Determination of Quality of Radiosurgery Treatment Plans with nPQI Index

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Objectives: The aim of this study is to test the accuracy of a new index derived to determine the quality of different radiosurgery treatment plans for the same patient.

Methods: Plans of 60 patients diagnosed with vestibular schwannoma who were treated between 2013 and 2019 at the CyberKnife Radiosurgery center of Medicana International Ankara Hospital evaluated retrospectively. Treatment plans were performed on these patients using isocentric and sequential optimization by the CyberKnife. All patients plans were planned as 1x12Gy. The evaluation process was done with the derived nPQI index. In the nPQI index, all the parameters using in radiosurgery was considered.

When considering that all parameters of nPQI index has equal importance;
If nCI>1 ise;

nPQI=nCI x 100/cov x GI x (Di/Dt)/n x (Vi/Vt)/n

If nCI <1 ise;

nPQI=1/nCI x 100/cov x GI x ?i=1 ((Di/Dt)/n) x ?i=1 ((Vi/Vt)/n)

nCI: Nakamura Conformity Index
cov: Coverage
GI: Gradient Index
Di: Maximum dose of critical organs
Dt Maximum tolerance dose in critical organs
Vi: Volume dose of critical organs
Vt: Volume tolerance dose in critical organs
n: Number of Critical Organs

nPQI index is as shown above. In this index, our expectation is must be;
nPQI =(?1) x (?1) x (<?) x (?0)
nPQI ? 0 olmali.

Treatment plans sometimes require high coverage plans, sometimes critical organs may be given more importance. Therefore, In case of all parameters are not equal, weighting will be evaluated. Importance of Critical organ based; nCI=2/8, Coverage=2/8, GI=3/8, Critical Organ=1/8

According to the desired situation, these values were used as coefficients in the formula. These values are our recommended values and can be changed in weight.
In patients diagnosed with Vestibular schwannoma, the maximum dose of cohlea was <4.2 Gy, the maximum dose of the brain stem was <15 Gy and 1cc <10 Gy. nPQI values ??close to 0 were evaluated as better in terms of plan quality. During the evaluation process, a radiation oncologist and a neurosurgeon were asked, "which plan would you choose?" and then was looked at the % alignment between the index and the plans chosen by the doctors.

Results: The average value of tumor volumes was 3.26 cc (0.06 cc-11.9 cc), the median value was 2.1 cc (0.06 cc-11.9 cc). The average nPQI value was 3.78 in plans made with Isocentric optimization and the average nPQI value was 1.03 in plans made with sequential optimization. The average nPQI value of plans made with isocentric optimization was 4.73 and the average nPQI value of plans made with sequential optimization was 1.11. In 56 of 60 patients diagnosed with vestibular schwannoma, the plan made with sequential optimization was preferred; while in 4 patients the plan made with isocentric was preferred with CyberKnife. In equally weighted planning, 93.33% alignment was achieved between the plans chosen by both the neurosurgeon and the radiation oncologist and the nPQI index. In small volume plans (0.06 cc - 0.1 cc), cohlea and brainstem doses yielded lower results in isocentric. When the plans were evaluated using the critical organ weight factor, 100% alignment was achieved between the neurosurgeon and the radiation oncologist and the nPQI index.

Conclusions: Using nPQI Index, we showed that more appropriate plans were selected by obtaining a numerical value for the evaluation of multiple treatment plans. This index which is developed by us can be used and developed not only on CyberKnife, but also on linac-based devices.