental hard tissue or – in the case of fissure sealing – to diagnostic needs. 	<ul style="list-style-type: none"> Slightly rough restoration surface which, however, does not promote plaque formation Repolishing easily possible
B	<ul style="list-style-type: none"> Material deficiency, formation of steps or grooves at the transition restoration/dental hard tissue Disruption of continuity which can be assessed with a fine probe Locally increased caries risk 	<ul style="list-style-type: none"> Color, opacity, and/or translucency – possibly following removal of any discoloration – are distinctly different from the surrounding dental hard tissue, apparently because of wrong color selection or color changes of the restoration material. The restoration is recognizable at normal speaking distance. 	<ul style="list-style-type: none"> Obviously rough surface which cannot be repolished and promotes plaque formation
C	<ul style="list-style-type: none"> Marginal gap, defect, and/or fracture The preservation of the dental hard tissue is compromised. 	<ul style="list-style-type: none"> The restoration objectively attracts attention because of a disturbingly wrong color, opacity, and/or translucency. 	<ul style="list-style-type: none"> Obviously rough, defective surface promoting plaque formation Impairment of the dental hard tissue and/or periodontium is to be expected.

	PATIENT CARE AND RESTORATION MAINTENANCE (follow-up quality) Criterion #09	ORAL HYGIENE OF THE PATIENT (follow-up quality) Criterion #10
A+	<ul style="list-style-type: none"> ▪ The patient is completely looked after as part of an adequate recall program including restoration maintenance. 	<ul style="list-style-type: none"> ▪ The oral hygiene of the patient is excellent. ▪ The caries and periodontitis risks are minor or medium.
A	<ul style="list-style-type: none"> ▪ The patient is checked at least once a year by the dentist. ▪ Professional tooth cleaning and/or restoration maintenance are sporadic and/or only partly adequate. 	<ul style="list-style-type: none"> ▪ Oral hygiene by the patient is performed regularly and is sufficient. ▪ The caries and periodontitis risks are minor or medium.
B	<ul style="list-style-type: none"> ▪ There are no regular examinations by the dentist. ▪ Restoration maintenance is missing. 	<ul style="list-style-type: none"> ▪ The oral hygiene of the patient is irregular and partly insufficient. ▪ The caries and/or periodontitis risk is/are high.
C	-	<ul style="list-style-type: none"> ▪ Missing dental awareness and generally insufficient oral hygiene by the patient ▪ The caries and/or periodontitis risk is/are high.

Assessment: Tooth-Colored Filling Materials

(Criteria 1–8)

A+

Initial quality: all assessments are in this range.

A

Initial quality: one or several of the worst assessments are in this range.

B

Initial quality: one or several of the worst assessments are in this range; in order to avoid damage, the work has to be repaired or redone.

Follow-up quality: if over time one or several of the worst assessments irreversibly fall in this range, the restoration at the patient's request can be improved to avoid damage, provided it is about the protection of the dental pulp, the preservation of the tooth, and/or the function; if it is only a matter of esthetic issues, the patient decides on the operative approach.

As a rule, the drop of the restoration quality in this range, according to any of the evaluation criteria, should not occur before eight years after placement of the restoration.

C

Initial quality: one or several of the worst assessments are in this range; for the limitation of damage the work necessarily or urgently has to be redone.

Follow-up quality: if over time one or several of the worst assessments irreversibly fall in this range, the restoration for the limitation of damage necessarily and urgently has to be replaced or repaired. As a rule, the drop of the restoration quality in this range, according to any of the evaluation criteria, should not occur before eight years (in the case of inlays and overlays, not before ten years) after placement of the restoration.

Evaluation Examples

Example 1: Class II restoration on the distal aspect of tooth 25 two years after placement (photograph after tooth cleaning)



- Crit. #01: A+ no marginal discoloration
- Crit. #02: A+ no hypersensitivity
- Crit. #03: A+ sensitivity test positive
- Crit. #04: A+ margin cannot be probed
- Crit. #05: A+ correct occlusion
- Crit. #06: A+ good adaptation
- Crit. #07: A color good, slightly more opaque than environment
- Crit. #08: A+ smooth surface
- Crit. #09: A+ recall program existing
- Crit. #10: A+ good oral hygiene

The restoration can be classified as A. Except for coloring, all criteria are in the A+ range.

Example 2: Cervical filling on the buccal aspect of tooth 16 five years after placement



- Crit. #01: A marginal discoloration
- Crit. #02: A+ no hypersensitivity
- Crit. #03: A+ sensitivity test positive
- Crit. #04: A margin can be probed
- Crit. #05: – restoration not in occlusion
- Crit. #06: A sign of excess material
- Crit. #07: A color good, discoloration can be removed by polishing
- Crit. #08: A slightly rough surface
- Crit. #09: A+ recall program existing
- Crit. #10: A+ good oral hygiene

The follow-up quality of this restoration is classified as A. The small deficiencies can easily be fixed by repolishing the margins of the filling.

Example 3: Class II restoration on tooth 14 several years after placement



- Crit. #01: C secondary caries mesial
- Crit. #02: A+ no hypersensitivity
- Crit. #03: A+ sensitivity test positive
- Crit. #04: C missing interproximal contacts
- Crit. #05: A sufficient occlusion
- Crit. #06: C marginal gap on the mesial aspect
- Crit. #07: A color good
- Crit. #08: A slightly rough surface
- Crit. #09: A+ recall program existing
- Crit. #10: B oral hygiene partly insufficient, additional risk (erosions)

The follow-up quality of this restoration is classified as C. The restoration has to be replaced.

3. Explanatory Notes

Restorative dentistry has to take the requests and ideas of the informed patient seriously, particularly if they themselves finance the dental services. The requests and ideas are to be taken into account in the treatment planning, if these do not require treatments which are unethical, destructive, or contraindicated based on the current state of knowledge.

According to communicative principles, the practitioner, prior to the start of operative measures, should feel certain that the patient is completely oriented about the intended and agreed dental service, has noticed and accepted the possible complications, and in principle has understood the technical procedure.

General Diagnostics

(see also chapter "Preventive Dentistry")

Probing of enamel caries can be destructive, and therefore enamel and dentin are to be probed gently. Additional elements of the caries diagnosis are visual inspection, radiography, transillumination, electro- and laser-diagnostics, particularly in relation to fissure caries, as well as caries detectors on the basis of dyes.

Occlusal Caries

(cf. Tab. IV: Occlusal surfaces)

Retentive fissure systems and pits which principally are at an elevated caries risk as well as fissure systems which are discolored or after drying appear whitish-opaque should be preventively sealed, if the caries risk is "high" or "normal". Fissure sealing is of use only if it tightly and permanently seals the entire fissure system and remains completely intact. Partly sealed fissure systems or fissure systems exhibiting a defective sealing are at an elevated caries risk. The main mistakes related to fissure sealing are insufficient enamel etching in regard to the duration

of etching and its extent in the environment of the fissure entrances, insufficient drying, and missing consideration of the absolutely necessary penetration time of 20 seconds before light curing of the sealant starts. Preparation of fissure systems using rotary instruments or powder-jet devices is damaging to the dental hard tissue, destructive, and therefore to be refused.

If hidden dentin lesions are suspected based on the morphology of opacities appearing whitish after drying (possibly in combination with a brown/black discoloration) as well as considering the caries history and caries risk, minimally invasive exploratory drilling (which should be as tooth substance-protective as possible) in the direction of the presumed dentin caries is indicated. Possibly existing dentin lesions are excavated in an undermining way and the prepared occlusal surface is treated according to the principles of extended fissure sealing.

Interproximal Caries

(cf. Tab. V: Interproximal-surface caries)

For the diagnostics, superior, correctly made bitewing radiographs with the necessary image sharpness are at the forefront, but inspection and, particularly in the area of the front teeth, transillumination is also useful. An in-vivo carious lesion is always more extended than shown by the radiograph. Teeth with a radiographic translucency restricted to the enamel are most likely in caries-active patients, but overall in only ten percent of the cases, exhibit a disruption of the enamel surface, which should be treated using restorative measures. Given appropriate prerequisites concerning caries risk, preventive care, and cooperation of the patient, enamel lesions as a rule should not be opened operatively, but rather remineralized. If necessary, progression or regression of the caries can be monitored with the aid of existing radiographs.

Smooth-Surface Caries, Cervical Caries, and Cervical Lesions

(cf. Tab. VI: Smooth surfaces and Tab. VII: Tooth neck)

In the case of smooth-surface caries, the options provided by remineralization and sealing techniques are to be assessed before invasive procedures are selected. In the case of cervical caries and cervical lesions, the principle of early, minimally invasive treatment with adhesive restorations applies because these have preventive properties regarding abrasion and erosion.

Plaque Retention

Plaque elimination or reduction of plaque pathogenicity is not only pivotal for the control of further attachment loss due to periodontitis, but also for the longevity of restorations, although other operative and material-inherent factors play a role as well. The restoration shape and border seal should be oral hygiene-friendly and the restoration surface should not promote plaque formation.

Function

The restitution of function aimed at with the placement of restorations as a rule also applies to the occlusion. Therefore, the latter has to be checked in advance and, if necessary, adjusted in a way that it functions normally and is free from interferences. Signs of functional disturbances are repeatedly occurring filling fractures, occlusal traumas, elevated tooth mobility, drifting teeth, disproportional wear of dental hard tissue and restorations, as well as discomfort in the area of the masticatory musculature and temporomandibular joint. A restitution of lost occlusal height in dentitions afflicted by abrasion and erosion can make sense.

Assessment of Existing Restorations

A significant part of the therapeutic cariology is “redentistry”. The criteria for the reparation or replacement of restorations can be taken from the chapter “Assessment of Restorations”, in particular Tables IV to VII.

If B ratings exist, it first has to be checked whether the deficiencies jeopardizing or damaging the pulp and/or dental hard tissue cannot be fixed within the scope of restoration maintenance or by means of a simple repair before the restoration is replaced. In case of esthetic insufficiencies which do not impair either the pulp or the preservation of dental hard tissue or the function, the subjective opinion of the patient is decisive concerning the operative approach.

Prevention

(for further information see also chapter “Preventive Dentistry”)

Caries and attachment loss due to periodontitis are usually regarded as avoidable. The goal of prophylaxis is the preservation of the primary oral health defined by the absence of diseases of the teeth, the periodontium, and the oral mucosa. Therapeutic measures are required within the scope of the secondary oral health, in which occurred damages are fixed and function is restored.

Decisive is the assessment of the caries risk. Attention should be paid to special risks such as emerging teeth, retentive fissures and pits appearing white-opaque after drying, exposed tooth necks, as well as short-term changes of the caries risk, which can result from psychological and physical alterations in the patient (existential stress, age- or disease-related degeneration, medication, drug abuse, irradiation etc.) and at short notice require a different preventive care.

Drilling or not Drilling?

Lesions in enamel normally can be remineralized; also lesions in the outer dentin layer exhibiting an intact enamel surface in teeth with a healthy pulp can be remineralized in the enamel area, while the dentin caries is arrested passively. Regarding the question “Drilling or not drilling”, the current caries risk of the carious lesion is decisive (importance assigned by the patient to oral and dental health; extent, intensity, and quality of the oral hygiene; willingness and capability to cooperate in a comprehensive, continuous dental care program).

Caries Removal

The diagnosis of caries within cavities is not easy. The zone of irreversibly demineralized dentin is located in front of the bacterially infected hard tissue. How far it should be excavated, can to date not be objectively determined in clinical practice. The discriminatory diagnostic potential and the clinical value of caries detectors or the application of diagnostic lasers are not assessed consistently or are not known yet. Relevant are also current findings such as the thickness of the remaining dentin, the condition and age of the pulp, as well as the question whether a border-tight restoration can be placed and the patient subsequently can be completely looked after by a dental caregiver.

Basically, carious dentin has to be removed as completely as possible; compromises are possible in the case of indirect capping in areas close to the pulp. If teeth are sensitive or the prognosis regarding indirect or direct pulp capping is unclear, the definite treatment should, if possible, be postponed and preference instead given to a temporary, however absolutely tight filling.

Deep Carious Lesions

In the case of deep carious lesions, the procedure according to the endodontic guidelines (cf. chapter “Endodontology”) is advisable. Crucial importance regarding success or failure has to be assigned to the assessment of the current pulp condition. Apart from the site of the pulp opening and its position in relation to healthy and infected dentin, the medical history, symptoms, the age of the patient, results of pulp sensitivity tests, and the radiographic findings are essential. Preparation using rubber dam improves the survival odds of the pulp because the remaining dentin or the possibly opened pulp are not additionally contaminated.

In the case of indirect or direct pulp capping, the patient has to be informed about possible complications; the reachability of dental care has to be warranted; subsequent controls are to be organized, and potential follow-up treatments should be ensured.

Principles of Cavity Preparation

In general, cavity preparation starts with the complete removal of the caries or of a restoration to be replaced. The further procedure is determined by the question whether a retentive or adhesive restoration is planned.

Retentive direct restoration (e.g. amalgam): new preparation of the defect to adapt the cavity to the requirements of the filling material (retention shape and resistance shape). Frequently box-shaped preparations ensue, which slightly converge outwards.

Retentive indirect restoration (e.g. cast gold restorations): slightly divergent preparation with sufficient retentive areas. In the case of broad occlusal cavities, covering of the cusps in the manner of an overlay or partial crown is required.

Adhesive direct restoration (e.g. direct composite restoration): no new preparation sacrificing hard tissue is required. In the case of primary treatments, a significantly less invasive approach is therefore possible. The objective of edge finishing is, on the one hand, to remove loosened enamel prisms and, on the other hand, to produce a broader bevel which in visible regions makes sense for esthetic reasons.

Adhesive indirect restoration (e.g. ceramic restoration): attention should be paid to a divergent preparation lacking sharp edges, abrupt transitions, and thinly tapering margins. Retentive areas are not required and increase the risk of fractures because they produce abrupt transitions. The material-dependent minimum layer thickness has to be considered.

In the case of interproximal preparations, attention should be paid to the high injury risk of neighboring teeth due to rotating instruments; through the utilization of oscillating, one-sidedly coated files or ultrasound attachments such injuries can be avoided.

Restorative Measures

Prior to cavity preparation centric and functional contacts have to be marked. Wherever possible these should be preserved or restored during the permanent treatment.

In all preparations sufficient water-cooling has to be ensured.

The utilization of rubber dam conforms to the state of the art. Thus, upon the removal of amalgam fillings, the patient is most widely protected from a possible sensitization or allergenic influence brought about by the contact with amalgam sludge. Furthermore, with a correctly placed rubber dam,

a microbial contamination of the exposed dentin is virtually impossible. The overview of the operative measures and the technical precision are improved. Adequately dry conditions of the operating field for the setup of the adhesion to enamel and dentin exist. When finalizing the restoration, the gingiva, tongue, and oral mucosa remain protected.

Prerequisites for success are, among others, the availability and mastering of an approved clinical concept and the respective operative procedures. The latter have to be observed meticulously in order to attain the required quality specifications. Shortcuts and simplifications made under entrepreneurial pressure or due to marketing promises on the part of the product manufacturers have an impact at the expense of the initial quality. Although, at the moment, this may be concealed, the consequences inevitably will become obvious later with respect to the follow-up quality.

Occlusal Management

Functional aspects have a strong influence on the result of restorative measures. If masticatory disorders exist, extensive permanent restorative measures are contraindicated without an adequate pretreatment.

Occlusal traumas in newly treated teeth can only be avoided with certainty by means of a functional analysis before and after placement of a restoration. If necessary, the occlusion has to be harmonized in advance.

Marking of the occlusal contacts in different colors (separated into intercuspatation, working contacts, and balancing contacts) prior to cavity preparation has the following advantages:

- The direct occlusal contact in centric relation can possibly be preserved.
- Margins of non-adhesive restorations can be relocated out of the area of occlusal contacts.
- The localization of an occlusal contact that has to be restored is clearly defined.

All restorations should be harmoniously in occlusion in order to avoid, on the one hand, destructions on restorations or restored teeth and, on the other hand, masticatory disorders accompanied by irreversible damage to the teeth and/or the periodontium.

The selection of the restoration material is determined by the planned restoration level (cf. Tab. I).

Table IV: Caries prophylaxis and caries therapy – tooth surface-specific procedure

Prerequisites: basic prophylaxis, individual dental care including at least one control session per year

Occlusal surfaces

General assessment: 1. medical history – 2. dental finding – 3. diagnosis: caries risk¹⁾

Diagnostic means²⁾: inspection after thorough drying, fluorescence, radiography

Finding Surface-specific after drying ³⁾	I Healthy	II Retentive/discolored and/or white-opaque after drying ⁵⁾	III Presumed or existing enamel lesion	IV Findings II + III + presumed dentin lesion ⁵⁾	V Existing dentin lesion ⁶⁾
Caries risk ⁴⁾ low				Diagnostic “drilling” (opening) ↓ No/minimal dentin lesion	Minimally invasive access cavity ⁷⁾ ↓
	Fluoride varnish	Fluoride varnish	Fissure sealing	Extended fissure sealing	Adhesive restoration
Caries risk medium⁸⁾	Fluoride varnish	Fissure sealing	Fissure sealing	Extended fissure sealing	
	Fissure sealing	Fissure sealing	Fissure sealing	Extended fissure sealing	
Caries risk high⁹⁾	Fissure sealing	Fissure sealing	Fissure sealing	Extended fissure sealing	

1) Preferably based on repeated assessments (cf. chapter “Preventive Dentistry”)

2) Order according to efficiency, effort, biological burden, invasiveness, and state of development

3) Powder/jet devices are not suitable for this (except glycine powder) because they congest the fissure system and are too abrasive; grinding preparation of the fissure system is to be rejected, because it is destructive.

4) General and surface-specific caries risk (tooth emergence)

5) During tooth emergence, until fissure sealing or extended fissure sealing can technically be performed impeccably, fluoride varnish two to four times a year, in the case of caries risk “high”, additionally chlorhexidine varnish two to four times a year

6) Powder/jet devices are not suitable for this, because they congest the fissure system and are too abrasive; grinding preparation of the fissure system is to be rejected, because it is destructive.

7) Restoration type depending on the finding after excavation of the carious dentin and removal of demineralized, no longer structured enamel; if necessary, inlays are optionally indicated in the case of large, box-shaped cavities; overlays if cusps are missing

8) Possibly prescription of highly fluoride-containing toothpaste

Table V: Caries prophylaxis and caries therapy – tooth surface – specific procedure

Prerequisites: basic prophylaxis, individual dental care including at least one control session per year

Interproximal surfaces

General assessment: 1. medical history – 2. dental finding – 3. diagnosis: caries risk¹⁾

Diagnostic means²⁾: inspection after thorough drying, radiography, transillumination, probing (dentin lesion with cavitation), fluorescence

Finding	I	II	III	IV	V
Surface-specific after drying ³⁾	No discoloration, no demineralization	White-opaque after drying, discoloration	Finding II and/or enamel lesion ⁵⁾	Finding III + presumed dentin lesion	Existing dentin lesion
Measures			Follow-up check ⁶⁾	Diagnostic "drilling" ⁹⁾ No/minimal dentin lesion	Minimally invasive access cavity ¹¹⁾
				Adhesive restoration ¹⁰⁾	Adhesive restoration
Caries risk low			Intensified individual prophylaxis, remineralization ⁷⁾		
	Fluoride varnish	Intensified individual prophylaxis			
Caries risk medium					
	Intensified individual prophylaxis ⁴⁾	Intensified individual prophylaxis			
Caries risk high					
			Filling, intensified individual prophylaxis ⁸⁾		

1) Preferably based on repeated assessments (cf. chapter "Preventive Dentistry")
 2) Order according to efficiency, effort, biological burden, invasiveness, and state of development
 3) General and surface-specific caries risk (tooth emergence)
 4) Individual dental care including more than one control session per year; professional tooth cleaning; instruction of oral hygiene; nutritional history and advice; fluoride prophylaxis including local application of fluoride-containing varnishes, gels, or fluids; highly fluoride-containing toothpaste
 5) Minimally invasive fillings in the case of radiographic lesions grade 3 and 4 with disrupted surface
 6) Dental care and control has to be intensified if expectantly a non-invasive procedure is pursued; if the cooperation of the patient is missing or if dental care cannot be adequately provided, at least in the case of caries risk "medium" and "high" an invasive approach has to be chosen
 7) Intensification of fluoride prophylaxis including local application of fluoride-containing gels or fluids; varnishes possibly infiltration
 8) Starting from radiographic lesion grade 2 with progression according to follow-up by means of radiographs, enamel marginal ridge or from the buccal or lingual side
 9) Minimally invasive, either from the occlusal surface using rotary instruments and, if possible, preserving the lingual side
 10) Class II adhesive restoration or planar filling with marginal bevel if the access is made from the buccal or lingual side
 11) Restoration type depending on the finding after excavation of the carious dentin and removal of demineralized, no longer structured enamel; if necessary, inlays are optionally indicated in the case of big, box-shaped cavities, overlays if cusps are missing

Table VI: Caries prophylaxis and caries therapy – tooth surface-specific procedure

Prerequisites: basic prophylaxis, individual dental care including at least one control session per year

Smooth surfaces

General assessment: 1. medical history – 2. dental finding – 3. diagnosis: caries risk¹⁾

Diagnostic means²⁾: inspection after thorough drying, fluorescence, probing (dentin lesion with cavitation)

Finding Surface-specific	I No discoloration, no demineralization	II White-opaque after drying, discoloration	III Finding II and/or enamel lesion Caries Erosion	IV Finding III + presumed dentin lesion	V Existing dentin lesion
Caries risk low			Follow-up check ⁵⁾		Minimally invasive access cavity ⁹⁾
			Intensified individual prophylaxis, remineralization ⁷⁾	Intensified individual prophylaxis, sealing ⁸⁾	Adhesive restoration
			Remineralization Sealing, filling		
Caries risk medium		Intensified individual prophylaxis	Intensified individual prophylaxis	Sealing/filling, intensified individual prophylaxis	
			Remineralization ⁶⁾ Sealing, filling ⁷⁾		
Caries risk high		Intensified individual prophylaxis	Sealing/filling, intensified individual prophylaxis		

1) Preferably based on repeated assessments (cf. chapter "Preventive Dentistry")

2) Order according to efficiency, effort, biological burden, invasiveness, and state of development

3) General and surface-specific caries risk

4) Individual dental care including more than one control session per year; professional tooth cleaning; instruction of oral hygiene; nutritional history and advice; fluoride prophylaxis including local application of fluoride-containing varnishes, gels, or fluids; highly fluoride-containing toothpaste

5) Dental care and control has to be intensified if expectantly a non-invasive procedure is pursued; if the cooperation of the patient is missing or if dental care cannot be adequately provided, at least in the case of caries risk "medium" and "high", the enamel lesion has to be sealed

6) Intensification of fluoride prophylaxis including local application of fluoride-containing gels or fluids; varnishes regarding erosion and abrasion has a preventive effect

7) Preventive sealing, in the case of substance loss; restoration of the anatomical form with adhesive filling, which regarding erosion and abrasion has a preventive effect

8) Filling in the case of extensively disrupted surface no longer structured enamel; inlays are contraindicated; in the front tooth region veneers are indicated for the correction of tooth form and tooth color, in the case of big and complex lesions, as well as for the correction of structural anomalies of the dental hard tissue

Table VII: Caries prophylaxis and caries therapy – tooth surface – specific procedure

Prerequisites: Basic prophylaxis, individual dental care including at least one control session per year

Tooth neck¹⁾

General assessment: 1. Medical history – 2. Dental finding – 3. Diagnosis: Caries risk²⁾

Diagnostic means³⁾: Inspection after thorough drying, radiography (interproximal lesion), probing (dentin lesion)

Finding	I No discoloration, no demineralization	II Discoloration	III Demineralization, no substance loss	IV Substance loss	
				Abrasion	Erosion Caries
Measures			Follow-up check ⁷⁾		
		Oral hygiene instruction	Intensified individual prophylaxis, remineralization ⁸⁾	Filling and sealing	Filling and sealing
Caries risk low	Oral hygiene instruction ⁵⁾	Oral hygiene instruction			
	Oral hygiene instruction	Intensified individual prophylaxis	Intensified individual prophylaxis, sealing	Intensified individual prophylaxis	Intensified individual prophylaxis ⁹⁾
Caries risk medium	Oral hygiene instruction	Intensified individual prophylaxis			
	Intensified individual prophylaxis ⁶⁾	Intensified individual prophylaxis	Sealing, intensified individual prophylaxis		
Caries risk high					

7) Dental care and control has to be intensified if expectantly a non-invasive procedure is pursued; if the cooperation of the patient is missing or if dental care cannot be adequately provided, demineralized enamel and demineralized dentin have to be sealed

8) Intensification of fluoride prophylaxis including local application of fluoride-containing gels or fluids; varnishes

9) Nutrition advice as well as guidelines for oral hygiene: toothbrush, toothpaste, and the oral hygiene technique as well as the point in time of oral hygiene in relation to the consumption of food and semiluxury food have to be adapted accordingly

1) Exposed radicular dentin, lesions exhibiting margins in enamel and dentin or entirely in dentin; regarding lesions exhibiting margins entirely in enamel cf. Table VI "Smooth Surfaces"

2) Preferably based on repeated assessments (cf. chapter "Preventive Dentistry")

3) Order according to efficiency, effort, biological burden, invasiveness, and state of development

4) General and surface-specific caries risk (cf. chapter "Preventive Dentistry")

5) Toothbrushes, toothpaste, and oral hygiene technique have to be adapted in order to avoid wedge-shaped lesions

6) Individual dental care including more than one control session per year; professional tooth cleaning; instruction of oral hygiene; nutritional history and advice; fluoride prophylaxis including local application of fluoride-containing varnishes, gels, or fluids; adaptation of the oral hygiene technique (cf. 5)

4. Literature

Core Literature

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