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Setting the retentive force of a partial denture

Load capacity of the clasp teeth

The anchoring of the denture or the force necessary to remove the denture (withdrawal force) is essentially defined through the undercut value and the clasp length. This undercut value results from the tooth status, the clinical, structural, as well as mechanical and geometric circumstances. The number and functional value of the retention areas used determine the withdrawal force. Ideally the clasp tooth should not be subjected to any horizontal shear when the denture is removed. A requirement for this is that the tooth is supported by a strong clasp element positioned opposite (reciprocator / embracement) at the same moment when the active clasp arm bends at the equator. The exact position of the embracement, which must be mounted at the same height, is determined with the analyzing rod. Often the requirement of an embracement cannot be structurally implemented. The horizontal shear on the clasp tooth should then be counteracted by means of a smaller undercut depth.

Assessment parameters to determine the load capacity of clasp teeth

Type of tooth

The dental technician sees in the laboratory order which tooth is earmarked as the clasp tooth. Canine teeth and upper molars have the greatest load capacity. The value of premolars depends on the number of roots, among other things. The first upper premolar does not always have two roots! Incisors are not suitable as clasp teeth in most cases. The load capacity of the lower central incisors is the lowest. The third molars are considered to be high-risk abutments because of their anatomy.

Tooth position

The position of a clasp tooth in the jaw is of special importance. Understandingly, clasp teeth that stand alone cannot be subjected to as much load as those in a closed row of teeth. The saddle dynamics processes must be taken into account in the selection of the clasp teeth, the definition of the type of clasp and the determination of the retention capacity of a tooth. For example, clasp teeth are especially at risk of being exposed to considerable masticatory pressure stress and/or leverage. Terminal teeth may not for example, be subjected to excessive load at the transition to the free-end saddle because of the expected forces. Teeth with position anomalies, particularly tilting, are suitable as clasp teeth only to a limited degree, depending on the extent of their divergence. The greater the specified tooth deviates from a normal tooth position, the less it can be subjected to load.

Periodontal load capacity

Only the dentist can reliably make a prognosis for a clasp tooth (vitality, periodontal condition). As the patient grows older, the relation of the root section in the bone to the entire tooth length changes. As the ridge is resorbed, the leverage conditions on the tooth change. The load capacity declines as the clinical crown elongates. The dental technician can determine the tooth mobility and/or the dimension of a possible undercut depth, which depends on tooth mobility, only if the relevant data regarding the degree of looseness are available to him/her.

Evaluation of the tooth mobility (degree of looseness) and retention capacity:

Degree 0

Clinically secure tooth, normal physiological mobility: can be subjected to max. load capacity

Degree I

Currently tangible mobility of max. 1 mm: restricted retention capacity

Degree II

Increased visible mobility of over 1 mm: very restricted retention capacity

Degree III

Very great horizontal mobility, tooth yields to tongue and cheek pressure: unsuitable as clasp tooth

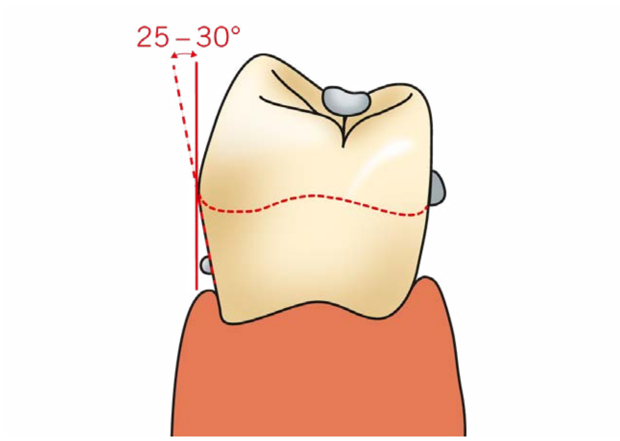
Degree IV

Extreme mobility (looseness), tooth no longer functional!: unsuitable as clasp tooth, possibly extraction prior to making denture

All high-risk teeth (deteriorated periodontium, pulp dead, root tip removal, etc.) have a poor prognosis as clasp teeth. Therefore, they should not be included in the construction as far as possible or only subjected to minimal load. Information on root length, root line, number of roots, anomalies and root treatments can be obtained from the X-ray status. This information must be taken into consideration in the assessment of the clasp tooth.

Tooth inclination in the retentive field

The angle of ascent when removing the clasp results from the tooth inclination (undercut angle, degree of undercut). A favorable angle is 25 – 30° to the path of insertion.



Tooth inclination towards the path of insertion

In the case of a larger off-axis angle, a smaller undercut of the clasp already provides enough retention.

Clasp length

The total length of a clasp also influences the undercut depth. Due to the height and width of the clasp crosssection, which continuously rises from the clasp tip in prefabricated clasp profiles, the clasp has a greater range of spring in the final third that tapers towards the tip. As the profile thickness increases, the undercut diminishes significantly. With shorter clasp arms, the undercut is considerably reduced.

A longer clasp arm enables greater elastic bending of the clasp with subsequent return to the initial position. Longer clasp arms can be placed deeper in the undercut areas. They have a more aesthetically favorable effect because they run underneath the prosthodontic equator over a longer section. Their position is also oriented to the marginal gingiva to which an adequate distance must be maintained (at least 1 mm).

Empirical values for determining depth of undercut

The following table with the empirical undercut values helps in defining the undercut depth and the type of clasp. The load capacity of the clasp teeth, i.e. their resistance to tensile forces, pressure and shear forces, is determined beforehand on the basis of the listed assessment parameters. Subsequently, an analysis is conducted to discover how much retentive force (undercut depth) is necessary for anchoring the denture. The retentive force (retention) of a denture increases with the number and value of the clasp teeth included in the construction. A larger number of clasps with lower undercut values in each case leads to less load on the individual teeth with equivalent prosthodontic anchoring.

Large-scale coverage of the teeth by means of clasps is disadvantageous, which is why a fundamental rule is: As many clasps as necessary – as few as possible.

Even construction made of WIRONIUM®

Individual corrections are possible through modification of the clasp line or profile. Proven empirical values can certainly be used to define the undercut. However, special individual features must not be ignored. The empirical undercut values are based on vital clasp teeth that do not diverge significantly. Further requirements for the use of empirical values are an acceptable angle of cervical convergence of 25 – 30° as well as standard clasp profiles and alloys of high strength.

Note: Only after the active clasp arm has surpassed the prosthodontic equator, can the rigid embracement lose contact to the tooth (reciprocal effect). If this is not the case, the higher shear load must be counteracted by the upright-bending clasp with lower undercut values. In the case of extremely small teeth or teeth with a short clinical crown, the undercut depth should be up to 30 % less. Alternatively, the clasp cross-section can be tapered by means of finishing work. A larger angle of cervical convergence results in more resistance being applied against the upright-bending clasp. According to experience, a smaller undercut is adequate here.

Empirical undercut values

Product details

Type of clasp	Tooth type	Remarks	Undercut
G clasp	premolar	connector e.g. distal	0.20 – 0.25 mm
	canine, molar	connector e.g. distal	0.25 – 0.30 mm
G clasp modified	premolar	connector e.g. disto-palatal	0.25 – 0.30 mm
	canine, molar	connector e.g. disto-palatal	0.30 – 0.35 mm
E clasp	premolar	2 retention fields	0.20 – 0.25 mm
	canine, molar	2 retention fields	0.25 – 0.30 mm
E clasp modified	premolar	1 retention fields – embracement rigid	0.25 – 0.30 mm
	Eckzahn, Molar	1 retention fields – embracement rigid	0.30 – 0.35 mm
Back-action clasp	premolar	1 retention field	0.25 – 0.35 mm
	canine, molar	1 retention field	0.30 – 0.40 mm
Bonwill-clasp	premolar	4 retention fields	0.20 – 0.25 mm
	molar	4 retention fields	0.25 – 0.30 mm
Bonwill-clasp modified	premolar	2 retention fields – embracement rigid	0.20 – 0.30 mm
	molar	2 retention fields – embracement rigid	0.25 – 0.35 mm
Ring clasp	molar	1 rest	0.30 – 0.50 mm
Ring clasp modified	molar	2 rests	0.25 – 0.30 mm
Roach clasp	front	connector exposed!	0.25 – 0.50 mm

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Empirical undercut values with differing clasp length

Product details

Clasp length	Undercut	Premolar clasp	Molar clasp	Ring clasp
up to 6 mm	0.20 – 0.25 mm	*		
up to 9 mm	0.25 – 0.30 mm	*	*	
up to 12 mm	0.30 – 0.35 mm	*	*	
up to15 mm	0.35 – 0.40 mm		*	*
over 15 mm	0.40 – 0.65 mm			*

Note: Stepless variable measuring units allow a more differentiated measurement!

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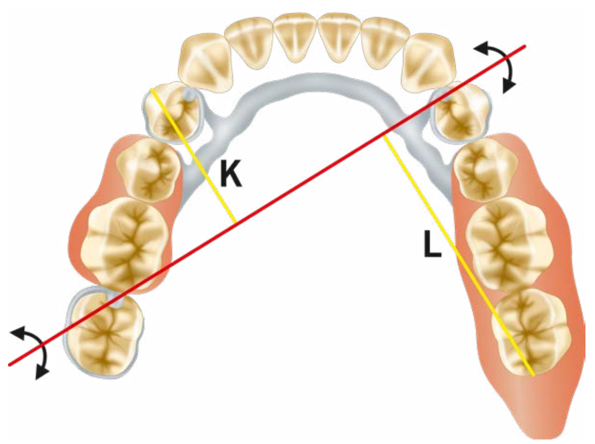
Setting the force of withdrawal (retentive force) of a denture

The definition of the undercut depth takes into consideration that the remaining natural teeth are not overloaded when the denture is inserted and removed. The undercut value defines the retentive force of the denture. It must be ensured that tensile forces, such as those which occur during the chewing of glutinous food, cannot detach the denture from its support. Ideally the retentive force is only slightly greater than the expected withdrawal forces. The stable, passive clasp arms, which are placed over a broad area on the remaining number of teeth, improve the secure fit of the denture.

Note: Tooth-bounded saddles with few replacement teeth require less retentive force than free-end dentures with long rows of replacement teeth.

Substantial stress results from the processes of motion based on saddle dynamics to which the clasp tooth is exposed. One must assume great tensile forces in the case of a free-end saddle (long load arm).



Unfavourable load/force arm relation

They occur at the clasp tip where the force arm ends. The withdrawal force of a clasp is primarily, but not exclusively determined by the undercut value. The function of a clasp is based on the following mechanical-geometric factors that must be matched to each other.

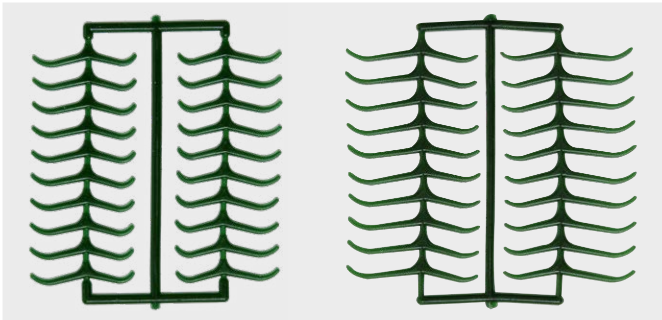
Factors that determine the clasp withdrawal force

Undercut value

The depth of the undercut can be selected from 0.10 mm (only frictional effect) to 0.65 mm (maximum undercut value, e.g. for a ring clasp). The undercut value depends, among other things, on the tooth type, inclination and position, the periodontal load capacity as well as the clasp length.

Clasp profile thickness

If the necessary undercut value cannot be achieved, the cross-section of the profile can be reinforced. For example: using molar instead of premolar clasp. If a deep clasp position is desired for aesthetic reasons or a large undercut exists, the more delicate premolar profile can be used instead of a molar profile.



BEGO premolar clasps **BEGO molar clasps**

Clasp length

The withdrawal force declines as the clasp length increases. Compensation by means of a deeper undercut is possible only to a limited extent. When the clasp length is defined, the necessary retentive force as well as the load capacity and required physical hold of the tooth must be taken into account.

Undercut angle (degree of undercut)

It is determined by the path of insertion, its mean value is 25 – 30°.

Large angle: Short clasp line in the undercut field - good retention, secure denture support.

Small angle: Clasp can be moved below the prosthodontic equator at an early stage, aesthetically more favorable, but the denture detaches itself more easily from its position in the case of strong tensile forces.

Images and illustrations are examples. Colors, symbols, designs, and information on the depicted labels and/or packaging may differ from reality.

Modulus of elasticity

WIRONIUM® – high modus of elasticity

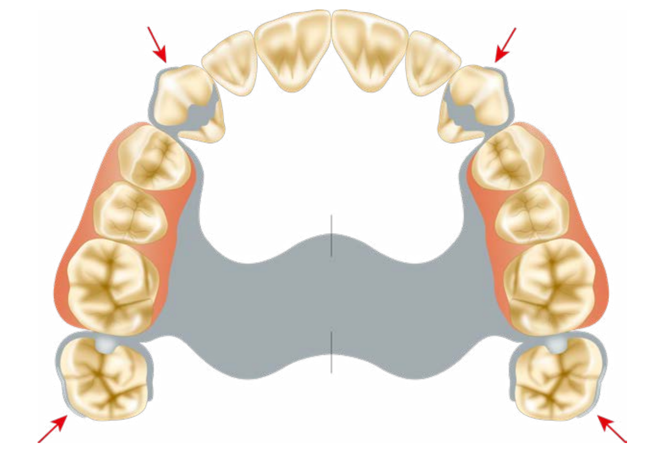
Through targeted selection of an alloy with a high modulus of elasticity, the mechanical properties of a clasp are improved. The force necessary to bend or move the clasp depends directly on the modulus of elasticity. A clasp made of an alloy with a high modulus of elasticity creates more resistance to the forces of deformation than with a low modulus of elasticity. The system-oriented process engineering ensures that the desired high modulus of elasticity, e.g. in the casting process, is not altered.

Coefficient of friction

The coefficient of friction or slippage resistance of a clasp depends on the surface roughness of the tooth and the technical dental processing of the inside of the clasp. Functionally, there is a big difference whether the inside of a clasp is only polished or additionally finished with a carbide drill or even rubber-polished.

Arrangement of fields of retention

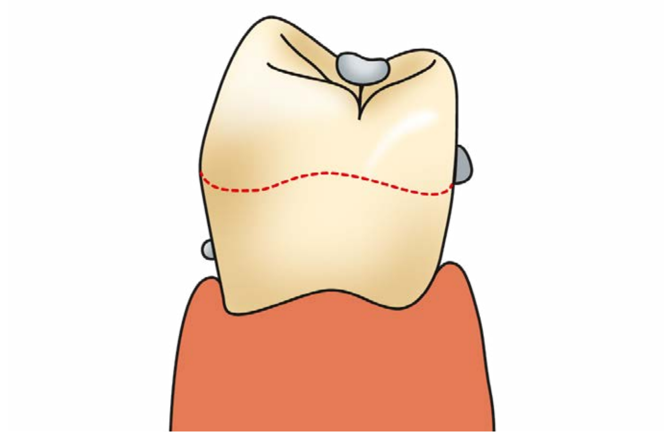
Flawless function is guaranteed by the right arrangement of the retention fields utilized at the clasp teeth. The retention fields acting against withdrawal forces have to be evenly distributed among the clasp teeth and ideally placed in a corresponding position.



Arrange retention fields „correspondingly“

If the clasp tooth has two equally large or deep retention fields, as far as possible; an E clasp is indicated, for example. If only a single undercut exists, a passive clasp arm that serves as an embracement is necessary (e.g. G clasp). This has the advantage that the clasp scarcely deviates from the specified insertion and removal direction. The natural tooth is exposed to a slight horizontal shear load at the most. A major functional disruption occurs if the rigid guide arms prematurely lose their contact to the tooth. If clasps are not arranged opposite of each other (correspondingly) in this case, the denture tilts and searches for the easiest path. In places where clasp arms must bend up or move excessively, this leads to physiologically unwanted shear stress on the clasp tooth. The undercuts specified in relation to the path of insertion deteriorate in value and function. Therefore, ring and back-action clasps arranged one-sidedly must be viewed very critically since both have extremely long clasp arms and deep undercuts.

Retention fields positioned opposite each other or in a line have to be used as an embracement for this reason. Only if the force of withdrawal is distributed evenly, can the denture be removed from the patient‘s mouth without tilting. The abutment tooth is thus not exposed to excessive load!



Provide rigid embracements

While the active clasp arm slides over the prosthodontic equator, the embracement should not lose contact to the tooth surface (reciprocal effect).

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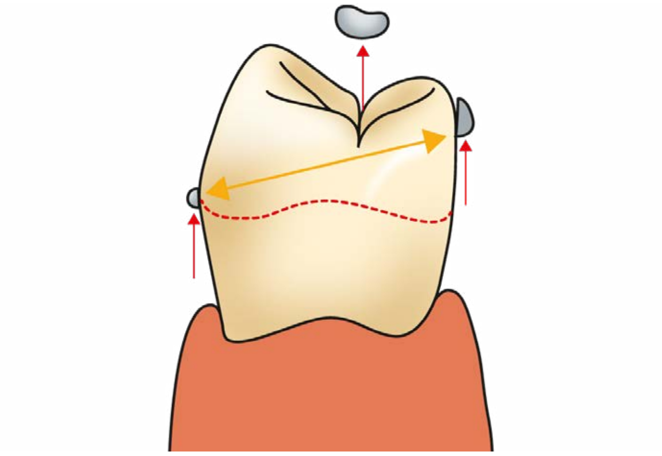

When removing – avoid single-sided shear stress

In the most favorable case, rigid clasp parts or the upper third of the minor connectors are designed as so-called „guiding planes“. They ensure that the denture does not deviate from the set path of insertion when it is removed.