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Effect of Isocenter Placement at Nasion and Symphysis Menti on the Quality of MRI Images in Cases of Nasopharyngeal Cancer

Nurbaiti, Thifal Humaira Zola
Department of Radiodiagnostics and Radiotherapy, Health Polytechnic of the Ministry of Health Jakarta II, Jakarta, Indonesia

Abstract

Magnetic Resonance Imaging (MRI) examinations require precise placement of the isocenter as it directly influences the quality of MRI images. In the context of nasopharyngeal MRI examinations, different opinions regarding the optimal placement of the isocenter exist. Currently, two methods of isocenter placement are commonly applied, i.e., nasion and symphysis menti isocenter placement. This study aimed to analyze how these different isocenter placements affect the quality of MRI images in T2 Turbo Spin Echo sequences of the nasopharynx in the coronal plane. This study was conducted in June 2023 at the Radiology Installation of Dharmais Cancer Hospital, Jakarta, Indonesia. This study used the quantitative experimental approach. Six samples were purposively selected from nasopharyngeal cancer patients, and two treatments were conducted: isocenter placement at the nasion and isocenter placement at the symphysis menti. Data processing was performed using a statistical software. The results of the Wilcoxon test for image quality from the perspective of the signal-to-noise ratio (SNR) yielded a p-value of 0.173, which was greater than 0.05, indicating that there was no significant difference in image quality as measured by the SNR between the two isocenter placements. Similarly, the paired sample t-test for image quality in terms of the contrast-to-noise ratio (CNR) resulted in a p-value of 0.610, which was also greater than 0.05. This demonstrated no significant difference in the image quality between the two isocenter placements from the perspective of the CNR measures. Thus, both isocenter placements resulted in comparable image quality.

Keywords: Image quality, isocenter, nasopharyngeal MRI

Introduction

Many cases of nasopharyngeal cancer are found in more advanced stages. The diagnosis of this cancer needs to be established early to determine the therapy and prognosis of the disease. The type of cancer most commonly observed in Indonesia, ranking fourth after cervical, breast, and skin cancer, is nasopharyngeal cancer.[1] There were 348,809 new cases and 207,210 deaths caused by nasopharyngeal cancer in Indonesia[2]. Quality of life assessed in cancer patients is often used as a reference for the success of therapy.[3] The therapy given to patients with nasopharyngeal cancer is radiotherapy and followed by chemotherapy.[4]

Consideration of the impact of cancer treatment on the patient's psychosocial and functional health is obtained from assessing the patient's quality of life.[5] MRI (Magnetic Resonance Imaging) is a body imaging technique based on the principle of magnetic resonance of the atomic nucleus and produces coronal, transverse, and axial cuts.[6] MRI imaging has become the primary method for examining patients with suspected pathology in the nasopharynx because it can provide contrast resolution for soft tissue. Another advantage of MRI is that it can detect tumor grade, perineural spread, and intracranial tumor extension.[7] MRI imaging can also show a better image of the tumor than examining nasopharyngeal cancer using endoscopy and endoscopic biopsy.

Optimal MRI image results need to be achieved for maximum diagnosis, so a suitable examination protocol is also needed. IMR image results have four characteristics: high signal-to-noise ratio (SNR), good contrast-to-noise ratio (CNR), high spatial resolution, and short imaging time.[8–10]SNR is the ratio between the amount of noise produced by the MR system and the amount of signal received from the tissue being imaged.

Corresponding Author:
Nurbaiti
Department of Radiodiagnostics and Radiotherapy, Poltekkes Kemenkes Jakarta II, Jakarta, Indonesia
Email: nurbaiti@poltekkesjkt2.ac.id

The difference in SNR between the two relevant types of networks is called CNR, a relationship between contrast and noise.[11] The meaning of the signal is the voltage induced in the receiver coil by precise coherent magnetization in the transverse plane at, or around, the time of Time Echo (TE), and noise represents frequencies that exist randomly in space and time.[8]

The MRI examination procedure starts with positioning the patient or object correctly. The object's center in an MRI examination is placed at the isocenter (B0) or the center point of the magnet. Each gradient in MRI will be centered at the midpoint of the isocenter.[6] Inappropriate object placement will reduce the accuracy and precision of image measurements, and good placement will increase statistical power in research to understand a particular clinical issue.[6] Also, incorrect isocenter placement will affect the quality of the resulting image, namely SNR and CNR.[8]

There are differences in isocenter placement during nasopharyngeal MRI examinations for nasopharyngeal cancer patients in several major hospitals, particularly regarding the positioning of the isocenter at the nasion or symphysis menti. This research is important due to the lack of consensus on this issue, with no robust studies supporting either method. To date, no previous research has examined the impact of different isocenter placements on image quality in these two areas. Therefore, this study aims to statistically assess the differences in isocenter placement at the nasion and symphysis menti during nasopharyngeal MRI examinations in nasopharyngeal cancer patients, specifically in relation to image quality metrics such as the Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR). The ultimate goal is to clarify the discrepancies in isocenter placement practices observed across different hospitals.

Methods

This study employed an experimental design with purposive sampling and a quantitative approach. Data collection was conducted in June 2023 at the Radiology Department of Dharmais Cancer Hospital. Practical considerations such as available resources, time constraints, and data accessibility resulted in a total sample size of six participants. Ethical approval for this research was granted by the Medical Research Ethics Committee of Dharmais Cancer Hospital under clearance number 124/KEPK/IV/2023.

The inclusion criteria are patients diagnosed with nasopharyngeal cancer, who are willing to participate in the study, and who do not have a pacemaker. To maintain the integrity of the research results and ensure the safety of participants during the study, individuals who experience claustrophobia or have conditions that could cause discomfort or complications during the procedure are excluded from participation. Each sample underwent two treatments: placing the isocenter at nasion and at symphysis menti. The parameters used are Time Repetition (TR) 5200 ms, Time Echo (TE) 110 ms, concatenations, and averages each with a value of 1. The only difference between the two procedures is the placement of the isocenter so that the results can be controlled. This research was conducted only on the T2 Turbo Spin Echo Fat Saturation coronal cut sequence. The samples chosen were patients with clinical nasopharyngeal cancer post-radiotherapy and post-chemotherapy at the request of the sending doctor for post-therapy evaluation images.

The data obtained was processed using the ImageJ application, which is an application that can provide information in the form of numbers for the blackness value of an image in the form of mean to standard deviation.[12]Measurements were taken from ten distinct Regions of Interest (ROIs) as illustrated in Figure 1. ROIs 1–4 were located in the nasopharyngeal area, ROI 5 represented the brightest point in the image, ROIs 6–8 were selected from other anatomical areas including residual tumor regions (taken consistently across all samples), and ROIs 9–10 were selected from the background or darkest areas of the image. The mean values obtained were then used to calculate Signal-to-Noise Ratio (SNR) and Contrast-to-Noise Ratio (CNR) using standard formulas.

The resulting data—including mean intensity, standard deviation, SNR, and CNR—were statistically analyzed using SPSS software. These analyses were conducted for both isocenter placement conditions to determine whether placement at the nasion or symphysis menti influenced image quality. A sample of data processed using ImageJ is shown in Figure 1.

Results

Data processing using the ImageJ application produces two data variations and is continued using statistical applications. The first test is the data normality test to determine the type of

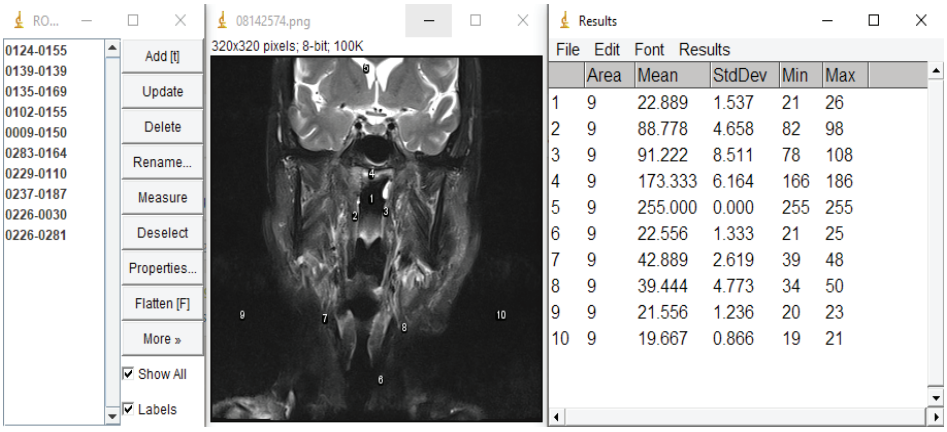

Figure 1 Example of Data Processing using ImageJ Application

statistical analysis that will be used in the next.[13] The first data processing is for image quality in the form of SNR and, after that, CNR. Table 1 shows the result.

Based on Table 1, the Shapiro-Wilk normality test showed that the SNR values from images with isocenter placement at the nasion had a p-value of 0.001 (≤0.05), indicating that the data were not normally distributed. In contrast, the SNR values for images with isocenter placement at the symphysis menti yielded a p-value of 0.387 (≥0.05), indicating normal distribution. Since one of the datasets did not meet the assumption of normality, a non-parametric statistical test was used. To determine whether there was a significant difference between the two isocenter placements, a Wilcoxon signed-rank test was conducted.

Table 2 presents the results of the Wilcoxon two-sample test, non-parametric test in assessing image quality in the form of SNR at the isocenter placement in nasion, obtaining a mean value of 22.471, a minimum value of 9.082, a maximum value of 69.990, and standard deviation is 23.614. In contrast, the isocenter placement at symphysis menti has a mean value of 11.228, a minimum value is 5.637, a maximum value is 14.703, and a standard deviation is 3.516, and a p-value is (0.173) ≥0.05. Therefore, no significant difference exists between the image quality

Tabel 1 Normality Test Results for Image Quality Based on SNR

Image Quality (SNR)	Normality Test *Shapiro-wilk*		
	Statistic	df	Sig. (p-value)
SNR isocenter at Nasion	0.636	6	0.001
SNR isocenter at Symphysis Menti	0.902	6	0.387

df=degree of freedom; Sig.=significance value

Tabel 2 Non-parametric Wilcoxon Test for Image Quality in SNR

Image Quality (SNR)	Non-Parametric Wilcoxon Two-Sample Test					
	N	Mean	SD	Min.	Max.	Asymp. Sig
SNR isocenter at Nasion	6	22.471	23.614	9.082	69.990	0.173
SNR isocenter at Symphysis Menti	6	11.228	3.561	5.637	14.703	

N=number; SD=standard deviation; Min=minimum; Max=maximum; Asyimp. Sig=asymtotic significance

Tabel 3 Normality Test for Image Quality in CNR

Image Quality (SNR)	Normality Test *Shapiro-wilk*		
	Statistic	df	Sig. (p-value)
SNR isocenter at Nasion	0.953	6	0.766
SNR isocenter at Symphysis Menti	0.868	6	0.220

df=degree of freedom; Sig.=significance value

Tabel 4 Parametric Paired Sample T-Test for Image Quality in CNR

Image Quality (CNR)	Parametric paired sample T-Test			
	Mean	Std. Deviation	Asymp. Sig	
CNR isocenter at Nasion	6	89.357	41.003	0.610
CNR isocenter at Symphysis Menti	6	100.657	75.588	

N=number; SD=standard deviation; Min=minimum; Max=maximum; Asyimp. Sig=asymptotic significance

(SNR) at the isocenter placement in nasion and symphysis menti on the coronal section T2 TSE nasopharyngeal sequence MRI examination.

Table 3 present the result of the normality test that was conducted on the isocenter positioning data at nasion and symphysis menti for assessing image quality in terms of CNR.

Based on Table 3, information is obtained that image quality in the form of CNR at isocenter placement in nasion using the Shapiro Wilk method produces p-value (0.766) ≥0.05 and at isocenter placement at symphysis menti produces a p-value (0.220) ≥0.05, so both data declared to be normally distributed. Therefore, the image quality assessment (CNR) data for the two isocenter locations at nasion and symphisis menti will be tested using parametric statistics to conduct statistical inference.[14] The Parametric paired sample T-test is used for two groups of samples that differ in certain variables.

Table 4 presents the results of assessing image quality in CNR with different isocenter placements. For the isocenter placement at the nasion, the mean value is 89.357, with a standard deviation of 41.003. In contrast, for the isocenter placement at the symphysis menti, the mean value is 100.657, with a standard deviation of 75.588. The p-value obtained is 0.610, which is greater than 0.05. Based on this, we conclude that there is no significant difference in image quality between the isocenter placements at the nasion and symphysis menti in the coronal section MRI nasopharyngeal sequence T2 TSE examination.

Discussion

Radiotherapy and chemotherapy are two modalities that are generally used to treat nasopharyngeal cancer.[4] Radiotherapy for nasopharyngeal cancer causes many changes in the patient. Changes that may occur are damage to brain tissue, necrosis of the nasopharynx exposed to radiation and the surrounding area, changes in the skull base, or the appearance of trismus symptoms in patients due to abnormal masticator muscles.[15,16] An imaging examination with MRI is needed to evaluate the patient's condition after therapy or to continue the patient's treatment to the next stage.[17]

Post-radiotherapy MRI imaging examination is needed to assess the anatomical structure in the area of nasopharyngeal cancer being treated and the surrounding area. Placement of the isocenter is important so that the resulting MRI imaging is optimal and helps radiologists or oncologists evaluate the patient's condition correctly to adjust the dose for subsequent radiotherapy.[17]

Isocenter placement in the nasopharyngeal MRI examination with clinical nasopharyngeal cancer in nasion and symphysis menti shows no difference in the respective image quality in SNR

and CNR. According to statistical analysis using various test calculations, both the SNR and CNR display values of 0.173 and 0.610, respectively. Both values surpass the threshold of 0.05, indicating no noteworthy distinction between two isocenter positions at nasion and symphysis menti concerning image quality in both SNR and CNR.

This study presents the average for each experiment with isocenter placement, specifically at nasion and symphysis menti. The statistical findings indicate a greater SNR value for isocenter placement at nasion and a higher CNR value for isocenter placement at symphysis menti. Yet these variations lack significance, aligning with the outcomes of other statistical assessments conducted.

Hence, MRI scans for nasopharyngeal cancer patients can employ two isocenter placement techniques at nasion and symphysis menti-since there's no discernible distinction in the resulting image quality between the two methods.

Further research can be carried out to assess isocenter placement with a higher level of validity through radiometric and dosimetric simulations using the model.[18] Research into the influence of other factors that can improve the quality of MRI imaging is needed to assess minor brain damage through MRI imaging. In this way, it is hoped that damage to the anatomical structure of the brain due to the nasopharyngeal cancer therapy process can be assessed early and can improve therapy management in the future.[17]

Although this study only utilized two isocenter placement variations and had a limited sample size, the findings from this research can be used as a reference. Based on the results of this study, the placement of the isocenter in two different places, the nasion or symphysis menti, on the nasopharyngeal MRI imaging sequence T2 turbo spin echo fat saturation coronal section provides no different imaging picture. Both can be used as isocenter options in nasopharyngeal MRI imaging procedures.

In conclusions, isocenter placement for nasopharyngeal MRI examinations for nasopharyngeal cancer patients can be carried out at Nasion and Symphysis. The results showed no significant difference in image quality between the two isocenter placements. It is hoped that these results can provide options for those responsible for implementing and overseeing the MRI examinations, and enable the selection of isocenter placement appropriate to each inspection location's environmental conditions.

References

1. Pratama AA, Yudhanto D, Kadriyan H, Djannah F. Korelasi antara usia dengan ekspresi epstein-barr virus pada kanker nasofaring tipe undifferentiated carcinoma. Unram Med J. 2017;6(3):28. doi:10.29303/jku.v6i3.144
2. Ferlay J, Colombet M, Soerjomataram I, et al. Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. Int J Cancer. 2019;144(8):1941–53. doi:10.1002/ijc.31937
3. Juwita DA, Almahdy A, Afdila R. The assessment of health related quality of life for patients with breast cancer in dr. M. Djamil Hospital Padang, Indonesia. J Ilmu Kefarmasian Indones. 2019;17. doi:https://doi.org/10.35814/jifi.v17i1.682
4. Xu C, Zhang LH, Chen YP, Liu X, Zhou GQ, Lin AH, et al. Chemoradiotherapy Versus Radiotherapy Alone in Stage II Nasopharyngeal Carcinoma: A Systemic Review and Meta-analysis of 2138 Patients. J Cancer. 2017;8(2):287–97. doi:10.7150/jca.17317
5. Alsafadi N, Alqarni M, Attar M, Mgarry R, Bokhari A. Nasopharyngeal cancer: prevalence, outcome, and impact on health-related quality of life at Princess Norah Oncology Center, Jeddah, Saudi Arabia. Cureus. 2020;12(5):e8199. doi:10.7759/cureus.8199
6. Walker A, Liney G, Metcalfe P, Holloway L. MRI distortion: considerations for MRI based radiotherapy treatment planning. Australas Phys Eng Sci Med. 2014;37(1):103–13. doi:10.1007/s13246-014-0252-2
7. King AD. MR Imaging of nasopharyngeal carcinoma. Magn Reson Imaging Clin N Am. 2022;30(1):19–33. doi:10.1016/j.mric.2021.06.015
8. Westbrook C, Talbot J. MRI In Practice. 5th ed. John Wiley & Sons Ltd; 2019.
9. Astuti NSD, Muzammil A, Aisyiyah N. Analisis kualitas citra tumor otak dengan variasi flip angle (FA) menggunakan sequence T2 turbo spin echo axial pada magnetic resonance imaging (MRI). Pertem Ilm Tah Fis Medis dan Biofisika. 2017;1:86–90.
10. Septiano AF, Susilo S, Setyaningsih NE. Analisis citra hasil scanning electron microscopy energy dispersive X-Ray (SEM EDX) komposit resin timbal dengan metode contrast to noise ratio (CNR). Indones J Math Nat Sci. 2021;44(2):81–5. doi:10.15294/

ijmns.v44i2.33143
11. Kartawiguna D. Tomografi resonansi magnetik inti; teori dasar, pembentukan gambar dan instrumentasi perangkat kerasnya. 1st ed. Yogyakarta: Graha Ilmu; 2015.
12. Khodanovich MY, Anan'ina T V, Krutenkova EP, et al. Challenges and practical solutions to MRI and histology matching and measurements using available ImageJ Software Tools. Biomedicines. 2022;10(7):1556. doi:10.3390 / biomedicines10071556
13. Miot HA. Assessing normality of data in clinical and experimental trials. J Vasc Bras. 2017;16(2):88–91. doi:10.1590/1677-5449.041117
14. Ali Z, Bhaskar Sb. Basic statistical tools in research and data analysis. Indian J Anaesth. 2016;60(9):662. doi:10.4103/0019-5049.190623
15. Ucuncu Kefeli A, Sanal-Toprak C, Asedov R, et al. Long-term neuromusculoskeletal side effects and quality of life in nasopharyngeal cancer patients receiving radiochemotherapy. Eur Arch Oto-Rhino-Laryngology. 2020;277(8):2325-2333. doi:10.1007/s00405-020-05932-w
16. Chen MY, Mai HQ, Sun R, Guo X, Zhao C, Hong MH, et al. Clinical findings and imaging features of 67 nasopharyngeal carcinoma patients with postradiation nasopharyngeal necrosis. Chin J Cancer. 2013;32(10):533–8. doi:10.5732/cjc.012.10252
17. Voon NS, Lau FN, Zakaria R, Md Rani SA, Ismail F, Manan HA, et al. MRI-based brain structural changes following radiotherapy of Nasopharyngeal Carcinoma: A systematic review. Cancer/Radiothérapie. 2021;25(1):62–71. doi:10.1016/j.canrad.2020.07.008
18. Cosson P, Lu Z. Geometric validation of a computer simulator used in radiography education. BJR|Open. 2020;2(1):20190027. doi:10.1259/bjro.20190027