

Peri-implantitis: A Classification Update

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ABSTRACT

The cases of peri-implantitis are soaring rapidly in the current scenario. It is very important to have adequate knowledge about the etiology, pathogenesis, clinical features, radiological features, and treatment of peri-implantitis. In this context, the classification of the disease is of utmost importance for planning and execution of the treatment. Various classifications have been proposed over the years and with each classification, more information is being added and there is a lack of universal acceptance of a single classification. Clinical errors may be anticipated due to miscommunication and misguidance. Thus, it is important to sensitize the clinicians about different classification systems. This review attempts to compile and critically analyze existing classification systems of peri-implant diseases.

Keywords: Dental implants; diagnosis; peri-implantitis.

INTRODUCTION

Peri-implantitis is defined as a plaque-associated pathologic condition occurring in the tissue around dental implants, characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone.¹ It is the most frequent complication of dental implants and occurs from 1% to 47% at implant level,²⁻⁹ based on various study designs and population sizes.¹⁰⁻¹² It presents a public health issue.¹³⁻¹⁵

Peri-implantitis is associated with a history of chronic periodontitis, poor plaque control skills, and lack of regular maintenance care after implant therapy.¹⁶ The risk factors for peri-implantitis are patient-related, prosthesis-related, clinician-related and implant design, and site-related.¹⁷ Further investigations are necessary for the role of occlusal overload¹⁸, genetic factors¹⁹, rheumatoid arthritis with concomitant

connective tissue disease²⁰, increased time of loading²¹, and alcohol consumption.²²

Peri-implantitis shows signs of inflammation, bleeding on probing and/or suppuration, increased probing depths and/or recession of the mucosal margin and radiographic bone loss compared to previous examinations.²³

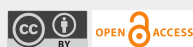
Diagnosis of peri-implantitis:²⁴

- Evidence of visual inflammatory changes in the peri-implant soft tissues combined with bleeding on probing and/or suppuration.
- Increasing probing pocket depths as compared to measurements obtained at the placement of the supra-structure.
- Progressive bone loss in relation to the radiographic bone level assessment at 1 year following the delivery of the implant-supported prosthetics reconstruction.
- In the absence of initial radiographs and probing depths, radiographic evidence of bone level ≥ 3 mm and/or probing depths ≥ 6 mm in conjunction with profuse bleeding represents peri-implantitis.

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Classification of peri-implant diseases and conditions is essential for proper treatment planning, prognosis, and communication.²⁵

Many classifications have been proposed and widely used. These are explained below:

1. Spiekermann (1984)

The type of bone resorption pattern was used to describe the peri-implant defect into 5 categories.²⁶

Class I: Horizontal

Class II: Hay-shaped

Class III a: Funnel-shaped

Class III b: Gap-like

Class IV: Horizontal-circular form

2. Jovanovic (1995)

The classification has coupled the amount of horizontal bone loss with the type of bone defect.²⁷

Class 1: Slight horizontal bone loss with minimal peri-implant defects

Class 2: Moderate horizontal bone loss with isolated vertical defects

Class 3: Moderate to advanced horizontal bone loss with broad, circular bony defects.

Class 4: Advanced horizontal bone loss with broad, circumferential vertical defects, as well as loss of the oral and/or vestibular bony wall

3. Sussman (1998)

Historically, the periapical implant lesion has been described into 2 types as retrograde peri-implantitis by Sussman in 1998.²⁸

Type 1: Occurs when the insertion of the implant results in devitalization of the adjacent tooth either by direct contact or overheating of the surrounding bone

Type 2: Occurs when a periapical lesion from a nearby endodontically involved tooth encroaches upon the implant and contaminates it

An updated classification was considered by adding classes 3 and 4 as additional causes of RPI were reported:

Class 3: A lesion that develops because of improper placement or angulation of the implant (ie, placed outside the envelope of bone). This can include implants that are placed too far labially or lingually/palatally.²⁹

Class 4: A lesion that develops despite proper placement in sound bone with adjacent vital teeth postoperatively, which may imply residual bacteria/viruses and/ or necrotic bone/subclinical infection remaining at the site or placement into an infected or inflamed sinus causing either nonhealing of the apical region of the implant or contamination.³⁰

4. Vanden Bogaerde (2004)

This classification considers peri-implant bone defects in the progression of the regenerative process:³¹

(1) Closed defects: It is characterized by the maintenance of intact surrounding bone walls.

(2) Open defects: It is the one that lack one or more bone walls.

5. Lang NP et al. (2004)

The classification has included clinical signs, radiographic features and treatment to describe various stages of peri-implantitis.³²

Pocket depth (PD) <3 mm, no plaque or bleeding:
No therapy

Stage A PD <3 mm, plaque and/or bleeding on probing: Mechanical cleansing and polishing, oral hygienic maintenance instructions.

Stage B PD 4–5 mm, radiologically no bone loss:
Mechanical cleansing and polishing, oral hygienic

maintenance instructions plus local anti-infective therapy (e.g Chlorhexidine).

Stage C PD >5 mm, radiologically bone loss <2 mm: Mechanical cleansing and polishing, microbiological test, local and systemic antibiotic therapy.

Stage D PD >5 mm, radiologically bone loss >2 mm: Resective or regenerative surgery.

6. Schwarz et al. (2008)

The configuration of the bony defect as:³³

Class I defect: Intraosseous

Subdivisions:

Class Ia: Buccal dehiscence

Class Ib: Buccal dehiscence + semicircular bone resorption to the middle of the implant body

Class Ic: Buccal dehiscence + circular bone resorption under maintenance of the lingual compacta

Class Id: Buccal dehiscence + circular bone resorption under loss of the lingual compacta

Class Ie: Circular bone resorption under maintenance of the buccal and oral compacta

Class II defect: Supra-alveolar in the crestal implant insertion area

7. Renvert & Claffey (2008)

Classification of peri-implant diseases and advised treatment regimen was given by Renvert and Claffey³⁴ as shown in Table1.

8. Koldslund et al. (2010)

The peri-implantitis levels of severity assessed were:³⁵

- 1) Radiographic peri-implant bone loss ≥ 2.0 mm and BOP/suppuration at PD ≥ 4 or ≥ 6 mm
- 2) Radiographic peri-implant bone loss ≥ 3.0 mm and BOP/suppuration at PD ≥ 4 or ≥ 6 mm

Table 1: Classification of peri-implant diseases by Renvert and Claffey.³⁴

	Signs of disease	Advised treatment regimen
Periimplant mucositis	Inflammation BOP PPD<4 mm No bone los	Nonsurgical instrumentation and disinfection with chlorhexidine
Peri-implantitis Grade 0	Failure of osseointegration Implant fracture Implant mobility>1mm horizontal movability	Explant
Peri-implantitis Grade1 (mild)	BOP+/- SUP PPD<4 mm Bone loss<2 mm Foreign body in peri-implant sulcus(commonly cement)	Removal of abutment Non-surgical instrumentation and disinfection
Peri-implantitis Grade 2 (moderate)	BOP+/- SUP PPD 4-6 mm Bone loss<2 mm	Removal of abutment Non-surgical instrumentation and disinfection
Peri-implantitis Grade 3 (severe)	BOP+/- SUP PPD>6 mm Bone loss>2 mm	Removal of abutment Surgical access Instrumentation and disinfection Systemic antibiotics Resective/Regenerative surgery

Table 2: Peri-implant mucosal inflammation (PIMI).³⁶

Diagnosis	Prognosis	Treatment	
No PIMI (Healthy) No bleeding/No bone loss	Favourable	OHI	SIT
Mild PIMI (Mucositis) Bleeding/No bone loss	Favourable	OHI+ISD	SIT
Moderate/Severe PIMI (Peri-implantitis) Bleeding, bone loss	Unfavourable	OHI+ISD or GBR	SIT
Systemic PIMI (Peri-implantitis) Bleeding, bone loss, systemic condition	Unfavourable	OHI+ISD or Implant(s) removal New Implant(s)	SIT
Advanced PIMI (Peri-implantitis) Infection and/or occlusal trauma, mobility	Hopeless	Implant(s) removal New Implant(s)	SIT

GBR=Guided Bone Regeneration, OHI= Oral Hygiene Instruction, ISD= Implant Surface debridement, SIT=Supportive Implant Treatment

9. Nogueira- Filho et al. (2011)

Peri-implant mucosal inflammation (PIMI) was described along with prognosis and treatment³⁶ as shown in Table 2.

10. Froum and Rosen (2012)

Peri-implantitis is classified into³⁷:

1. Early Peri-implantitis: PD \geq 4 mm, Bleeding and/or suppuration on probing, Bone loss <25% of the implant length.
2. Moderate Peri-implantitis: PD \geq 6 mm, Bleeding and/or suppuration on probing, Bone loss ranging from 25% to 50% of the implant length.
3. Advanced Peri-implantitis: PD \geq 8 mm,

Bleeding and/or suppuration on probing, Bone loss >50% of the implant length.

(Bleeding and/or suppuration noted on two or more aspects of the implant. Bone loss measured on radiographs from time of definitive prosthesis loading to current radiograph. If not available, the earliest available radiograph following loading to be used.)

11. Kadkhodazadeh and Amid (2013)

The classification system for peri-implant disease in association with natural teeth was termed peri-implant soft tissue (PIST).³⁸ It gave a better view to the clinicians about the etiology of the disease. The classification is shown in Table 3.

Table 3: Peri-implant soft tissue (PIST).³⁸

Classification	Definition/ Origin	1 st step of treatment
Primarily: periodontitis		
P-1	Secondarily: apical peri-implantitis	Pulp vitality test rct+/-surgical intervention
P-2	Secondarily: marginal peri-implantitis	Non-surgical+/-surgical debridement of involved areas
P-3	Secondarily: marginal and periapical peri-implantitis	Combination
Primarily: peri-implantitis		
I-1	Secondarily: apical periodontitis	Pulp vitality test rct surgical intervention of involved implant+/-tooth
I-2	Secondarily: marginal periodontitis	Non-surgical+/-surgical debridement of involved areas
I-3	Secondarily: marginal and periapical periodontitis	Combination

Separately		
S-1	Apical lesions	For involved tooth: RCT, follow-up, peri-apical surgery For implant: follow-up, surgery
S-2	Marginal lesions	Non-surgical+/-surgical debridement of involved areas
S-3	Apical and marginal lesions	Combination
Traumatic lesions		
T0	Non symptomatic	Follow-up
T-1	Symptomatic lesions	RCT, Extraction of involved tooth/ implant

12. Zhang L et al. (2014)

The peri-implant bone defects (PIBDs) were classified on the basis of their panoramic radiographic shapes in patients with lower implant-supported overdentures.³⁹

Type 1: Saucer-shaped; Bone pocket characterized by a concave bottom (classified as type 4, if the undercut was below the alveolar bone crest).

Type 2: Wedge-shaped; Bone pocket characterized by a straight or convex wall.

Type 3: Flat or no pocket; No pocket present or angle between flat alveolar crest and implant surface $\geq 90^\circ$.

Type 4: Undercut; Bone pocket characterized by a concave bottom, with obvious undercutting, that is, with an undercut >0.5 mm and proportion of undercut $>50\%$.

Type 5: Slit-like; Bone pocket is narrow and deep, with a width of ≤ 0.5 mm and a depth equalling twice the width or more, or an undercut >0.5 mm and proportion of undercut $<50\%$.

13. Kazemi (2015)

Kazemi in 2015 classified peri-implantitis into four classes:⁴⁰

Peri-Implantitis Type 1: Inflammation of the gum tissue with no loss of bone or gum tissue. The gum tissue may appear red, is painful to touch, and may bleed during brushing or flossing.

Peri-Implantitis Type 2: Inflammation, along with loss of bone on one side of the implant, with normal gum tissue level. Depending on the amount of the bone loss, it can be further categorized as:

Type 2a: Bone loss 1-4 mm

Type 2b: Bone loss greater than 4 mm

Peri-Implantitis Type 3: Advancement of inflammation with loss of bone on one side of the implant and receding gum tissue.

Type 3a: Bone loss 1-4 mm

Type 3b: Bone loss greater than 4 mm

Peri-Implantitis Type 4: Severe inflammation with bone loss on more than one side or all around the implant.

Type 4a: Normal gum tissue level

Type 4b: Loss of gum tissue

14. Ata Ali et al. (2015)

This is combined (peri-implant mucositis and peri-implantitis) classification.⁴¹

Proposed classification for peri-implant mucositis:

Stage A: Probing Pocket Depth ≤ 4 mm and Bleeding on probing and/or suppuration, with no signs of loss of supporting bone following initial bone remodelling during healing

Stage B: Probing Pocket Depth >4 mm and Bleeding on probing and/or suppuration, with no signs of

loss of supporting bone following initial bone remodelling during healing

Proposed classification for peri-implantitis:

Stage I: Bleeding on probing and/or suppuration and bone loss ≤ 3 mm beyond biological bone remodelling

Stage II: Bleeding on probing and/or suppuration and bone loss >3 mm and <5 mm beyond biological bone remodelling

Stage III: Bleeding on probing and/or suppuration and bone loss ≥ 5 mm beyond biological bone remodelling

Stage IV: Bleeding on probing and/or suppuration and bone loss $\geq 50\%$ of the implant length* beyond biological bone remodelling

*Depending on implant length, if peri-implantitis can be classified as simultaneously corresponding to more than one stage, the most advanced should be chosen.

15. Decker et al. (2015)

They grouped peri-implantitis according to the prognosis⁴² as shown in table 4. The prognosis was done by the recommended clinical intervention and probability of achieving implant stability.

16. Shah et al. (2016)

Shah et al. classified retrograde implantitis into 3 classes.⁴³ It is defined as a clinically symptomatic

periapical lesion that develops within the first few after implant insertion while the coronal portion of the implant sustains a normal bone to the implant interface.

Class I: Mild; Extends $< 25\%$ of the implant length from implant apex.

Class II: Moderate; Extends 25–50% of the implant length from implant apex.

Class III: Severe; $>50\%$ of the implant length from implant apex.

17. Ramanauskaite and Juodzbalys 2016

The classification was done on the basis of Radiographic bone level evaluation (mesial and distal):⁴⁴

Slight peri-implantitis PBL: 0.5 - 1 mm

Moderate peri-implantitis PBL: 1.1 - 1.5 mm

Severe peri-implantitis PBL: ≥ 1.5 mm

Amount of bone loss (ABL) = $1.5 + 0.2 \times$ years of implant in function

Pathological bone loss (PBL) = present amount of bone loss – ABL

18. Passi D (2016)

This classification uses mnemonics B (Bleeding, Bone loss), M (Mobility), P (Probing depth, Proposed treatment, and Prognosis).²⁶ Thus, the name BMP

Table 4: Decker’s classification of peri-implantitis.⁴²

Prognosis	Favourable	Favourable	Questionable	Unfavourable	Hopeless
Characteristics	No bone loss PD ≥ 4 mm BOP/Suppuration No mobility	Bone loss $\leq 1/4$ implant PD ≥ 4 mm BOP/Suppuration No mobility	Bone loss $1/4-1/2$ implant PD ≥ 6 mm BOP/Suppuration No mobility	Bone loss $>1/2$ implant PD ≥ 8 mm BOP/Suppuration No mobility	Bone loss $>1/2$ implant PD ≥ 8 mm BOP/Suppuration Mobility
Diagnosis	Periimplant mucositis	Early periimplantitis	Moderate periimplantitis	Advanced periimplantitis	Advanced periimplantitis
Recommendation	Nonsurgical therapy	Nonsurgical therapy	Surgical treatment	Extraction Redevelop site	Extraction

Table 5: BMP Classification. [(Bleeding, Bone loss), M (Mobility), P (Probing depth, Proposed treatment, and Prognosis)]²⁶

STAGE	Bleeding on Probing	Probing Depth	Bone loss (%) of implant length	Mobility	Proposed Treatment & Prognosis
STAGE 1	=	2–3 mm	10–25%	No mobility	No treatment
STAGE 2	+	4–6 mm	25–50% Vertical Horizontal combination	Grade 1	vertical defect <2– 4 mm- GBR, osteoplasty Horizontal Defect < half of implant height – APF, GBR, osteoplasty Combination Defect: Bone augmentation and GBR. Prognosis is fair.
STAGE 3 Horizontal	+	6–8 mm	>50% Vertical Horizontal combination	Grade 2	vertical defect 2– 4 mm-GBR, ABWG Defect > half of implant height – GBR and Augmentation. Combination Defect: Implant removal. Questionable Prognosis
STAGE 4	+	>8 mm	> 50%	Grade 3	Implant removal Poor prognosis

APF- Apically positioned flap, GBR- Guided bone regeneration, ABWG- Autogenous bone wedge grafting.

classification of implant defects was given. The classification is given in Table 5.

19. Sarmiento et al. (2016)

It was proposed by Sarmiento, Norton, and Fiorellini in 2016.²⁵ It was based on the etiology of peri-implantitis which is listed as follows:

- Peri-implantitis induced by pathogenic bacteria/biofilm
- Peri-implantitis induced by exogenous irritants
- Peri-implantitis induced by iatrogenic factors
- Peri-implantitis induced by extrinsic pathology
- Peri-implantitis induced by the absence of keratinized tissue (AKT)

20. Canullo et al. (2016)

They proposed a classification based on the etiology associated with distinguishing predictive profiles.⁴⁵

The three subtypes are

- 1, Plaque-induced
2. Prosthetically triggered
3. Surgically

21. Suzuki, Hsiao and Misch (2017)

They described implant quality scales based on clinical conditions and management as shown in Table 6.⁴⁶

22. AAP (2017)

In 2017, the world workshop planned and conducted jointly by the American Academy of Periodontology and the European Federation of Periodontology presented a consensus report (of workgroup 4) in which classification of Peri-Implant Diseases and Conditions was done:⁴⁷

1. Peri-implant health
2. Peri-implant mucositis
3. Peri-implantitis
4. Soft- and hard-tissue deficiencies

Table 6: Implant quality scale.⁴⁶

Implant Quality Scales	Clinical Conditions	Management
Success (optimal health) Osseointegration/ Stage 0 osseoseparation	No pain or tenderness upon function 0 mobility <2 mm radiographic bone loss from initial surgery PD<4 mm No suppuration No BOP	Normal maintenance
Survival (satisfactory health) Stage I osseoseparation Peri-mucositis	No pain 0 mobility <2 mm radiographic bone loss from initial surgery Perimucosal inflammation PD±4 mm (bleeding and/or suppuration on probing)	Frequent SPT Nonsurgical debridement (hand, machine, air powder, lasers, etc) Patient self-administered care Adjunct local and systemic antimicrobials Soft tissue and/or prosthetic corrections if required
Survival (potentially compromised) Stage II osseoseparation Early peri-implantitis	No pain 0 mobility 2-4 mm mm radiographic bone loss PD±4 mm (bleeding and/or suppuration on probing) Perimucosal inflammation Bone loss <25% of the implant length	
Survival (compromised health) Stage III osseoseparation Moderate peri-implantitis	Variable pain 0 mobility Perimucosal inflammation PD≥6 mm (bleeding and/or suppuration on probing) Bone loss 25% to 50% of the implant length	Treatment as above plus surgical reentry and revision Laser Implant surface decontamination Regeneration
Failure (clinical failure) Stage IV osseoseparation Advanced peri-implantitis	Perimucosal inflammation Pain upon function PD>8 mm (bleeding and/or suppuration on probing) Bone loss>50% of the implant length Mobility Uncontrolled diabetes Maybe no longer in mouth	Surgical reentry and revision Lasers Removal of implant
Others (such as retrograde peri-implantitis)	Variable perimucosal inflammation Radiographically: periapical lesion around implant Clinical pain, tenderness, fistula formation or swelling	Surgical reentry and revision or removal of implant

23. Tallarico et al. (2018)

They categorized diagnostic criteria for the estimation of the implant pathologic bone loss around an implant in function as DC1-6.⁴⁸ In DC-4, the progression of pathologic bone loss was described as chronic and acute.

Chronic (slow to moderate progression of the disease):

Localized (peri-implantitis to 1 implant)

Focalized (peri-implantitis localized in 1 sextant/quadrant)

Generalized (peri-implantitis > 2 implants in different quadrants)

Acute (rapid peri-implant bone destruction):

Localized (peri-implantitis to 1 implant)

Focalized (peri-implantitis localized in 1 sextant/quadrant)

Generalized (peri-implantitis > 2 implants in different quadrants)

Implant success index (ISI)

Besides the above, Implant success index (ISI) was introduced by Abrishami in 2014.⁴⁹

CRITICAL APPRAISAL OF DIFFERENT CLASSIFICATIONS

The first attempt to classify defects in implant bone was done by Spiekerman in 1984, who described the type of bone loss around implant according to the shape of the defect.²⁶ The classification failed to give a quantitative value to the amount of bone loss. This was followed by the classification given by Jovanovic, which mainly addressed the horizontal bone loss and a combination pattern was addressed.

Implant periapical lesions were classified as inactive and infected by Reiser and Nevins in 1995.⁵⁰ The

first attempt to classify retrograde peri-implantitis was done by Sussman.²⁸ In 2006, Diago et al. described retrograde peri-implantitis as acute non-suppurated, acute suppurated, or chronic according to its evolution.⁵¹ Shah et al. in 2016 gave a simpler classification of retrograde peri-implantitis.⁴³

Vanden Bogaerde described the bone defects as closed and open.³¹ It is the simplest classification but it lacks important information due to its broad approach. In the same year, Lang et al. gave a complete classification by including clinical, radiographic features and also guiding the treatment.³² It was the first classification that gave definite values for the definition of the stages and was not objective. Peri-implant pocket depth was included along with radiographic features and treatment. It was the first classification that gave a complete narration of the disease involved. But the radiographic bone loss was only differentiated as <2 mm and >2 mm. The severity of all the cases with radiographic bone loss >2 mm was grouped in one class, which cannot be justified.

In 2008, Schwarz et al. classified peri-implant bone loss as intraosseous and supraalveolar. Special consideration was given to dehiscence on the buccal aspect.³³ Renvert and Claffey in their 2012 classification included implant fracture and mobility in their classification.³⁴ Implant mobility > 1mm horizontal movability was given the treatment of explantation. The degree of mobility was not considered. Koldslund et al. in 2010 grouped peri-implantitis under two categories.³⁵ All the cases with radiographic bone loss ≥ 3 mm were placed in one category. This classification also failed to address the severity of peri-implantitis as in Lang's classification. Moreover, the classification was more primitive compared to Lang's classification which was given half a decade earlier. In 2011, Nogueira F et al. described Peri-implant mucosal inflammation (PIMI) along with prognosis, treatment, and supportive implant treatment.³⁶ But, the classification lacked the important parameter of diagnosis: the peri-implant pocket depth.

It was only in 2012 that Froum and Rosen addressed another important aspect: the severity of radiographic bone loss.³⁷ Kadkhodazadeh and Amid in 2013 gave a classification system for peri-implant disease in association with natural teeth.³⁸ Zhang et al. classified the peri-implant defects according to shape in the orthopantomograms.³⁹ This system did not provide any quantitative and definite value and was more objective. Classifications were also given by Kazemi; Suzuki, Hsiao, and Misch; Ata-Ali et al. and Decker et al.^{40-42,46} Decker et al. included prognosis and Ramanauskaite and Juodzbalys evaluated peri-implantitis based on only radiographic bone level evaluation (mesial and distal).⁴⁴

The most detailed classification was given by Passi et al. in which all the important parameters required for the diagnosis of peri-implantitis were addressed.²⁶ This was the first time that the grade of implant mobility was considered. Sarmiento et al. and Canullo et al. in 2016 gave separate classifications based on the etiology of peri-implantitis.^{25,45} Tallarico et al. defined terms such as acute, chronic, localized, focalized, and generalized in terms of peri-implantitis.⁴⁸

Most of the classifications proposed have different criteria for the definition of peri-implantitis. According to the AAP classification,⁴⁷ peri-implantitis is described as radiographic evidence of bone level ≥ 3 mm and/or probing depths ≥ 6 mm in conjunction with profuse bleeding (in the absence of initial radiographs and probing depths). Thus, any system which has defined periimplantitis with pocket depth less than 6 mm or radiographic evidence of bone loss less than 3 mm cannot be incorporated as periimplantitis in actual sense by the AAP criteria⁴⁷. This necessitates the need for the introduction of a new classification system of peri-implantitis.

SUMMARY

Various classification systems have been introduced to classify peri-implantitis. Mere diagnosis of peri-implantitis is not enough as the cases of peri-implantitis is rapidly increasing. It is the duty of the clinician to be aware of the classification systems and incorporate the most appropriate system in their routine classification.

Conflict of interest: None.

NJHS

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