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Optimisation of the CT parameters with evaluation of MDCT double-scan images in the planning of the dental implant treatment

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Summary

Background: The aim of the present study was optimisation of the examination parameters and evaluation of reliability of the MDCT double-scan images obtained with computer navigation for dental implant treatment.

Material/Methods: With the use of a MDCT scanner SOMATOM Sensation (Siemens), CT-images of a phantom were performed: slice-collimation (10×0.75 mm, 10×1.5 mm), slice-thickness (0.75, 1, 2, 3, 5 mm), pitch (0.5, 1, 1.5). Additionally, the analysis on various filters from H20f to H60f was performed. For study used a phantom of the human cadaver head

Qualitative analysis was done using Nobel Guide (Nobel Biocare, Sweden), assessing possible artefacts on the images, and measurements of the bone structure on all filters in comparison with the real image.

Results: The quality of the phantom images was assessed as optimal for the slices thickness 0.75 and 1 mm. The use of various values of the pitch did not have statistically significant difference on the image quality. Application of various filters did not alter the parameters of the bone structure, however the use of lower filters (H30f and H40f) had a beneficial effect on the quality of 3D reconstruction. The arrangement of the "window" parameters in CT seemed to have a greater influence on the measurement and evaluation of the bone structure.

Conclusions: Slice-collimation and slice-thickness are the most important parameters in selection of the optimal scan-protocol. It is recommended to use in the postprocessing, the mentioned above parameter succession with the application of various filters (H30f and H60f) at a stable arrangement of the "window" in the CT examination.

Key words: **computer simulation • dental implants • human cadaver • three-dimensional • computer-assisted • computed tomography**

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Background

The development of the software used for CT data processing allowed for introduction of new solutions in the diagnostic evaluation of images. An important step was the creation of systems of computer-aided detection that make the evaluation of images carried out by radiologists easier and more precise, by revealing pathological lesions. The widest application of CAD can be found in mammography. However, these systems are also becoming increasingly popular in computed tomography, magnetic resonance imaging and dental examinagions [1,2]. They make the diagnosis more objective.

Modern techniques of CT imaging wield enormous influence on the development of implantology. At present, every procedure of dental implantation is fully based on data obtained in the course of CT. This allows for a precise evaluation of the osseous structure in location of the planned procedure. CT provides us with all possible measurements of the bone, so that it is possible to use the longest implants, guaranteeing the best stabilisation [3]. The safety of the procedure gets significantly increased when we localise such structures as the sinuses, nerves and vessels (their course) and when we detect possible pathologies. For the last few years, the systems of computer-planned implantation have been the basis of implantology. They changed the way of procedure performance and introduced many new solutions. The first system of that kind was NobelGuide™, presented in 2003 by a Swedish company, Nobel Biocare. Simulation of the implant procedure in the program bases on a 3D reconstruction of the maxilla or the mandible [4]. After an exact analysis and determination of an optimal location for an implant within the bone, special surgical templates are prepared, ensuring the precision of the procedure and minimising potential surgical mistakes. Systems of virtual implantation are connected with an introduction of techniques of immediate loading. The classic procedure involves two treatment stages: first, there is the introduction of the intraosseous element, and then, after some time required for a proper osteointegration, proceeds attachment of the external part and fixation of the prosthetic implant. Owing to the system of virtual planning, the prosthetic implant is designed before the procedure. With no contraindications, the implant is fixed right after its placement. This technique is a breakthrough in implantology, as it shortens the treatment time, reduces the degree of invasiveness and is aesthetically advantageous for the patients [5].

Modern techniques of immediate loading, based on three-dimensional images of the maxilla or the mandible, enable the performance of a virtual procedure with the use of specialised programs. Computer planning of the procedure involves: quantitative and qualitative evaluation of the osseous structures, determination of the course of nerves and vessels and location of the sinuses. This analysis allows for the establishment of an optimal intraosseous implant location, which increases the odds of a correct osteointegration and enhances the safety and precision of the procedure.

Virtual planning bases on a 3D processing of the data obtained during CT. Proper performance of the CT examination is essential for a reliable analysis and a full application of the possibilities of the planning system. The fulfilment of the aforementioned conditions depends on the right choice of the examination parameters, which will result in the production of images of the highest quality, with the possibly lowest rate of radiation dose at the same time [6].

Aim of the work

The aim of the work was to optimise the examination parameters and to evaluate the reliability of the images obtained in the MDCTdouble-scan technique, in the planning of dental implantation procedures.

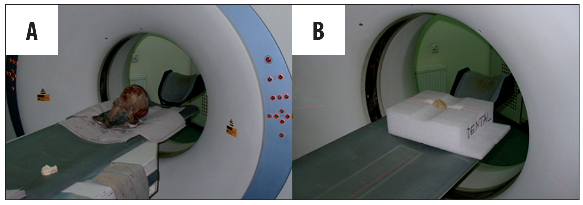

Figure 1. Double-scan CT. (**A**) phantom with a radiological template in the mouth, (**B**) radiological template.

Material and Methods

Study material and equipment

CT examinations were conducted with the use of a human cadaver head, in the double-scan technique, with a 10-row Somatom Sensation 10 scanner (Siemens).

The following constant parameters were used:
- Lamp voltage – 120 kV,
- Lamp current intensity – 80 mAs,
- Lamp rotation time – 0.5 sec.

Double-scan technique

This technique involves two acquisitions of the maxilla and the mandible in a specific way (Figure 1).

In case of patients, the first stage involves CT visualisation of the phantom with radiographic template in the mouth. In the second stage, the radiographic template is scanned alone. The precondition of a correct performance of the second-phase scanning is a proper placement of the radiographic template in the gantries, exactly in the same position as it was seen in the mouth of the examined person. This requires application of a pad made of material absorbing x-rays, e.g. polystyrene foam. Scanning of the radiographic template uses the same parameters as in the first stage of examination.

In this study, the template was placed in the phantom's mouth.

Conducted examinations and analysis methods

In order to examine the influence of some selected acquisition parameters on the quality of obtained CT images, we analysed: slice thickness, pitch, reconstruction interval, and collimation. Different filters, used in the process of secondary reconstruction, and their influence on image quality, was also evaluated. This required so called digital processing of the data, performed with a diagnostic console of CT, after the scanning stage. Digital processing let us obtain secondary reconstructions of the images, for the following values of the examined parameters:
- Slice thickness: 0.75, 1, 1.5, 2, 3, 4 i 5 mm,
- Pitch: 0.5, 1 and 1.5,
- Reconstruction interval: 50% and 100%,
- Collimation: 10x0.75 mm and 10x1.5 mm,
- Filters: H20f, H30f, H40f, H50f and H60f.

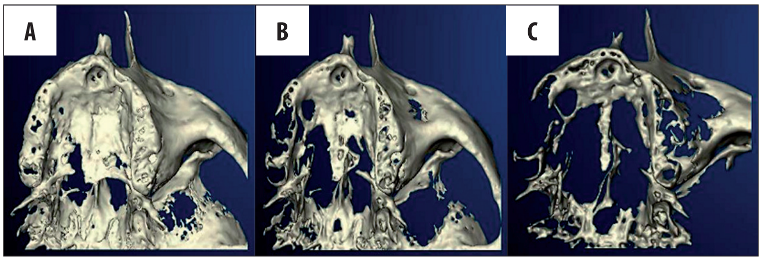

Figure 2. Examples of the images rated as (from the left): optimal, good, poor; at pitch =0.5 and (**A**) slice thickness =0.75 mm, overlap 50%, (**B**) slice thickness 2 mm, overlap 50%, (**C**) slice thickness =2 mm, overlap =100%.

Table 1. Qualitative analysis. Number of optimal, good, and poor images, depending on the presence of geometrical distortions and artefacts. The results were added up for all pitch values, reconstruction intervals of 50% and 100%. The applied collimation amounted to 10×0.75 mm.

Slice thickness [mm]	Geometrical distortion			Artefacts			Final evaluation result		
	Optimal	Good	Poor	Optimal	Good	Poor	Optimal	Good	Poor
0.75	6			2	4		8	4	
1	3	3		3	3		6	6	
1.5	1	5		2	2	2	3	7	
2		3	3	2	1	3	2	4	6
3		1	5			6		1	11
4			6			6			12
5			6			6			12

We obtained images at all possible combinations of: slice thickness, pitch, reconstruction interval, and collimation. All these reconstructions applied bone filter H60f. In two selected images with the best parameters, all possible filters were used: from H20f to H60f. As a result, we obtained 76 protocols. Next, a 3D reconstruction of the data was carried out with the use of two algorithms: SSD - surface shade display, and VR – volume rendering.

Data presented in this way, in the DICOM format, were recorded on CD-ROMs and transferred on PCs.

The qualitative analysis applied 3D reconstructions of the data and was carried out in the eFilm program, Workstation 1.5.3, MERGE Healthcare company. This program allows for image review, comparison, enlargement of some chosen structures, and performance of measurements, in order to establish possible image distortions.

We analysed potential geometrical distortions and artefacts. Geometrical distortions were defined as changes of image dimensions (elongation or shortening of the image), while the artefacts – as distortions of the image surface (creases and folds).

The evaluation was based on a three-stage scale (Figure 2), defined in the work by Laghi et al. [7]:

- Optimal image – image of the highest quality, sharp outlines, without geometrical distortions or artefacts,
- Good image – image worse than the optimal one, but without significant deviations. Minor distortions or artefacts may be present,
- Poor image – image of low quality; visible distortions and artefacts of substantial degree.

The evaluation was performed by two independent observers. Next, the examination results were merged and objectified on a joint session.

The statistical analysis was carried out with the use of the Fisher test.

Results

Influence of the slice thickness on the quality of CT images

Juxtaposition of the results of phantom imaging with the number of geometrical distortions and artefacts was presented in Table 1. Scans of the highest quality were obtained when the slices measured 0.75 and 1 mm. The slice thickness of 1.5 mm was also evaluated as good. When compared to the slice thickness of 1 mm, some minor artefacts on the surface of the evaluated structures in the 1.5-milimiter slices were revealed. However, they were not significant. We concluded that "slice thickness' parameter has the highest influence on the quality of the obtained images.

Slice thickness of 2 mm is the highest one that can be used for the purposes of 3D reconstructions. The comparison of the results obtained with the best slices (0.75 mm, 1 mm) and with the 2-milimeter slices, confirmed by an exact Fisher test (P=0.007), points to a strong correlation between the quality of the images and slice thickness. This

Table 2. Comparison of the quality of images performed with reconstruction interval equal to 50% and 100%, with slice thickness of 2 mm.

Reconstruction interval	Geometrical distortion			Artefacts		
	Optimal	Good	Poor	Optimal	Good	Poor
50%		3		2	1	
100%			3			3

Table 3. Qualitative analysis. Number of optimal, good, and poor results, with collimation of 10×0.75 and reconstruction interval of 50% and 100%.

Slice thickness [mm]	Reconstruction interval 50% and 100%											
	Geometrical distortion						Artefacts					
	Optimal		Good		Poor		Optimal		Good		Poor	
	50%	100%	50%	100%	50%	100%	50%	100%	50%	100%	50%	100%
0.75	3	3					1	1	2	2		
1	3			3			3			3		
1.5	1		2	3			2		1	1		2
2			3			3	2		1			3
3			1		2	3					3	3
4					3	3					3	3
5					3	3					3	3

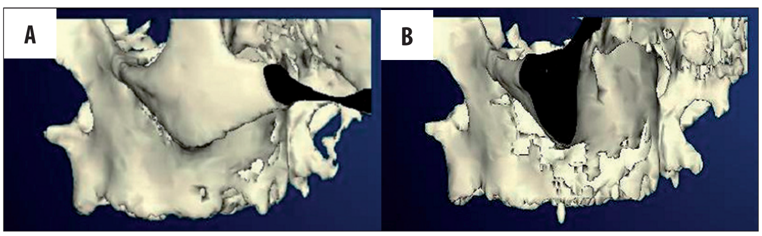

Figure 3. Images at slice thickness amounting to 2 mm, pitch 0.5, reconstruction interval of (**A**) 50%, (**B**) 100%.

means that the 2-milimiter slice should not be used for the creation of 3D images and for the purposes of the treatment procedure. The analysis of all images obtained at this slice thickness showed that their quality is highly dependent on other parameters, especially the reconstruction interval.

The sine qua non condition for the use of 2-milimeter slices is the application of the reconstruction interval of 50%, at which such slices were evaluated as good. However, a very specific comparison of the structures in the 2-milimeter slices and in thinner ones showed some appearing artefacts within the observed structures, as well as minor geometrical distortions. Although the image was good, the observed artefacts could result in misrepresentations and inaccuracies in the virtual preoperative planning. That is why, the slices measuring 0.75 mm, 1 mm, and 1.5 mm are much more advantageous (Table 2).

Irrespective of other examination parameters, slice thickness equal to 3, 4, and 5 mm results in images of a very low quality. Such images cannot be used in the planning of dental implant treatment.

Influence of the reconstruction interval on image quality

Table 3 presents the juxtaposition of the phantom imaging results with respect to the number of geometrical distortions and artefacts, at collimation 10×0.75 mm, at three values of pitch and at reconstruction interval of 50% and 100%.

In the scans performed at reconstruction interval of 100%, there were much larger distortions, folds and defects in bone structure – even in the thinnest slices. When the slices were 2 mm thick, the image performed with a 100-percent interval became completely unclear.

Our measurements confirmed the required value of the reconstruction intervals: 50% (Figure 3).

Influence of the pitch value on image quality

The analysis of the influence of the 'pitch' parameter on image quality did not confirm our theoretical predictions. It was assumed that with an increasing pitch, i.e. with table increment during lamp rotation, and with decreasing

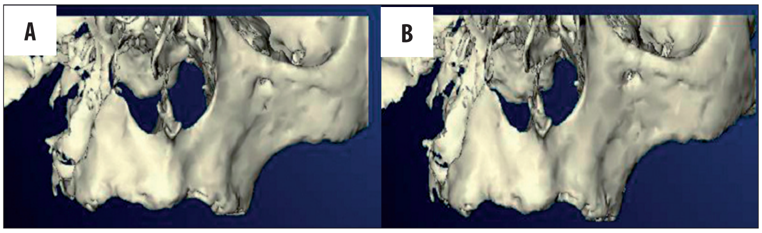

Figure 4. Slice thickness of 1 mm, reconstruction interval of 50% and (**A**) pitch of 0.5, (**B**) pitch of 1.5.

Table 4. Qualitative analysis. The number of optimal, good, and poor results, depending on the presence of geometrical distortions and artefacts. Reconstruction interval of 50%, collimation of 10×0.75 mm.

Slice thickness [mm]	Pitch 0.5			Pitch 1			Pitch 1.5		
	Optimal	Good	Poor	Optimal	Good	Poor	Optimal	Good	Poor
0.75	2			1	1		1	1	
1	2			2			2		
1.5	2				2		1	1	
2	1	1		1	1			2	
3		1	1			2			2
4			2			2			2
5			2			2			2

Table 5. Qualitative analysis. The number of optimal, good, and poor images, depending on the presence of geometrical distortions and artefacts. Reconstruction interval of 50%.

Slice thickness [mm]	Collimation 10×0.75 mm			Collimation 10×1.5 mm		
	Optimal	Good	Poor	Optimal	Good	Poor
2	2	4		1	4	1
3			6			6
4			6			6
5			6			6

time of the examination, the quality of the image would decrease.

Scanning time at different pitch values was as follows:
- Pitch 0.5–19.29 sec,
- Pitch 1–15.35 sec,
- Pitch 1.5–7.07 sec.

However, on the basis of the performed examinations, it was concluded that the increasing pitch, with other parameters remaining stable, had an insignificant influence on the quality of the visualised structures. Figure 4 presents an image of a bone structure at different pitch values.

Images at pitch 0.5 were the ones that obtained the best scores. Images at pitch 1 and 1.5 were evaluated as worse but the decrease of quality is insignificant. And thus, higher pitch values may be used without any risks of quality reduction. The comparison of the quality of images at different pitch values and slice thicknesses was presented in Table 4.

Influence of collimation on image quality

The next stage of the examinations was to analyse the influence of increasing collimation on image quality. We compared two options of the CT scanner: collimation 10×0.75 mm and 10×1.5 mm. It was expected that the use of the 2-milimiter slice with collimation 10×1.5 mm would produce qualitatively satisfactory images (slice of 2 mm is the thinnest one at collimation equal to 10×1.5 mm). When comparing the images obtained with these two collimations, at slice thickness of 2 mm, reconstruction interval of 50%, and at all pitch values, it turned out that the change in collimation value does not improve the quality of the scans ($p=0.5$).

Table 5 presents the comparison of image quality at collimation 10×0.75 mm and 10×1.5 mm, added up for all three pitch values.

The compared images did not differ much, and in some cases, at collimation equal to 10×1.5 mm, they were even slightly worse.

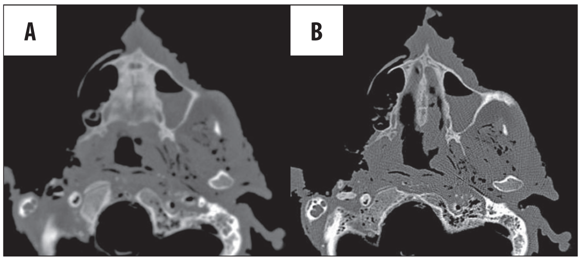

Figure 5. Influence of filters on the quality of visualised slice: (**A**) H30f, (**B**) H60f.

The influence of the filters on image quality

The last stage of the analysis was the comparison of the impact of different filters on the quality of obtained images. We chose two scans, with the following parameters:
1. Slice thickness: 0.75 mm, pitch: 1.5, reconstruction interval: 50%, collimation: 10×0.75 mm,
2. Slice thickness: 2 mm, pitch: 1.5, reconstruction interval: 50%, collimation: 10×1.5 mm.

Reconstructions were performed with the use of filters, i.e. H20f, H30f, H40f, H50f, and H60f. Filter H60f was treated by the software producer as a referential parameter, and thus other filters were compared to it.

At a high filter, H60f, the obtained transverse images were very sharp, with many distinctly delineated details (Figure 5).

When performing the 3D reconstructions, we concluded that filter H60f produces an artificial sharpening of anatomical details within bones.

Therefore, the authors decided that in order to create three-dimensional reconstructions necessary for virtual planning, it is much more advantageous to use lower filters, such as H30f or H40f, which smoothen the structures, and remove insignificant elements that make the image more unclear (Figure 6).

Discussion

Introduction of the methods of computer image analysis and graphical programs enabling 3D reconstructions of different structures examined with CT, created new options of image processing and interpretation. Appropriate systems enable the creation of (inter alia) detailed plans of implant treatment, so called virtual implantation, and virtual endoscopy of many different organs: virtual bronchoscopy, gastroscopy, colonoscopy, angioscopy, cystoscopy, ureteroscopy, and endoscopy of paranasal sinuses and vertebral canal. With the introduction of techniques of diagnostic information acquisition on the basis of 3D CT reconstructions, there has appeared a need for determination of image reliability. The analysis of the obtained results showed that the key parameter for the CT image quality is the slice thickness. Yasuhiko et al. [8] analysed the impact of the CT parameters on the quality of images on the basis of which the implantation procedures are planned. The examinations were performed with the use of the phantom of the mandible. Influence of the following parameters was analysed: slice thickness, table speed and lamp current intensity. It was shown that image quality decreases with increasing thickness of the slice. With the same table speed, a much better image quality was obtained in case of thinner slices, 1 mm thick, than in case of the thicker ones, 2 mm thick. Slice thickness equal to 2 mm was rejected by the authors as insufficient and unsatisfactory for the preoperative analysis.

Larici et al. [9] came to similar conclusions when evaluating the impact of, i.a., slice thickness in the determination of the size of nodules within the lungs, on the basis of three-dimensional reconstructions of images of a specially made chest phantom. Two values of slice thickness were compared: 1.25 mm and 2.5 mm. Irrespective of other parameters, only at slice thickness of 1.25 mm all lesions were properly distinguished by the program analysing the obtained data.

Loubele et al. [10], when developing the protocol that would decrease patient's radiation dose, applied the slice thickness of 0.75 mm in all trials. Although thicker slices would allow for the reduction of the dose, the authors did not decide to increase this parameter, due to the need of a very high scanning precision in the planning of the dental implant procedures.

Gahleitner et al. [11], in their review presenting (among others) the technique of CT examinations in dentistry, when trying to describe the criteria of choice of a proper protocol, pointed out that the slice thickness cannot exceed 1.5 mm.

Apart from the above mentioned studies, there were also many articles on virtual endoscopy that underscored the significance of a correctly selected thickness of the slice and the evaluation of 3D reconstructive options.

Ling et al. [12], in their study on virtual colonography, evaluated the influence of: the size of some protruding elements within the phantom of the large intestine, positioning of the phantom, thickness of the applied slices, and scanner type (single- or multi-detector row). It was found that the largest elements of the phantom (10 mm), clinically most significant, were always visible, in all positions, and at all possible values of slice thickness. The thickest slices in that study amounted to 5 mm.

In their work, Laghi et al. [6] presented not only the indentations within the lumen of the phantom but also the

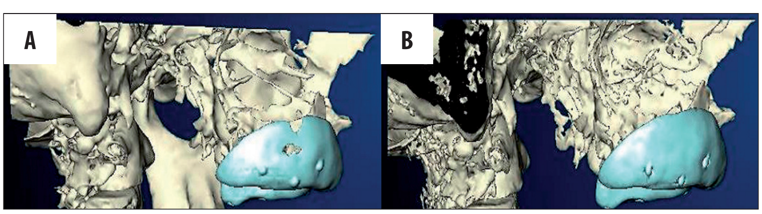

Figure 6. Three-dimensional reconstructions with the use of filters: (**A**) H30f, (**B**)H60f.

elements surpassing its outlines. That is how the authors were trying to show the images of artificial polyps and diverticula of different sizes, present in the large intestine. By defining optimal parameters of the multi-detector row CT, authors revealed a gradually decreasing scanner sensitivity with an increasing thickness of the slices. The worst results in the quoted work were obtained at slice thickness equal to 5 mm, and the best ones at 1 mm.

Similar results were obtained in our work, where the highest number of optimal observations was found with slices 0.75 mm and 1 mm thick. However, after a detailed analysis of these parameters, no difference in image quality was revealed with the slices 0.75 mm and 1 mm thick. Due to that fact, this slightly higher value of slice thickness may be used without any quality reduction. That is why, the recommended and sufficient slice thickness in implantation planning is that of 1 mm.

Results of our own experiment indicate that the series of images obtained in CT examinations with standard protocols, setting the thickness of the slices for 3, 4, and 5 mm, are unquestionably useless for 3D reconstructions and virtual planning of dental implant procedures. These protocols lead to visible artefacts and image distortions. And thus, in multi-detector row tomography, setting the right thickness of the slice is of the highest importance for the choice of optimal examination parameters.

At this point, we should underscore one significant difference between the single- and the multi-detector row CT. In the single-detector row CT, the term collimation thickness and slice thickness are equivalent – assuming the same values. In the multi-detector row CT, on the other hand, there is collimation thickness, which is the product of rows and width of the detectors, and there is slice thickness, which is the parameter of the reconstruction process in further data processing.

Owing to that, the multi-row CT provides us with many more possibilities, as compared to the single-row CT – there is a possibility of a more elastic processing of the 'raw' data obtained in the acquisition process. Moreover, an increased number of rows and a shortened rotation time (of the lamp) reduced the time of acquisition and improved the quality of the images.

The most important factor in the multi-detector row CT is the right choice of a proper collimation thickness. In this work, the multi-row CT scanner had two collimations to chose: 10×0.75 mm and 10×15 mm.

With the first collimation used, we obtained slices 0.75–5 mm thick. With the collimation of 10×1.5 mm, the thinnest possible slice had 2 mm, and the thickest – 5 mm. In this second option (10×1.5 mm), the quality of the obtained images was unsatisfactory, even if the slices were 2 mm thick and the reconstruction interval was 50%. When we increase the thickness of the slice, the number of the poor-quality images rose as well. Owing to that, the series of images obtained in CT examinations applying protocols with slice thickness equal to 2–5 mm and collimation of 10×1.5 are useless in the planning of virtual implant procedures, in the multi-detector row techniques.

In clinical cases, when we need to evaluate precisely the structure of the bones, it is recommended (according to our results) to use the collimation of 10×0.75 mm and the lowest values of slice thickness (0.75 and 1 mm), with the pitch value equal to 1.5, although the parameter of 1 mm would be sufficient not to lose the quality of the image.

Similar conclusions were made by Lackner et al. [13], in their work evaluating the impact of the acquisition parameters on the distinguishability of structures of different densities, during the detection of intraocular foreign bodies. The authors found out that the decrease in the collimation value, from 16×1.5 mm to 16×0.75 mm, resulted in a two-fold improvement in the image – noise ratio.

A similar position was presented by Wessling et al. [14], after their study aiming at the selection of the best parameters of CT colonography. They used the phantom of the large intestine with structures corresponding to the polyps, 2–12 mm in size. They analysed the impact of a thinner (4×1 mm) and a thicker (4×2.5 mm) collimation. The studies revealed a higher number of distortions and artefacts in the thicker collimation. Polyps smaller than 6 mm were visible only at collimation equal to 4×1 mm.

In multi-detector row tomography, the choice of such values as the reconstruction interval and pitch is of lower significance. Hara et al. [15] defined the reconstruction interval of 50% as optimal, but pointed out that this value would bring on a high number of transverse images, which extends the process of reconstruction, the transfer, and the time of a secondary 3D reconstruction on a workstation. This study was performed in mid-90s of the 19th century. However, today, in the times of a constant augmentation of the computing power of the contemporary computers and modernisation of the available computer programs for secondary data processing, a higher number of obtained images is not such a big problem.

The conclusions of Hara et al. [15] were confirmed by other authors, who, in their papers, definitely recommended using the reconstruction interval equal to 50% [10,16]. Considerable differences in the quality of 3D reconstruction, performed with intervals equal to 50%, 75% and 100%, were shown by Shin et al. [17]. They confirmed that the best results are obtained with the reconstruction intervals amounting to 50%.

Hopper et al. [18] pointed to a high effectiveness of the interval of reconstruction ranging from 25% to 75%.

The results of our study overlap with the above quoted conclusions. That is why, the recommended value of the reconstruction interval in this work amounts to 50%.

When evaluating the impact of the pitch value on image quality, Neumann et al. [19] suggested to use (in the protocol) the thinnest slice option of a scanner, with a maximal pitch. They claimed that the quality of the reconstruction would improve then.

A similar conclusion was made by Laghi et al. [6] who revealed step-like artefacts, with the pitch value increasing to 1.5. At this pitch value, the artefacts were more pronounced, but they decreased with a decreasing slice thickness. We also found that the slice thickness of 1 mm and the reconstruction interval of 50% resulted in formation of images that were nearly free from distortions and artefacts, despite the pitch values of 1.5.

Observations presented in the work by Hopper et al. [18] confirm the high quality of the scans, irrespective of the applied pitch values (1 or 1.5). At the same time, Schorn et al. [20], when examining the values of pitch, ranging from 1 to 3, found out that values higher than 2 lead to an evident deterioration of the image quality.

In our work, changes in pitch value did not influence image quality significantly. With pitch increase, only the thicker slices (3, 4, 5 mm) produced step-like artefacts. With thinner slices, the pitch did not have any impact on the quality of the reconstruction but revealed a significant influence on the acquisition time. For example, examination time of the phantom at pitch equal to 0.5 amounted to 19.29 seconds, at pitch = 1–15.35 seconds, and at pitch = 1.5, only 7.07 seconds. Nobel Biocare company recommends using only the sharpening bone filter H60f, when creating the three-dimensional reconstructions for virtual planning of the implant treatment [6]. However, our study results revealed that the use of lower filters, and especially H30f and H40f, is much more advantageous in subsequent 3D processing [5]. Smoothening of the structures makes the images more clear and undisturbed with small, insignificant details.

Summing up, an optimal protocol for CT examinations, on the basis of which 3D reconstructions and virtual planning of dental implant treatment can be carried out, should, due to the results of own experiment, involve the following parameters:

- Slice thickness: 0.75 or 1 mm,
- Reconstruction interval: 50%,
- Pitch: 1.5,
- Collimation: 10×0.75 mm,
- Filter: H30f – for 3D reconstructions, and H60f – for the evaluation of bone structure in transverse sections.

Conclusions

Correct performance of the examination in the double-scan technique, with the use of proper parameters, results in a comprehensive and a precise image of the studied structures. In order to use all the possible options of the planning system and to ensure reliability of the information obtained with it, it is necessary to perform the CT scanning precisely, in the double-scan technique, complying with the recommendations and choosing an examination protocol appropriate for a given type of scanner.

The method of mandible and maxilla examination, with the use of the technique of CT virtual preoperative planning, should apply the following, optimal parameters: the most significant parameter for image quality is the slice thickness. In this study, the optimal value of this parameter was 0.75 mm and 1 mm. This thickness may be obtained only at collimation amounting to 10×0.75 mm. Optimal pitch and reconstruction interval were as follow: 1.5 and 50%, respectively.

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