Purpose: To evaluate the neutron and photon dose equivalent (Hn,D and HG) at the outer maze entrance after the removal of the flattening filter of a Varian Clinac 23EX accelerator; and to evaluate the effectiveness of semiempirical calculations for a flattening filter free (FFF) accelerator.

Methods: A Varian Clinac 23EX accelerator was used to produce 18 MV photons without the flattening filter. The Hn,D was measured using an Andersson-Braun neutron Rem meter, and the HG was measured using a Geiger Müller gamma-ray survey meter at the outer maze entrance. The measurements were compared with semiempirical calculations such as the Kersey method, the modified Kersey method and a newly proposed method by Falcão et al.

Results: With the gantry head tilted close to the inner maze entrance and with the jaws closed, the neutron dose equivalent reached its maximum. The FFF dose equivalent per monitor unit (MU) is 14 -41% lower than that of a flattened beam under different field size and gantry angle settings. The calculation to measurement ratio of the Hn,D was 4.6 for the Kersey method and 16.7 for the Falcão method. The modified Kersey method has a calculation to measurement ratio about 0.8. The total photon dose equivalent calculation using formulae in NCRP report No. 151 is about 1.5 times of the measurement.

Conclusions: This work indicates that the neutron production per MU from a flattening filter free accelerator is reduced at the maze entrance. The Kersey method and the Falcão method overestimate the neutron dose equivalent. The modified Kersey method gives the closest estimation of a Varian Clinac 23EX accelerator operated at 18 MV photon mode without flattening filter in a maze with a similar design as in our study. However, its tendency to underestimate the Hn,D need to be considered during shielding calculation.