

Received: 2005.01.18
 Accepted: 2005.05.13
 Published: 2005.09.20

A comparison of two scoring systems for late radiation toxicity in patients after radiotherapy for head and neck cancer

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Summary

Background

The EORTC/RTOG late effects classification has been used for many years and covers nearly all organs and tissues, which may develop late radiation injuries. Dische developed a scoring system for radiation toxicity in which each clinical sign or symptom, that is characteristic for disturbance of function in an irradiated organ, is given scores for severity individually. EORTC and RTOG formed working groups to up-date their systems, for the recording of late injury to normal tissues, to be used in future clinical trials. The resulting system is called LENT-SOMA (1993).

Aim

In preparation for the introduction of the LENT-SOMA scale into clinical practice at the Centre of Oncology-Institute in Gliwice, we followed a sizeable cohort of patients using two scoring systems for the assessment of delayed radiation toxicity at each follow-up examination which took place every 6 months for up to 5 years after curative radiotherapy for head and neck cancer.

Materials/Methods

The analysed material comprised of 113 patients with oral cavity, pharyngeal or supraglottic cancer (T2-4N0-1) irradiated by conventional methods (18 patients), continuous accelerated irradiation (CAIR) (52 patients) or concomitant boost (CB) (43 patients). Total dose was in the range of 66-74 Gy. Delayed radiation toxicity was evaluated by two classification systems, those of Dische and LENT-SOMA, in the mucosal membranes, skin, larynx, salivary glands and spinal cord every 6 months after completion of radiotherapy treatment. The values in every scale were normalised (as a proportion of the maximum intensity for all symptoms) which permitted statistical comparison of the scales by use of the Wilcoxon test.

Results

Analysis of all materials indicated a difference in the intensity of late radiation toxicity as estimated by the Dische and LENT-SOMA scales. The intensity of delayed radiation toxicity in the normalised Dische scale, for mucosal membranes and for skin, had higher values than observed in the LENT-SOMA system for the majority of examined patients. In the case of the larynx and salivary glands, the opposite situation was noted. The extent of conformity between normalised scales was evaluated in the case of the spinal cord.

Conclusions

The scoring systems of Dische and LENT-SOMA can not be interchangeably used, in clinical practice, for the estimation of delayed radiation toxicity in tissues of the head and neck region. The sensitivity of the scoring systems is similar only for the evaluation of radiation reactions in spinal cord.

Key words

delayed radiation toxicity • head & neck cancer

Full-text PDF:	http://www.rpor.pl/pdf.php?MAN=7842
Word count:	2771
Tables:	11
Figures:	5
References:	15

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BACKGROUND

In the treatment of any disease, the therapeutic benefit has to be balanced against potential harmful side-effects. Radiation oncology is a special case in that critical changes in normal tissue, caused by radiotherapy, appear long after the end of treatment and usually develop gradually over a period of months and sometimes years. Often they can only be revealed by careful long-term follow up of patients, and the use of standardised examination protocols. As cancer treatment becomes more effective, and as more patients survive for longer periods, the importance of long-term morbidity will increase even further.

Innovations in radiation oncology are designed to improve the long-term control of malignant disease, but may also lead to increasing severity and frequency of untoward acute effects. Examples of such innovations include delivering higher doses to the tumour volume, new fractionation schedules such as hyperfractionation and/or accelerated fractionation and strategies for the combination of other therapeutic modalities, such as surgery or chemotherapy with radiation. The optimal therapeutic ratio will ultimately depend equally on the frequency of complete tumour clearance and on the incidence rate of unacceptable long term radiation injury to surrounding, vital, normal tissues and organs.

Methods are required for the quantitative description of the severity of signs and symptoms of progressive late radiation damage. Such methods permit a rational comparison and balance between tumour effects and the late side effects of alternative treatment protocols. The EORTC/RTOG late effects classification has been used for many years and covers nearly all organs and tissues, which may develop late radiation injuries. It is well recognised, however, that there are difficulties when comparing one study with another, since there appears to be no common language with regard to late morbidity effects. Dische [1] analysed a large number of consecutive papers in a leading

journal of radiation oncology and described considerable variability in the reporting of complications. He noted that the EORTC/RTOG scale was not consistently applied by different investigators. Therefore, Dische [1] developed a scoring system for radiation toxicity in which each clinical sign or symptom, that is characteristic for disturbance of function in an irradiated organ, is given scores for severity individually. The total sum of all the severity values for listed symptoms is the overall measure of late radiation toxicity according to this scale.

The two large organisations that initiated and coordinated the multicentre clinical trials in Europe and in North America, the EORTC [2] and the RTOG [3], formed working groups to update their systems, for the recording of late injury to normal tissues, to be used in future clinical trials. The resulting system is called LENT-SOMA and has been in use since 1993. The response of each organ or tissue included in the irradiated volume is assessed by four separate criteria: subjective symptoms, objective signs, management of signs and symptoms and the findings of special analytical investigations. In this scoring system, all four aspects play a role in defining the overall level of late radiation toxicity.

In both scoring systems, the grades vary with time after radiotherapy and need to be re-recorded each time a patient is seen in follow-up clinics.

AIM

Although numerous publications have been devoted to the subject of scoring delayed normal tissue damage after radiotherapy, no systematic study has been undertaken in which the same cohort of patients is compared by both of the recommended scoring systems. Therefore, in preparation for the introduction of the LENT-SOMA scale into clinical practice at the Centre of Oncology-MSK Institute in Gliwice, we followed a sizeable cohort of patients for a period of up to 5 years using both scoring systems at each follow-up ex-

amination. These examinations took place every 6 months for each patient.

MATERIALS AND METHODS

We systematically recorded the development of delayed normal tissue injury in 113 patients with advanced cancer of the oral cavity, pharyngeal cancer or supraglottic cancer (AJCC) T₂₋₄N₀-1M₀, who were irradiated between the years 1994 and 2000 in the Centre of Oncology in Gliwice. All patients were irradiated radically using an external megavoltage beam of Co₆₀ or X 6 MV and a two parallel opposing fields technique. All were in good condition (ZUBROD <2) and aged 70 years or less. The dose per fraction was 1.8 or 2.0 Gy. 18 patients received 5 weekly fractions of 2 Gy per fraction ("conventional"), 52 patients received 7 weekly fractions of 1.8 Gy per fraction, by continuous accelerated irradiation (CAIR), and 43 patients were irradiated with a concomitant boost schedule in which the reduced boost field was given a second dose, of 1.8 Gy, 6 hours after the dose to the large field each week (CB). The total dose was in the range of 66–74 Gy. The parameters of the 3 treatment protocols are described in Table 1.

Delayed radiation toxicity was evaluated by two classification systems, Dische and LENT-SOMA, for selected critical tissues, as follows: pharyngeal and oral cavity mucosal membranes (Table 2), skin (Table 3), larynx (Table 4), salivary glands (Table 5) and spinal cord (Table 6). Estimations were made every 6 months after completion of radiotherapy. Colour photographs of the skin and mucosal membranes were made and direct laryngoscopy was performed for assessment of changes in appearance. In order to monitor delayed radiation toxicity in a group of patients with neurological disturbances, MRI scans of the cervical spinal cord were employed. Salivary flow analysis was not performed in the investigation of the salivary glands.

The two scoring systems cover a different range of values for each organ. A completely asymptomatic patient would score 0 in both scoring systems for all organs, whereas the maximum values of each scale are different for each organ and also between organs. In order to compare the clinical usefulness of the two systems, some normalisation was required. Each recorded value was presented as a proportion of the theoretical maximum values, i.e. the sum of maximum severity scores of all S, O and M variables in the

LENT-SOMA scale and analogous criteria in the Dische scale. The Wilcoxon test was used for statistical comparison of the two scales.

RESULTS

Analysis has indicated that, for most organs, systems do not differ significantly in the quantification of delayed radiation toxicity.

Intensity in the mucosal membranes progressed to its highest level over 30 months in both scales (Figure 1). It was associated with higher values for telangiectasia and dysphagia in the Dische system than in the LENT-SOMA scale (Table 7). Superficial ulceration of the mucosal membrane was observed in one patient 6 months after radiotherapy, but healed after this period. A second patient (CB schedule) with ulceration which was developing from 18 months after completing radiotherapy to form osteoradionecrosis of mandible – was qualified for salvage surgery.

For skin, the intensity of delayed radiation toxicity in the normalised Dische scale had significantly higher values than in the LENT-SOMA scale for the majority of examined patients. The intensity of reactions increased until 24 months after treatment and then slowly stabilised in both scales (Figure 2). Atrophy and fibrosis had higher values in the Dische scale. Telangiectasia and alopecia were comparable however (Table 8).

In the case of the larynx, the intensity of delayed radiation reactions always had higher values in the LENT-SOMA scale than in that of Dische (Figure 3). No ulceration, chondritis or necrosis was observed according to Dische system. Hoarseness and oedema rose to moderately high values up to 24 months after irradiation but subsequently decreased. Telangiectasia remained stable during the whole period of observation and dyspnoea on exertion, observed in three patients, was no longer evident after 30 months (Table 9).

The intensity of delayed radiation effects on the salivary glands increased over the course of the first 30 months after the conclusion of radiotherapy, according to the LENT-SOMA system, and for 12 months according to the Dische scale. After this period, the effects diminished until 60 months after completion of therapy (Figure 4). Dryness of mouth and consistency of saliva after irradiation had higher values in the Dische scale. Generally, the intensity of reactions in the salivary glands was rated higher in the LENT-SOMA

Table 1. Physical parameters of irradiation.

CAIR, CB		Conventional radiotherapy
68.4–72.0	total dose (Gy)	66.0–74.0
1.8	fraction dose (Gy)	2.0
7×/week	fractionation method	5×/week
38–40	total treatment time (days)	45–55

Table 2A. Delayed radiation reactions of the mucosa according to Dische's scale.

	0	1	2	3	4
dysphagia	no	some discomfort in swallowing, no disturbance of diet	difficulty in swallowing, soft diet required	considerable difficulty in swallowing, fluids only	severe difficulty in swallowing fluids
atrophy	nil	yes			
telangiectasia	nil	minimal	distinct	severe	
ulceration					
– depth	nil	superficial	deep		
– distribution	nil	patchy			
orocutaneous fistula	no	yes			

Table 2B. Delayed radiation reactions of the mucosa according to the LENT-SOMA scale.

Stage	1	2	3	4
subjective				
pain	occasional & minimal	intermittent & tolerable	persistent & intense	refractory & excruciating
dysphagia	difficulty eating solid food	difficulty eating soft food	can take liquids only	totally unable to swallow
taste alteration	occasional, slight	intermittent	persistent	
objective				
mucosal integrity	patchy atrophy or TELANGIECTASIA	diffuse atrophy or TELANGIECTASIA, superficial ulcer	deep ulcer with no bone or cartilage exposure	deep ulcer with bone or cartilage exposure
management				
pain	occasional, non narcotic	regular, non-narcotic	regular, narcotic	surgical intervention
ulcer		cleanse	antibiotics or oxidants	surgical intervention
dysphagia	lubricants, diet modification	non narcotic	narcotic	PEG tube and/or surgical intervention
taste alteration	minor diet changes (non-acidic)	minor diet changes (semi-soft)	major diet changes (soft)	major diet changes (liquid)
analytic				
colour photo	assessment of changes in appearance			
cytology, biopsy	rule out persistent tumor			
smear, culture, anti-fungal trial	rule out candidiasis			

Table 3A. Delayed radiation reactions of the skin & subcutaneous tissues according to Dische's scale.

	0	1	2	3	4
pigmentation	nil	slight increase	moderate increase	very marked	decrease
telangiectasia	nil	slight	moderate	marked	
atrophy	nil	mild	moderate	severe	
hair loss	nil	slight	moderate	complete	
sweating	no change	definite reduction	absent		
subcutaneous tissues					
– induration fibrosis	nil	slight	moderate	severe	
– subcutaneous fat loss	nil	slight	moderate	severe	

Table 3B. Delayed radiation reactions of the skin & subcutaneous tissues according to the LENT-SOMA scale.

Stage	1	2	3	4
subjective				
scaliness/roughness	present/asymptomatic	symptomatic	require constant attention	
sensation	hypersensitivity, pruritus	intermittent pain	persistent pain	debilitating dysfunction
objective				
oedema	present/asymptomatic	symptomatic	secondary dysfunction	total dysfunction
alopecia (scalp)	thinning	patchy, permanent	complete, permanent	
pigmentation change	transitory, slight	permanent, marked		
ulcer / necrosis	epidermal only	dermal	subcutaneous	bone exposed
TELANGIECTASIA	minor	moderate <50%	gross ≥50%	
fibrosis/scar	present / asymptomatic	symptomatic	secondary dysfunction	total dysfunction
atrophy/contraction	present / asymptomatic	symptomatic/<10%	secondary dysfunction/ 10–30%	total dysfunction/>30%
management				
dryness			medical intervention	
sensation		intermittent medical intervention	continuous medical intervention	
ulcer			Medical intervention	Surgical intervention/ amputation
oedema			Medical intervention	Surgical intervention/ amputation
fibrosis / scar			Medical intervention	Surgical intervention/ amputation
analytic				
colour photographs	assessment of changes in appearance			

Table 4A. Delayed radiation reactions of the larynx according to Dische's scale.

	0	1	2
ulceration	nil	superficial	deep
chondritis	no	yes	
necrosis	nil	yes	

Table 4B. Delayed radiation reactions of the larynx according to the LENT-SOMA scale.

Stage	1	2	3	4
subjective				
pain	occasional & minimal	intermittent & tolerable	persistent & intense	refractory & excruciating
voice/hoarseness	occasional hoarseness on prolonged use	intermittent hoarseness, voice unreliable, varies in day-to-day communication	persistent hoarseness, incapable of normal communication	complete loss of voice
breathing	occasional difficulty	intermittent difficulty	laboured breathing	stridor
objective				
edema	arytenoids only	arytenoids and aryepiglottic folds	diffuse edema of the supraglottis, airway adequate	diffuse with significant narrowing of airway, <1/2 normal
mucosal integrity	patchy atrophy, TELANGIECTASIA	complete atrophy, extensive TELANGIECTASIA	ulcer, cartilage not exposed	necrosis, cartilage exposed
respiration		dyspnoea on exertion	labored at rest	stridor et rest
management				
pain	occasional non-narcotic	regular non-narcotic	regular narcotic	surgical intervention
hoarseness		rest voice, or whisper only	no talking or whispering	laryngectomy
respiration		humidifier, steroids	temporary tracheostomy	permanent tracheostomy
analytic				
indirect laryngoscopy	assessment of oedema, mucosal integrity, vocal cord motion, ulcer, necrosis			
direct laryngoscopy	assessment of oedema, mucosal integrity, vocal cord motion, ulcer, necrosis			
CT	assessment of oedema, necrosis, asymmetry			
MRI	assessment of oedema, necrosis, asymmetry			

Table 5A. Delayed radiation reactions of the salivary glands according to Dische's scale.

	0	1	2	3
dryness of mouth	nil	mild	moderate	severe
saliva – consistency	normal	watery	thick	sticky
loss of taste	nil	minimal	partial	marked
induration	no	minimal	definite	marked

Table 5B. Delayed radiation reactions of the salivary glands according to the LENT-SOMA scale.

Stage	1	2	3	4
subjective				
xerostomia	occasional dryness	partial but persistent dryness	complete dryness, non-debilitating	complete dryness, debilitating
objective				
saliva	normal moisture	scant saliva	absence of moisture, sticky, viscous saliva	absence of moisture, coated mucosa
management				
xerostomia		occasional saliva substitute, sugarless candy or gum, sialogogues	frequent saliva substitute or water sugarless candy or gum sialogogues	needs saliva substitute or water in order to eat sugarless candy or gum sialogogues
analytic				
salivary flow/quantity/stimulation	76–95% of pre-treatment	51–75% of pre-treatment	26– 50% of pre-treatment	0–25% of pre-treatment

Table 6A. Delayed radiation reaction of the spinal cord according to Dische’s scale.

	0	1	2	3	4
lhermitte’s syndrome	nil	yes			
paresthesia	nil	slight	moderate	marked	
paraparesis	nil	mild	moderate	severe	complete
sensory loss	no	mild	moderate	marked	complete
bladder function	no change	impaired	lost		
radiology spinal cord	no	yes			
anal sphincter function	no change	impaired			
limb movement limitation					

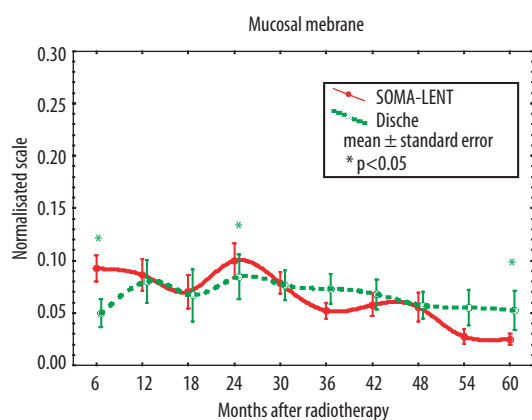


Figure 1. Mean values for delayed radiation toxicity according to two scoring systems, LENT-SOMA and Dische, following post-radiotherapy examinations.

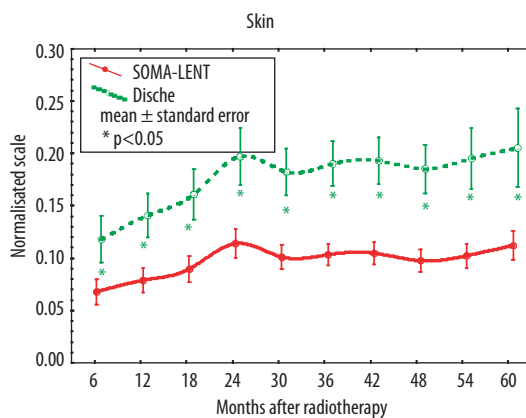


Figure 2. Mean values for delayed radiation toxicity in the skin according to two scoring systems, LENT-SOMA and Dische, during follow-up examinations after radiotherapy.

Table 6B. Delayed radiation reactions of the spinal cord according to the LENT-SOMA scale.

Stage	1	2	3	4
subjective				
paresthesia (tingling sensation, shooting pain, hermitte's syndrome)	occasional & minimal	intermittent & tolerable	persistent & intense	refractory & excruciating
sensory (numbness)	minimal change	mild unilateral sensory loss	partial unilateral sensory loss; needs assistance for self care	total loss of sensation, danger of self-injury
motor (weakness)	minor loss of strength	weakness interfering with normal activities	persistent weakness preventing basic activities	paralysis
sphincter control	occasional loss	intermittent loss	incomplete control	complete incontinence
objective				
neurological evaluation	barely detectable decrease in sensation or motor weakness on one side	easily detectable decrease in sensation or motor weakness on one side, disturbs but does not prevent function	full brown-sequard syndrome, loss of sphincter function, prevents function	complete transection, disabling, requiring continuous care
management				
pain	occasional non narcotic medication	persistent non-narcotic medication, intermittent low dose steroids	intermittent high dose steroids	persistent high dose steroids
neurological function	needs minor adaptation to continue working	regular physiotherapy	intensive physiotherapy plus regular supervision	intensive nursing
incontinence	occasional use of incontinence pads	intermittent use of incontinence pads	regular use of incontinence pads or self-catheterisation	permanent use of pads or catheterisation
analytic				
MRI	edema	localized demyelination	extensive demyelination	necrosis
CT	assessment of swelling, edema, atrophy			
MRS	assessment of chemical spectra			
PET	assessment of metabolic activity			
serum	assessment of myelin basic protein levels			
CSF	assessment of total protein and myelin basic protein			

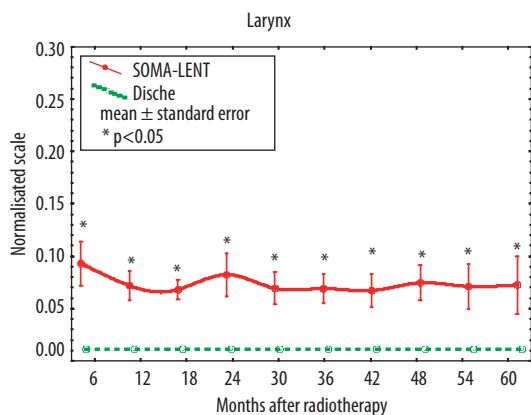


Figure 3. Mean values for delayed radiation toxicity in the larynx according to two scoring systems, LENT-SOMA and Dische, during follow-up examinations after radiotherapy.

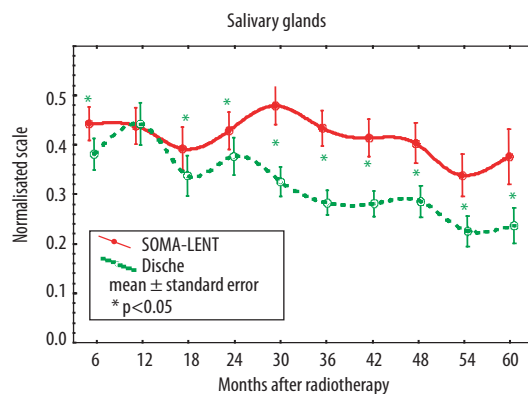


Figure 4. Mean values for delayed radiation toxicity in the salivary glands according to two scoring systems, LENT-SOMA and Dische, during follow-up examinations after radiotherapy.

Table 7. Mean normalised values for examined signs and symptoms in the mucosal membrane.

Mucosal membrane	months after radiotherapy									
	6	12	18	24	30	36	42	48	54	60
LENT-SOMA										
subjective										
pain	0.11	0.03	0.03	0.06	0.04	0.03	0.03	0.05	0.03	0.03
dysphagia	0.09	0.13	0.12	0.12	0.12	0.07	0.08	0.07	0.03	0.03
taste alteration	0.26	0.27	0.17	0.24	0.13	0.07	0.09	0.10	0.02	0
objective										
mucosal integrity	0.06	0.10	0.09	0.13	0.12	0.12	0.13	0.09	0.11	0.12
weight	0.13	0.10	0.09	0.14	0.12	0.08	0.08	0.10	0.04	0.01
management										
pain	0.02	0.02	0	0	0	0.01	0.01	0.02	0	0
ulcer	0.01	0	0.02	0.02	0	0	0	0	0	0
dysphagia	0.09	0.06	0.07	0.09	0.09	0.05	0.05	0.03	0.01	0.03
taste alteration	0.07	0.06	0.06	0.09	0.08	0.04	0.06	0.05	0.02	0.01
dische										
dysphagia	0.10	0.14	0.13	0.16	0.13	0.10	0.10	0.11	0.04	0.05
atrophia	0.08	0.16	0.07	0.11	0.10	0.11	0.12	0.09	0.11	0.05
telangiectasia	0.09	0.18	0.14	0.19	0.22	0.23	0.19	0.14	0.18	0.21
ulceration – depth	0.03	0	0.03	0.03	0	0	0	0	0	0
ulceration – distribution	0.01	0	0.03	0.03	0	0	0	0	0	0
orocutaneous fistula	0	0	0	0	0	0	0	0	0	0

system, because less symptoms are taken into account than in the Dische system. The management of dryness is an important issue after irradiation and, in our material, the high values stabilised between 6 and 60 months after completion of therapy. (Table 10).

Conformity of the normalised scales was evaluated for the spinal cord. Significant progression of (mild, functional) delayed toxicity was observed during the second year of treatment (Figure 5). Higher levels were observed in the Dische system after 24 months, owing to the influence of normalised values for Lhermitte's syndrome (Table 11).

DISCUSSION

We report observations on the development of late normal tissue damage in several critical or-

gans over a period of up to 5 years. These observations were made in a fixed cohort of patients, at 6 month intervals, by a single observer. The organs examined are often included in the planning of radiotherapy target volumes in cases of head and neck cancers such as those of the oral and pharyngeal mucosal membranes, skin, larynx, salivary glands and spinal cord. The clinical observations at each examination were documented in parallel using the LENT-SOMA and Dische scoring systems. Analysis permitted definition of intensity and study of the dynamics of delayed radiation reactions during follow-up.

The degree of radiation damage to the mucosal membranes varies widely according to the size of the dose, the quality of radiation and dosing schedules. Atrophy, ulceration and fibrosis are induced to varying degrees in the oropharyngeal mucosal membrane. During a one to

Table 8. Mean normalised values for signs and symptoms in the skin.

Skin	months after radiotherapy									
	6	12	18	24	30	36	42	48	54	60
LENT-SOMA										
subjective										
scaliness/roughness	0.05	0.04	0.04	0.09	0.03	0.06	0.07	0.03	0.02	0.04
sensation	0.03	0	0.02	0.02	0.01	0	0	0.01	0.01	0.01
objective										
oedema	0.07	0.08	0.03	0.04	0.02	0.03	0.01	0.02	0.01	0.01
alopecia (scalp)	0.38	0.51	0.46	0.48	0.43	0.42	0.47	0.45	0.51	0.51
pigmentation change	0.22	0.25	0.32	0.41	0.40	0.41	0.38	0.39	0.39	0.39
ulcer/necrosis	0.01	0	0.03	0.03	0	0	0	0	0	0
telangiectasia	0.08	0.12	0.18	0.25	0.24	0.25	0.24	0.22	0.21	0.26
fibrosis/scar	0.06	0.04	0.08	0.10	0.09	0.09	0.11	0.12	0.12	0.13
atrophy/contraction	0.03	0.04	0.05	0.11	0.08	0.10	0.09	0.06	0.09	0.12
management										
dryness	0.02	0	0.03	0.05	0.09	0.06	0.07	0.05	0.05	0.07
sensation	0	0	0	0	0	0	0	0	0	0
oedema	0	0	0	0	0.01	0.01	0	0	0	0
fibrosis/scar	0.02	0	0	0	0	0	0	0	0	0
ulcer	0	0	0	0	0	0	0	0.01	0	0
dische										
pigmentation	0.10	0.13	0.16	0.20	0.19	0.20	0.18	0.20	0.20	0.24
telangiectasia	0.09	0.14	0.16	0.21	0.24	0.26	0.25	0.24	0.24	0.26
atrophy	0.05	0.08	0.09	0.14	0.13	0.13	0.12	0.12	0.12	0.16
hair loss	0.41	0.53	0.52	0.50	0.46	0.42	0.46	0.44	0.49	0.44
sweating	0.06	0.02	0.03	0.05	0.05	0.04	0.05	0.02	0.04	0.03
subcutaneous tissues – induration fibrosis	0.09	0.04	0.11	0.14	0.11	0.14	0.16	0.15	0.15	0.14
subcutaneous tissues –subcutaneous fat loss	0.04	0.04	0.07	0.11	0.09	0.12	0.13	0.11	0.14	0.16

five year period, there is a generally continuous chronic stage, and even a slow progression to the degree of fibroatrophy with telangiectasia in some areas [4]. In the analysed material, we observed a stabilisation in radiation reactions of the mucosal membranes from 36 months, according to the LENT-SOMA system, and from 30 months by the Dische scale (Figure 1). The intensity of delayed effects in the mucosal membranes was decreasing and, we noticed, lower grades were being recorded for dysphagia and taste alteration.

Generally, the same radiation-induced responses and lesions, which have been described for the mucosal membrane, are also induced to varying degrees in the skin. After the first year, the skin in the treatment field is depigmented and atrophied, with some retraction. Telangiectasia may be diffusely distributed throughout the entire field. Chronic changes may include epilation and suppression of glandular activity. Ulceration occurs rarely and often is associated with re-irradiation. The deep fibrosis sometimes noticed after radiotherapy now occurs seldomly and is more a

Table 9. Mean normalised values for signs and symptoms in the larynx.

Larynx	months after radiotherapy									
	6	12	18	24	30	36	42	48	54	60
LENT-SOMA										
subjective										
pain	0.09	0.04	0.04	0.05	0.03	0.03	0.02	0.04	0.03	0.04
voice/hoarseness	0.23	0.21	0.22	0.24	0.17	0.18	0.17	0.15	0.16	0.13
breathing	0.06	0.04	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.04
objective										
oedema	0.18	0.12	0.11	0.13	0.10	0.06	0.10	0.10	0.09	0.08
mucosal integrity	0.05	0.07	0.09	0.11	0.11	0.11	0.09	0.10	0.11	0.10
respiration	0.05	0.02	0	0	0.02	0	0	0.01	0	0
management										
pain	0.02	0.01	0.01	0.01	0	0.01	0.01	0.01	0	0
hoarseness	0.03	0.02	0.01	0.03	0.02	0.02	0.03	0.04	0.05	0.08
respiration	0.02	0	0	0.04	0.04	0.06	0.07	0.06	0.05	0.08

Table 10. Mean normalised values for signs and symptoms in the salivary glands.

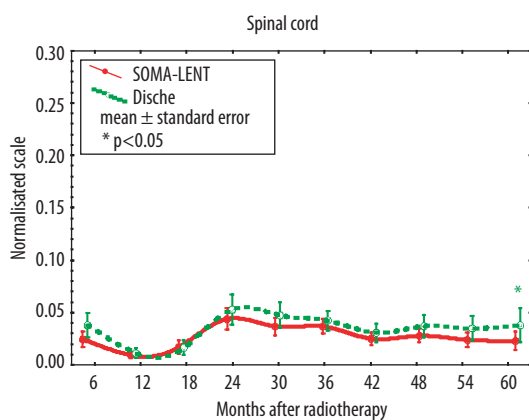
Salivary glands	months after radiotherapy									
	6	12	18	24	30	36	42	48	54	60
LENT-SOMA										
subjective										
xerostomia	0.43	0.47	0.40	0.39	0.39	0.38	0.35	0.34	0.29	0.33
objective										
saliva	0.53	0.63	0.54	0.59	0.58	0.55	0.53	0.53	0.49	0.49
management										
xerostomia	0.33	0.19	0.23	0.28	0.40	0.34	0.33	0.31	0.24	0.30
dische										
dryness of mouth	0.61	0.64	0.52	0.54	0.53	0.49	0.50	0.47	0.35	0.37
saliva – consistency	0.63	0.77	0.62	0.68	0.65	0.58	0.56	0.58	0.57	0.61
loss of taste	0.25	0.28	0.17	0.21	0.10	0.07	0.08	0.11	0.05	0.02
induration	0.03	0.03	0.07	0.08	0.04	0.04	0.05	0.04	0.04	0.04

cosmetic defect than a functional one [5]. In our material, the average values for delayed reactions of the skin showed increases up to 24 months after treatment according to both scales, but stabilised during the period 30–60 months after treatment (Figure 2). Telangiectasia was the most frequently observed symptom, along with minimal fibrosis and epilation of the chin region in males.

Laryngeal chondronecrosis occurs rarely (<1%) at conventional daily fractions of 2.0 Gy to total doses of 70 Gy [6]. If larger daily fractions are used, the risk increases. Chondronecrosis may result as a complication when irradiation is employed in the treatment of extensive laryngeal carcinomas. The irradiation of tumours, which invade and destroy the epiglottis, thyroid or arytenoid car-

Table 11. Mean normalised values for signs and symptoms in the spinal cord.

Spinal cord	months after radiotherapy									
	6	12	18	24	30	36	42	48	54	60
LENT-SOMA										
subjective										
paresthesia (tingling sensation, shooting pain, lhermitte's syndrome)	0.06	0.02	0.03	0.09	0.07	0.07	0.04	0.05	0.05	0.05
sensory (numbness)	0.04	0.01	0.03	0.08	0.07	0.06	0.04	0.06	0.05	0.05
motor (weakness)	0.01	0.01	0.02	0.03	0.03	0.04	0.03	0.02	0.01	0
sphincter control	0.01	0	0	0.02	0.01	0	0	0	0	0
objective										
neurologic evaluation	0.03	0.01	0.03	0.07	0.06	0.07	0.04	0.04	0.04	0.04
management										
pain	0	0	0.01	0	0.01	0	0	0.01	0	0
neurologic function	0	0	0	0.01	0	0	0	0	0	0
incontinence	0	0	0	0	0	0	0	0	0	0
dische										
lhermitte's syndrome	0.15	0.03	0.03	0.19	0.18	0.15	0.12	0.11	0.14	0.16
paresthesia	0.08	0.02	0.04	0.11	0.11	0.10	0.08	0.10	0.08	0.09
paraparesis	0.01	0	0	0.01	0.00	0.01	0.00	0.01	0	0
sensory loss	0.02	0	0.02	0.04	0.03	0.03	0.01	0.02	0.01	0.01
bladder function	0	0	0	0.01	0	0	0	0	0	0
radiology spinal cord	0	0	0	0	0	0	0	0	0	0
anal sphincter function	0	0	0	0	0	0	0	0	0	0
limb movement limitation	0	0	0	0.01	0	0.01	0	0.01	0	0

**Figure 5.** Mean values for delayed radiation toxicity in the spinal cord according to two scoring systems, LENT-SOMA and Dische, during follow-up examinations after radiotherapy.

tilages is a calculated risk. Another radiation related complication of laryngeal treatment, which is more common than chondronecrosis, is laryngeal oedema. The TD 5/5 and TD 50/5 of 50 Gy and 70 Gy respectively are based on the literature [7]. Fu [8] noted a 13.7% incidence of laryngeal oedema at doses lower than 70 Gy, rising rapidly to 46.2% at doses of 70 Gy and above.

In our material, the intensity of delayed radiation reactions in the larynx always scored higher on the LENT-SOMA scale than on that of Dische (Figure 3). Oedema of the arytenoido-epiglottidean plica and arytenoid regions was noted in our patients as stabilising at a very low level 24 months after irradiation. Ulceration, chondrolysis and necrosis, basic symptoms in the Dische scale, did not occur and thus a value of "0" was recorded for every patient

in the analysed cohort. Clinical advancement of laryngeal cancer in two patients required tracheotomy before treatment, and cicatrization within the larynx did not allow for de-cannulation. No patients required tracheotomy after irradiation.

Dryness of the mouth, associated with decreasingly moist saliva, is an important symptom after irradiation of the head and neck region. Generally, if some portion of the major salivary gland has been spared, dryness of the mouth subsides after 6 to 12 months. If xerostomia persists beyond one year, the chance of a significant return of function and flow is less likely. A major secondary complication is the development of radiation induced caries and mandibular necrosis [5]. Tolerance doses (TD 50/5) differ in range, 40–65 Gy according to Mossman and al. [9] and 70 Gy according to Rubin and Cassaret [5]. In our material, a significant portion of the salivary glands were included into the target volumes and total doses were in the range of 66–74 Gy. The intensity of radiation toxicity for the salivary glands increased up to 30 months after completion of therapy according to the LENT-SOMA scale, but later decreased. The intensity of delayed effects as ascertained by the Dische system showed increases to 24 months followed by decreases to 60 months (Figure 4). Dryness of the mouth was a persistent symptom in the majority of patients.

Spinal cord radiation toxicity can be characterised by different symptoms. Paresthesia (shooting pain) and Lhermitte's syndrome, numbness, motor weakness and loss of sphincter control, were assessed in a neurological examination to identify a cumulative cord level. Clinically, Lhermitte's syndrome occurs 2–4 months after irradiation and then persists or returns at 6 months. Paresis, numbness, altered sphincter control appearing at 6 to 12 months with progression comprise the classic onset of radiation-induced spinal cord transaxion [10]. The length of the latent period decreases with increasing dose and appears to be shorter among children who develop radiation myelopathy than among adults [11]. The latent period is also decreased after more than one treatment course to the same segment of spinal cord [12]. The most widely observed dose limit for the spinal cord is 45 Gy in 22–25 fractions with an incidence of myelopathy of less than 0.2% [13]. The TD5/5 level is probably between 57 and 61 Gy and the TD50 is between 68 and 73 Gy. No volume effect has been shown. Shortening the interval from 23 hours to between 6 and 8 hours reduces spinal cord tolerance by 10% to 15% [14]. While neurological examination has an important role in clinical detection, the most important area is radiological imaging. MRI scans may show cord swelling or

atrophy, decreased intensity on T1-weighted images, or increased intensity on T2-weighted images. Such changes are indicative of oedema, necrosis or demyelination patterns [15].

In the analysed material, the peak intensity for spinal cord radiation toxicity was observed 24 months after radiotherapy with good conformity between scoring systems. All patients were examined regularly by a single neurologist every 6 months after irradiation. MRI scans of the spinal cord were performed in 20 patients (17.5%) who presented with neurological complications during clinical examinations at follow-up. There were no radiological abnormalities within the spinal cord and any neurological problems were found to be associated with cervical spondylosis.

In summary, the progress of late radiation reactions in the mucosal membranes, skin, larynx, salivary glands and spinal cord, may be evaluated by the scoring systems of Dische and LENT-SOMA. The extent of conformity of the normalised scales was evaluated in the case of the spinal cord because the component symptoms of delayed radiation reactions, and measures of their intensity, are similar in every scoring system. Management and analytical methods play an important role in the assessment of delayed radiation reaction intensity for all of the examined tissues and it is therefore necessary to include them, as proposed in the LENT-SOMA system.

CONCLUSIONS

1. The scoring systems, Dische and LENT-SOMA, can not be used interchangeably in clinical practice, for the estimation of delayed radiation toxicity in tissues of the head and neck region.
2. The LENT-SOMA scoring system is more precise, in our opinion, than the Dische scale, but will require further exploration.

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