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A Review of Mlc-Based Multiple Target Intracranial Radiosurgeryusing K-Means Clustering to Analyze the Isocenters' Numbers and Positions

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Stereotactic radio surgery (SRS) was developed over six decades ago and it has proved to be a successful technique of treating both malignant and benign lesions using anticancer drugs [1]. Different machine configurations or treatment machines are used to treat patient with multiple brain metastases (mets or cancer cells that spread from the primary tumors in some body organs to the brain) [2]. The machines include the linear accelerator (linac), CyberKnife, and Gamma Knife which involve targeting several mets sequentially or individually [3]. The configuring the linac and the MLCs (multileaf collimator) provides a good alternative for targeting the mets using an isocenter within a greater jaw-defined area [4]. The extra blocking which is offered by the multileaf collimator helps to attain compliance around the targets [5]. Therefore, the numerous brain mets can successfully be X-rayed concurrently, which improves the effectiveness of the treatment by lowering the time taken for the radiation to beam as well as the duration the patient undergoes the procedure [6]. Decreasing the time taken is also important since the experimental degree of intrafractional motion [7]. There is need to consider other additional factors which are generated by the single isocenter for numerous targets system owing to the isocenterexceptional position as compared to the targets [8]. The isocenter is usually placed in the middle of the set of targets covered within the area [9]. Three typical tasks arise as a result of the distinct configuration and needs to be addressed by the physician [10]. The tasks include selecting the suitable number of isocenters and treatment plans relied to treat the full set of targets, determining the location of individual isocenter, lastly, identifying the target groups to undergo treatment concurrently by utilizing the similar isocenter [11].

The K-means clustering which is used to cluster data by lowering the variance or sum of squares within the clusters. A defined number of classes are given as input to the algorithm together with the experiential dataset [12]. With regards to treatment planning of SRS that involve a single isocenter to target multiple mets, the k-means is used to offer a cluster of targets as well as the position of the isocenters that lowers the total number of squared distance between each isocenter and the target [13]. Furthermore, it offers a quantitative metric that can be relied on to assess the treatment methods of diverse numbers of isocenters [14]. The k-means clustering algorithm as used to clustering position and targets the isocenter has numerous benefits. For instance, it can be regarded as a natural application of a robust and simple algorithm is independent and quick [15]. It produces to the targets configuration as well as the patient-specific number; besides, it needs slight effort on behalf of the physician [16].

The researcher sought to propose how the k□means clustering algorithm can be applied to improve treatment plans of Stereotactic radiosurgery which are characterized by a solitary isocenter for many targets [17]. The algorithm can be regarded as a tool used to guarantee a dependable and independent treatment planning strategy while automatically dealing with the three evolving tasks typical of such treatment method [18]. The researchers recruited thirty patients with multiple brain metastases to be treated with the stereotactic radiosurgery; besides, a treatment planning system was used to establish the ranges and the geometric centroids of all the independent mets [19]. The k-means unweighted and weighted versions together with internal software were used to cluster the targets which were to undergo treatment with a solitary isocenter as well as to correctly place each isocenter [20]. The outcome of the algorithm was assessed through the use of a least coverage metric of the target that took into consideration the impact of the target size. Ultimately, the researcher found out the k□means algorithm's unweighted and weighted versions were applied effectively to establish the isocenters' position and number.

The algorithm concurrently optimizes the clustering of targets to undergo treatment. It chooses the location of all the independent isocenter and explains the effect of the total number of isocenters [21]. Therefore, the researchers technique that offers physicians a simplified and efficient tool to reduce the harmful impacts of variances and extreme field sizes, in that way it improve the treatment plans of intracranial stereotactic radiosurgery by utilizing a single isocenter for many targets [22]. The variance between the k-means clustering algorithm versions illustrated the benefit of the unweighted version [23]. Both the k□means algorithm versions offer objective, quantifiable, constant, and spontaneous solutions to the tasks related with the treatment plans of the SRS by utilizing a single isocenter for many targets [24]. The study proves that applying the k-means clustering algorithm can instinctively clusters the targets to be treated with a distinct isocenter in addition to the place the isocenter in reliable and unreliable way [25].

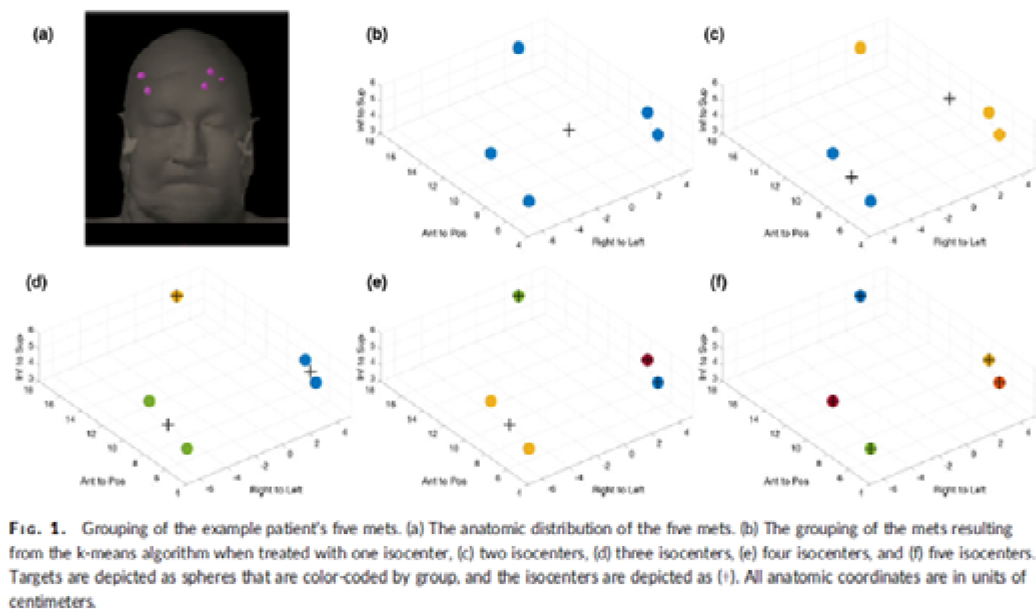

Figure 1: Grouping of the patient's five mets (Source: Thomas A, Niebanck M, Titania J, Zhiheng W, Mark O (2013) A comprehensive investigation of the accuracy and reproducibility of a multitarget single isocenter VMAT radiosurgery technique. Medical physics 40: 121725).

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