Bundesverband der implantologisch tätigen Zahnärzte in Europa e.V.
European Association of Dental Implantologists

Cologne Classification of Alveolar Ridge Defects (CCARD)

8th European Consensus Conference of BDIZ EDI
February 2013

European Association of
Dental Implantologists (BDIZ EDI)

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Why Cologne Classification of Alveolar Ridge Defect (CCARD)?

With its Expert Symposium in February 2013 the European Association of Dental Implantologists (BDIZ EDI) focused on State of the Art in oral augmentation surgery. For many decades, autologous bone had been considered the gold standard in regenerative dentistry, although the harvesting of autologous bone material is associated with a significant burden on the patient's health. Is the use of biomaterials for hard-tissue regeneration now a general treatment alternative to autologous bone? What biological processes are influenced in what manner, and what is the implication of the various treatment approaches for long-term implantological success?

On the day before the symposium, the 8th European Consensus Conference (EuCC) of BDIZ EDI discussed this topic with a view to reaching consensus and providing guidelines for the use of both autologous bone and bone replacement materials. The participants of the EuCC, hosted by Dr Daniel Rothamel, had pondered the draft submitted by the University of Cologne, considering previous classification papers thereto, arriving at a consensus after constructive deliberations: The Cologne Classification of Alveolar Ridge Defect (CCARD) was born.

The Cologne Classification of Alveolar Ridge Defects uses three-part codes to describe the effect of the alveolar ridge as comprehensively as possible with a view to existing therapeutic options:

Part 1: **Orientation of the defect**
h: horizontal
V: vertical
C: combined
S (or +S): sinus area

Part 2: **Reconstruction needs associated with the defect**
1. low: < 4 mm
2. medium: 4-8 mm
3. high: > 8 mm)

Part 3: **Relation of augmentation and defect region**
i: internal, inside the contour
e: external, outside the ridge contour

This system describes each defect by a single defect code consisting of letters and numbers:

Defect code H.1.i: Small defect up to 4 mm, inside the ridge contour

Defect code S.1: Small defect in the sinus area lower than 4 mm (internal/external not required)

Defect code C.2.e.S.1: Combined alveolar ridge defect of 4-8 mm, outside the envelope, with sinus defect < 4 mm

Since sinus floor augmentation is associated with an environment favourable to regeneration – due to the multi-wall nature of the defect and the localization inside the ridge contour – the third part of the code (i/e) is not needed for the description of sinus defects.

These CCARD-recommendations are intended to serve as a general guideline only, in cases of healthy soft tissue and good general conditions. They can be departed from in exceptional cases (e.g. previous surgery, co-morbidity, compromised bone quality, soft-tissue deficiencies), based on the Cologne ABC Risk Score of the 7th European Consensus Conference which may be obtained from the internet: www.bdizedi.org > Professionals > Guideline Cologne ABC Risk Score, and if the treatment is performed by designated specialists.

Future therapies with autologous stem cells and recombinant growth factors may have potential to reduce the need for autologous bone harvesting in the future. However, until now these therapies are limited to designated medical centers, and different growth factors need further regulatory clearance in the European Union.

The Cologne Classification of Alveolar Ridge Defects (CCARD) classifies volume deficiencies of the alveolar process regardless of their aetiology as vertical, horizontal and combined defects (H, V, C), possibly in conjunction with a sinus area defect (+S). It takes into account the extent of the augmentation needed (1: < 4 mm, 2: 4-8 mm, 3: > 8 mm) and the relation of the graft to the surrounding morphology (i: intern, inside the ridge contour vs. e: extern, outside the ridge contour) and makes recommendations on possible treatment approaches based on the current literature.

Previous guidelines of BDIZ EDI (may also be obtained from the internet: www.bdizedi.org > Professionals)

2006 - Immediate restoration and immediate loading of oral implants
2007 - Ceramics in dental implantology
2008 - Peri-implantitis - prevention - diagnosis - therapy
2009 - Three-dimensional imaging in dental implantology
2010 - Avoiding treatment errors - managing surgical complications
2011 - Short and angulated implants
2012 - Cologne ABC Risk Score for implant treatment
2013 - Cologne Classification of Alveolar Ridge Defects (CCARD)

Bundesverband der implantologisch tätigen Zahnärzte in Europa

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Guideline

Cologne Classification of Alveolar Ridge Defects (CCARD)

Consensus paper approved at the 8th European Consensus Conference (EuCC) in Cologne, 9 February 2013

Participants

Dr Dr Peter Ehrl, Dr Ulrich Fürst, Dr Arndt Happe, Professor Dr Fouad Khoury, Professor Dr Pavel Kobler, Professor Dr Vitomir Konstantinovic, PD Dr H.J. Nickenig, Professor Dr Hakan Özyuvaci, PD Dr Dr Daniel Rothamel, Dr Witold Tomkiewicz, Dr Jairo Vargas, Professor Dr Andrzej Wojtowicz, Professor Dr Dr Joachim E. Zöller

Host: PD Dr Dr Daniel Rothamel
Secretary: Tim Fienitz

Key words: Bone defect, implantology, classification, sinus floor elevation

Objective

Development of an easy-to-handle, therapy-centered defect classification in due consideration of already existing classifications; integration of various defect characteristics and recommendations of different well-established therapy techniques for the respective defect class.

Introduction

A sufficient bone supply in both the horizontal and vertical dimensions is the foundation of any successful oral rehabilitation with dental implants. Challenges in this area include the resorptive changes of the alveolar ridge after tooth extractions and hard-tissue deficits due to chronic periodontal disease or congenitally missing teeth. Tumours, osteomyelitis, cysts or trauma can also compromise the oral situation. All these factors require the oral implantologist to create, using regenerative techniques, sufficient hard-tissue support at the appropriate site (as determined by restorative needs) before or during implant placement.

Procedure for developing the guide/consensus conference

A first draft of the Cologne Classification of Alveolar Ridge Defect (authored by PD Dr Dr Daniel Rothamel, PD Dr H.J. Nickenig, Dr Arndt Happe and Professor Dr Dr Joachim E. Zöller, Interdisciplinary Policlinic for Oral Surgery and Implantology and Department of Oral and Maxillofacial Plastic Surgery at the University of Cologne; director: Professor Joachim E Zöller) was made available to the members of the working group on the day of the consensus conference.

The agenda of the consensus conference consisted of five points: Reviewing the preliminary draft, collecting alternative proposals, voting on recommendations and levels of recommendation, discussing non-consensual issues, final voting.

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Existing defect classifications

Different classifications to describe alveolar ridge defects have been published in the dental literature. In 1988 Cawood and Howell published a classification of the general dimensional changes after tooth loss Here, maxilla and mandible show different absorption patterns (Cawood and Howell 1988). Seibert et al. subdivided the defects of the alveolar ridge according to the dimension in which the absorption occurred: In addition to strictly horizontal defects (class I, 33%) and strictly vertical defects (class II, 3%), they reported as the most common variant a so-called mixed form with bone loss in the horizontal and vertical dimensions (class III, 56%) (Seibert 1983). A similar classification was proposed by Allen in 1985, who distinguished between vertical (type A), horizontal (type B) and combined (type C) defects (Allen, Gainza et al. 1985).

With regard to the aetiology of different defects, it should be noted that in terms of dimensional changes of the alveolar ridge, bone resorption – especially of the buccal bone plate – is regularly observed after extraction of teeth (Schropp, Wenzel et al. 2003, Araujo and Lindhe 2005). This manifests itself clinically as a vestibularly sloping ridge (class I defect), which often requires augmentation because of dehiscence in the context of implant placement. Long-term load reduction in the corresponding region will ultimately result in combined bone loss (class III defect), as the functional stimulus for vertical preservation of the hard tissue in the extraction area will be missing.

The special anatomic relationship between the posterior maxilla and the maxillary sinus is another source of potential bone defects. Because the maxillary sinus tends to expand, alveolar ridge height can be reduced not only by crestal resorption of the alveolar process but also by bone resorption on the basal aspect of the maxillary sinus. Davarpanah et al. distinguished four categories of sub-sinus bone loss (Davarpanah, Martinez et al. 2001): vertical bone loss originating at maxillary sinus, vertical bone loss at alveolar crest, horizontal bone loss at alveolar crest and combined sub-sinus bone loss (the most common form). It is important to note that strictly horizontal or vertical bone loss can also be assigned to Seibert classes I or II, respectively.

Studer (1996) published the first semi-quantitative classification of defects of the alveolar process according to the perceived need to reconstruct the hard and soft tissues, with classes defined as > 3 mm, 3–6 mm and > 6 mm. A gradation of the loss in vertical dimension relative to the tips of the adjacent papillae has also been presented (Studer, Zellweger et al. 1996).

Different classifications also exist for the description of extraction sockets; due to their obvious clinical relevance, they include the morphology of the soft tissue in addition to the bony situation. A number of authors classify extraction sockets without hard-tissue defect by thick or thin gingival biotype (types Ia and Ib), contrasting them with extraction sockets with buccal bone defects (type II) and generalized defect situations (type III) (Elian, Cho et al. 2007).

Current thinking

The various extant defect classifications address only a subset of the possible hard-tissue defect situations, largely disregarding the overall intraoral situation and the environment of the defect. Yet it would appear obvious that, for example, the number of walls delimiting the defect and their relationship to the overall jaw situation significantly impacts the extent of treatment required as well as the post-augmentation success rates. Small, localized defects with ideally shaped hard tissue possibly bordering on still existing adjacent teeth or ridge areas are located within the jawbone geometry (“within the contour”) and are therefore easier to reconstruct and stabilize (Khoury, Antoun et al. 2007). They have advantages in terms of higher regenerative capacity (originating from the defect floor), smaller volume and lower soft-tissue pressure.

Extended defects without close bony delimitation or involving bone reconstruction needs "outside the contour" require more extensive stabilization of the bone substitute (Araujo, Sonohara et al. 2002). In addition, other materials and also an admixture of autologous bone may be required to achieve a comparable result that is stable in the long term.
Clinical implantologists should also be aware that a bone defect is usually associated with soft-tissue deficits (Scharf and Tarnow 1992). While the latter may at first appear to be of little relevance, once the hard-tissue augmentation has been performed and the associated mobilization of the soft tissue is a fact, soft-tissue reconstruction in the form of e.g. a vestibuloplasty or soft tissue graft will regularly be required.

Furthermore, it should be noted that alveolar ridge defects in the aesthetic zone must be treated differently from defects in the posterior region or the edentulous jaw (Scharf and Tarnow 1992). While in the aesthetic zone, the vertical position of the implant shoulder and the implant-abutment interface relative to the adjacent teeth and bone are of overriding importance (Tarnow, Magner et al. 1992), this parameter will often play a subordinate role in the posterior region, particularly in edentulous patients. In these cases, less demanding and costly treatment options may be chosen (short and narrow implants, sinus floor elevation rather than vertical ridge augmentation, apical implant placement) to obtain an implant that, while possibly not in the anatomically perfect position, will be fully adequate functionally.

Cologne Classification of Alveolar Ridge Defects (CCARD)

The remainder of this paper presents an anatomically and therapeutically based classification of anatomic ridge defects that may also serve to simplify treatment decisions. This classification is being related to various established reconstruction methods and surgical treatment concepts. Because of the special role of the soft tissue and the dimensional dynamics involved, extraction-related defects are not included. The treatment recommendations presuppose implementation by an experienced practitioner and necessarily disregard any co-factors such as pre-existing conditions, previous surgical interventions or patient-specific stress situation. For individual assessment of the case-sensitive risk-profile, the Cologne ABC Risk Score of the 7th European Consensus Conference should be considered (BDIZ EDI 2012).

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Treatment options

The autologous bone graft – important to remember – has been considered the gold standard for any type of defect reconstruction (Schliephake, Neukam et al. 1997). Intraoral or extraoral donor sites can be involved depending on the extent of augmentation required. It also makes a difference in what form (cancellous bone chips or block graft) the autologous bone is introduced. Moreover, block grafts require an explicit fixation. Depending on the configuration of the defect, various alternatives to autologous bone may be considered (Klein and Al-Nawas 2011). Avoiding harvesting-related morbidity, they may reduce the burden on the patient while at times producing the same long-term outcome (Cricchio and Lundgren 2003, Silva, Cortez et al. 2006).

H: Horizontal defects

Established treatment modalities for horizontal defects include, in addition to augmentation with autologous bone, the use of bone-expansion (bone-splitting) techniques and guided bone regeneration (GBR). Bone expansion as sole treatment requires sufficiently flexible oral and vestibular bone lamellae, so this approach is suitable only where reconstructive needs are moderate (H.1.i, H.1.e). Same also applies to sinus area, where osteotome technique is limited to smaller augmentation needs (S.1).

The GBR technique is based on the use of tissue barriers to separate the hard tissue to be regenerated from the overlying connective tissue (Dahlin, Linde et al. 1988, Dahlin, Sennerby et al. 1989). For localized horizontal defects, GBR has shown results comparable to those obtained with autologous bone (von Arx, Cochran et al. 2001, Araujo, Sonohara et al. 2002). Slow-resorbing bone substitutes and membranes or non-absorbable barrier membranes are recommended for more extensive GBR procedures (H2x, H3x) and for augmentation outside the envelope (Hxe) (Canullo, Trisi et al. 2006). Note that higher infection rates were found when augmenting extended defects with non-absorbable membranes and bone substitutes than for autologous bone block grafts (Chiapasco, Abati et al. 1999). Collagen membranes are associated with lower complication rates than non-absorbable membranes (Zitzmann, Naef et al. 1997), but should maintain longer absorption time in the case of larger augmentation volumes.

To improve the osteogenic potential of the augmentation material, the admixture of natural bone (e.g. chips obtained while preparing the implant bed) is recommended. For medium and extended augmentation outside the contour (H.2.e, H.3.e), immobilization of the augmentation material introduced (osteosynthesis of block grafts, use of osteosynthesis screws for “tent-pole technique”, membrane pins) may be considered.

V: Vertical defects

Due to the increased difficulty of soft-tissue management and the need to stabilize the augmentation material, treating vertical defects is more demanding than treating strictly horizontal defects (Tinti, Parma-Benfenati et al. 1996). Possible options include, in addition to autologous bone block grafts, stabilizing systems such as titanium-reinforced ePTFE membranes, positioning screws (tent-pole technique) or screw fixations for allogenous blocks. In addition, distraction osteogenesis may also be employed. Especially where the soft-tissue situation is severely compromised, distraction osteogenesis has advantages – not least because of the soft-tissue histogenesis induced (Hidding, Lazar et al. 1999, Chiapasco, Lang et al. 2006) – and produces similar implant placement conditions and long-term results as the pre-existing bone (Chiapasco, Zaniboni et al. 2006). Osteoconductive bone substitutes in onlay apposition technique may be used in combination with autologous bone and non-adsorbable membranes, and remain limited to situations with minor vertical augmentation requirements (V.1.x) (Canullo, Trisi et al. 2006). Larger defects (V.2.x, V.3.x) may be treated with application of biomaterials in sandwich-technique, where bone formation is supported from both crestal and basal bone matrix after horizontal split osteotomy (Smiler 2000, Jensen 2006).

C: Combined defects

The treatment of combined defects usually follows the more exacting aspect of the defect, which in practice means it is essentially the same as in vertical augmentation. Outside the aesthetic zone, reconstruction of smaller vertical discrepancies will usually not be required, especially not if delimiting bone walls exist near adjacent teeth that supports the soft tissue, especially the papillae. When performing distraction osteogenesis of combined defects, some overexpansion with subsequent subtractive adjustment of the compromised horizontal areas is feasible. Extensive horizontal and vertical bone resorption without bone walls (C.2.e, C.3.e) can usually only be treated with autologous bone grafts, since the augmentation bed will not offer enough osteogenic potential for substitute material application only.

S: Sinus area, +S: combined sinus area

Unlike vertical crestal defects, defects in the basal part of the alveolar process can be addressed by elevating the sinus floor; the success rate is very high. In low-severity cases (S1, X+S1), sinus floor elevation can be performed internally using an osteotome expansion technique. Transalveolar preparation of the sinus mucosa is available for smaller and larger defects (Sx) (Jensen and Terheyden 2009). The use of an external access via the facial sinus wall allows minor as well as more extensive augmentation (Sx), both with autologous bone and with bone substitute (Hallman, Sennerby et al. 2002). Recent studies have shown that standard sinus floor elevation produces comparable results with autologous bone and with bone substitute (Hallman, Sennerby et al. 2002, Kasabah, Simunek et al. 2002, Schlegel, Fichtner et al. 2003, Zijderveld, Zerbo et al. 2005, Klein and Al-Nawas 2011). In combined sinus defects, where there is an additional need for reconstructing the alveolar process (x.x.x+Sx), treatment beyond the sinus floor elevation will also depend on the crestal aspect of the defect and may be a two-stage procedure, but occasionally also a one-stage procedure.

The various treatment options can be summarized as follows:

		Horizontal			Vertical			Combined			Sinus		
		<4	4–8	>8	<4	4–8	>8	<4	4–8	>8	<4	4–8	>8
Expansion/splitting	inside the ridge contour	X	X					X			X		
Intraoral bone chips		X	X	X	X						X	X	X
Intraoral bone block		X	X	X	X	X	X	X	X	X	X	X	X
Iliac crest (block and chips)					X	X	X	X	X	X	X	X	X
BSM (incl. GBR)		X	X		X			X			X	X	X
BSM + autol. bone (incl. GBR)		X	X*	X**	X*	X**	X**	X*	X**	X**	X	X	X
Distraction osteogenesis					X	X	X	X	X	X			
Sandwich technique					X	X	X	X	X	X			
Expansion/splitting	outside the ridge contour	X											
Intraoral bone chips													
Intraoral bone block		X	X	X	X	X	X	X	X	X			
Iliac crest (block and chips)		X	X	X	X	X	X	X	X	X			
BSM (incl. GBR)		X*											
BSM + autol. bone (incl. GBR)		X	X*	X**	X**			X**					
Distraction osteogenesis					X	X	X	X	X	X			
Sandwich technique		X	X	X	X	X	X	X	X	X			

*volume-stable bone-substitute materials (BSM) and membranes with long-term barrier function
**non-absorbable membranes plus stabilization, if needed

These recommendations are intended to serve as a general guideline only, in cases of healthy soft tissue and good general conditions. They can be departed from in exceptional cases (e.g. previous surgery, co-morbidity, compromised bone quality, soft-tissue deficiencies), based on the Cologne ABC Risk Score (BDIZ EDI 2012), and if the treatment is performed by designated specialists.

Future Therapies with autologous stem cells and recombinant growth factors may have potential to reduce need for autologous bone harvesting in the future. However, until now these therapies are limited to designated medical centers, and different growth factors need further regulatory clearance in the European Union.

Summary

The Cologne Classification of Alveolar Ridge Defects (CCARD) classifies volume deficiencies of the alveolar process regardless of their aetiology as vertical, horizontal and combined defects (H, V, C), possibly in conjunction with a sinus area defect (+S).

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Cologne, 9 February 2013

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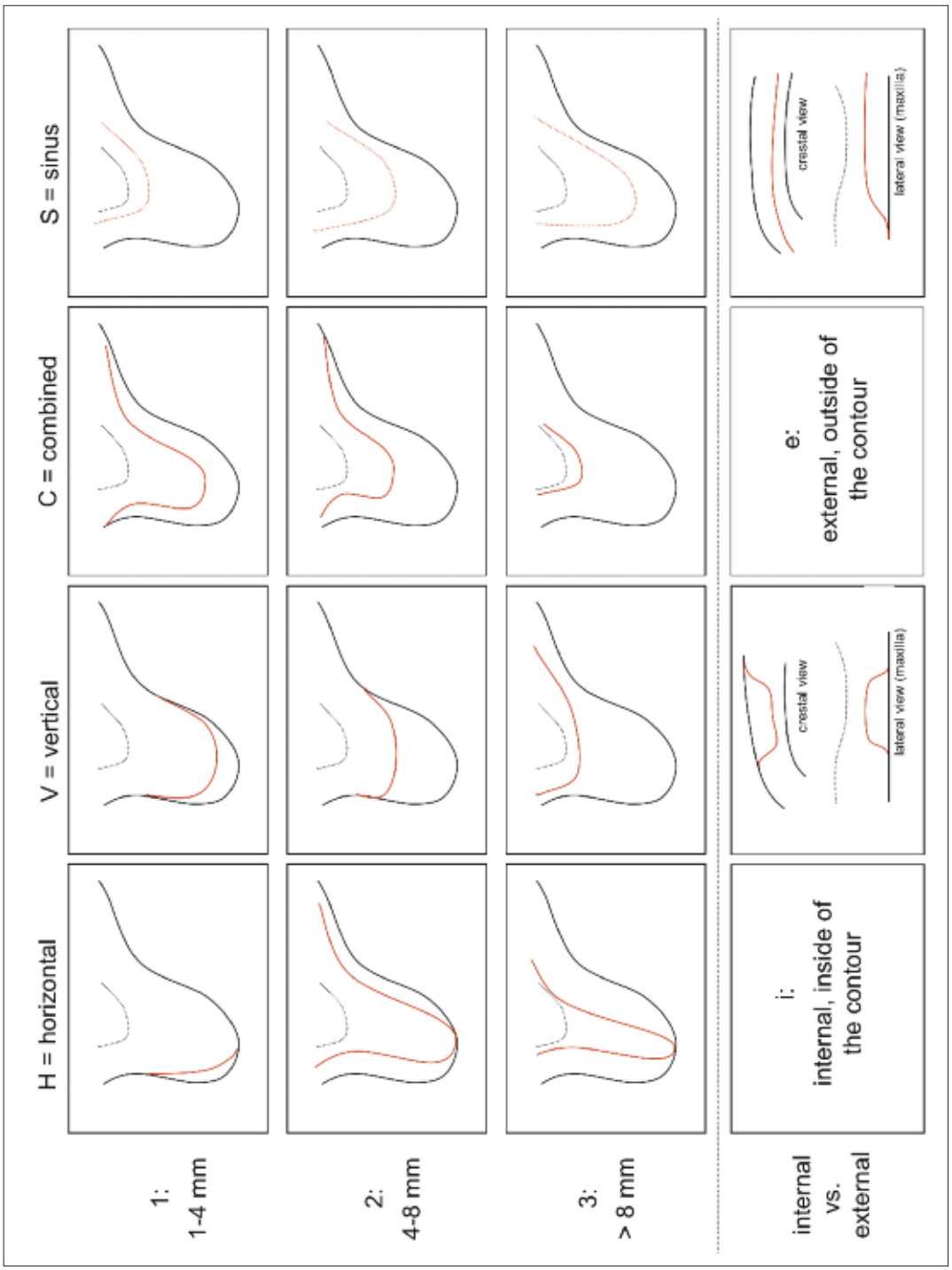
H = horizontal
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cranial view
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