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Improving Radiation Safety in Interventional Radiology: An Experimental Dosimetric Analysis

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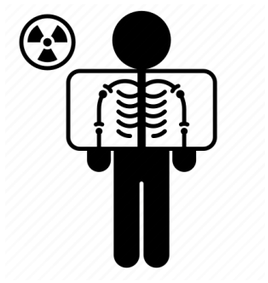
1. Background-Aim

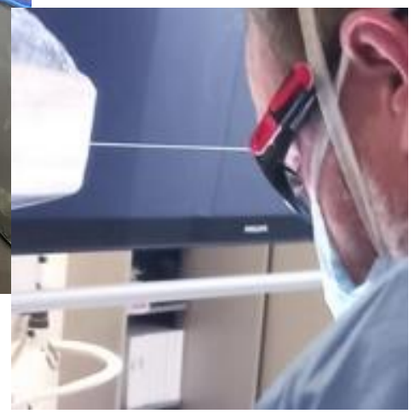


Interventional radiologists/cardiologist are exposed to high levels of secondary radiation during procedures, necessitating robust radiation protection measures.

•To ensure the safety of the professionals, dosimeters provided by the Greek Atomic Energy Commission (GAEC) are used to track monthly radiation doses received by cardiologists.

- The data were collected from the current GAEC dosimeters positioned:
  1. Over Aprons
  2. Near the eye

(1)



(2)

The assessment is carried out both prior to and following the application of a appropriate radioprotective shield, designed to reduce the ionizing radiation exposure for interventional doctors without affecting clinical practice.

1. Background-Aim

Appropriate radiation protection garments are required for the entirety of interventional radiology staff.

Radiation exposure result in varying levels of damage to different organs, depending on radiation dose.

1. **Leaded Glasses** -> Increased frequency of cataracts.
   -> reduced eye radiation up to 35%-90%.
2. **Thyroid collar** -> thyroid gland -> radiosensitive organ
   -> high radiation exposure -> thyroid cancer.
3. **Lead Aprons**-> reduce radiation load to employees implicated to ionizing exposure.

Type of dose limit	Limit on occupational radiation exposure
Total Effective Dose	20mSv/year
Effective Dose during Pregnancy	≤1mSv
Equivalent Dose for Skin	500mSv/year
Equivalent Dose for Extremities	500mSv/year
Equivalent Dose for the Lens of the eye	20mSv/year

THE AIM OF THIS STUDY

To evaluate the effectiveness of the radioprotective shield using the GAEC dosimeter indications pre and post the introduction of the shielding.

2. Materials & Methods

Radiation protection → Paramount importance in interventional laboratories,
→ Cardiologists remain within the room during radiation exposure.

In this study, along with the dosimeters provided by GAEC, a appropriate radiation protection shield, the Egg Nest, was utilized.
Previous studies (Wilson et al [3], Steege et al [4]) demonstrated reduced radiation dose of 82% to 97% with the aid of the shield.

The Egg Nest radiation protection shield:

- Adapts to all types of fluoroscopic systems without obstructing the procedures.
- Interacts only with scattered and leakage radiation from the X-ray tube
- Provides protection to all individuals present in the room.

The system from which the measurements were obtained:

- Philips Azurion 3 M12 C-arm
- X-ray tube (40-125 kVp,) flat panel detector, field sizes of 30, 27, 22, and 19 cm.
- Automatic exposure control system and anti-scatter grid (Bucky).

2. Materials & Methods

Equivalent dose measurements from the monthly GAEC staff dosimeters were collected from cardiologist for the procedures **Angioplasty** and **Coronary angiography**.

GAEC Dosimeters

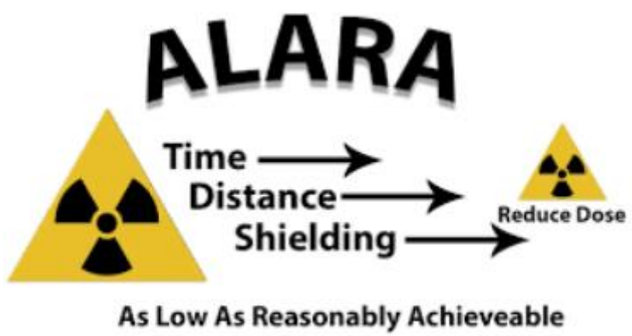
Then were normalized with Dose Area Product (DAP) to compare the monthly doses per individual cardiologist.

-> **before** and
-> **after** the implementation of the shielding.

A t-test statistical analysis was conducted to verify the statistical significance of our results.

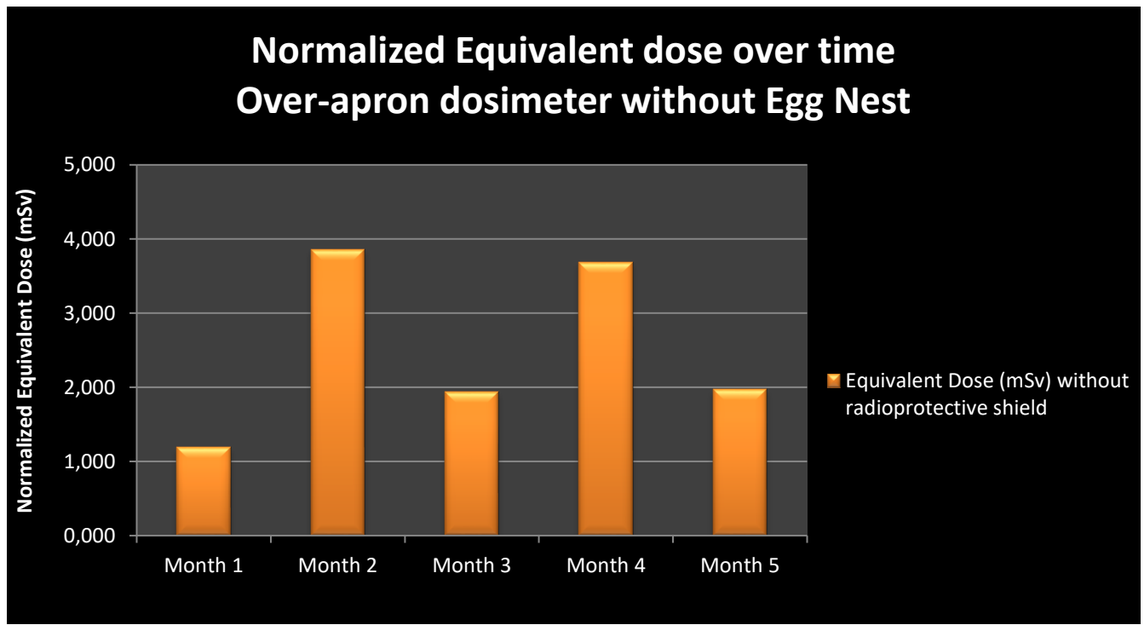
Radioprotective shielding in Cardiac Catheterization Laboratory

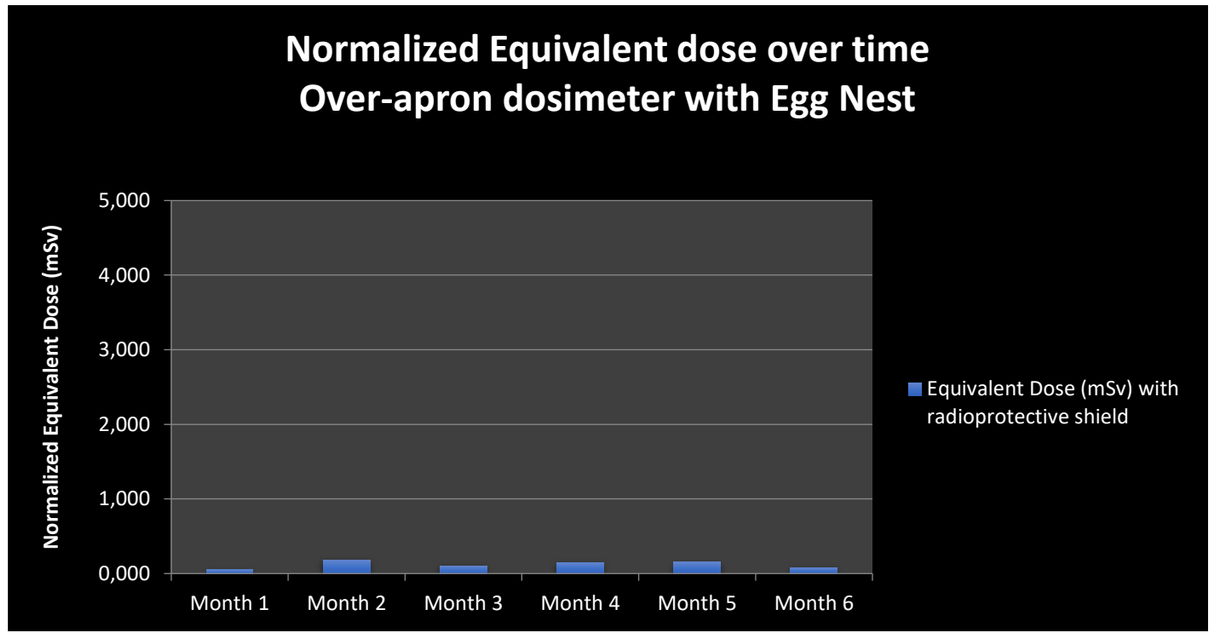
The application of radioprotective shielding follows the ALARA principle, which stands for **As Low As Reasonably Achievable**. According to this approach, any dose of radiation, no matter how small, should be avoided if it doesn't offer a clear benefit to the patient. The goal is to minimize unnecessary exposure whenever possible.

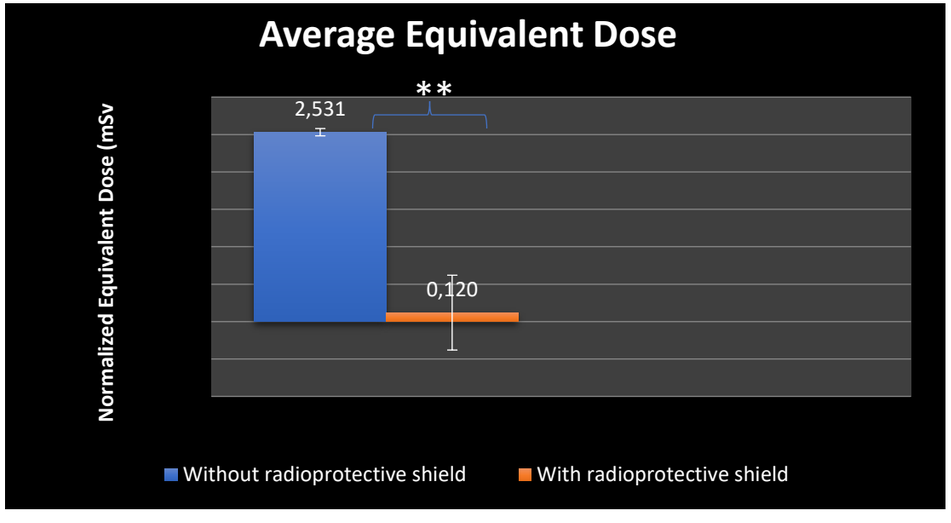


3. Results

MONTHLY DOSIMETRIC DATA FOR CARDIOLOGIST 1 WITH AND WITHOUT RADIOPROTECTIVE SHIELDING / OVER-APRON DOSIMETER







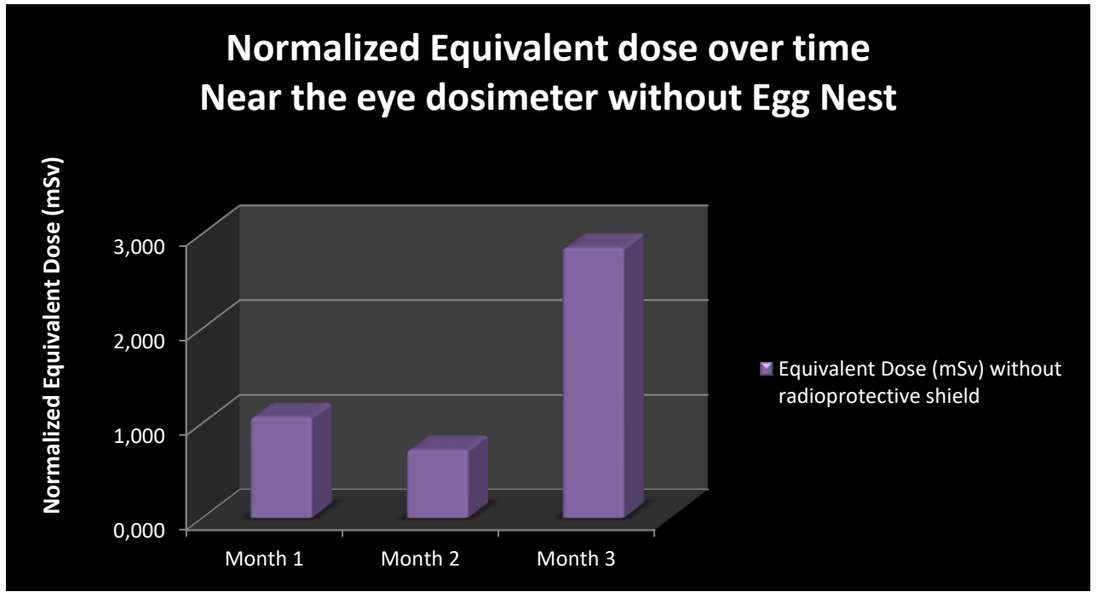
* < 0.05
** < 0.005

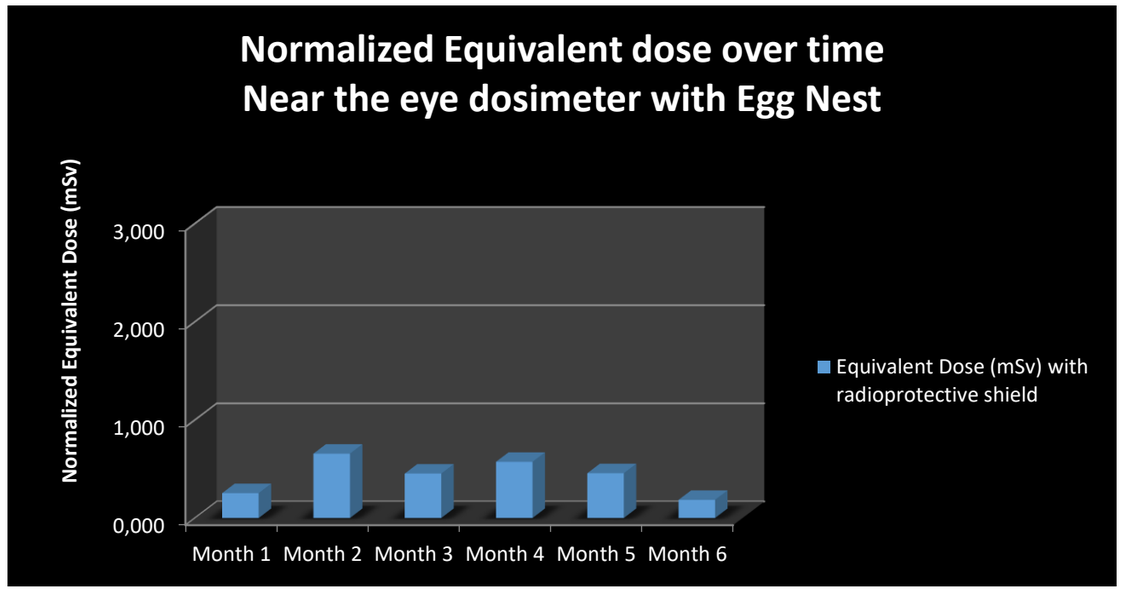
There is a reduction in the dose during the months when the protective shield, Egg Nest, is used, reaching up to **95.26%** of the value it had before.

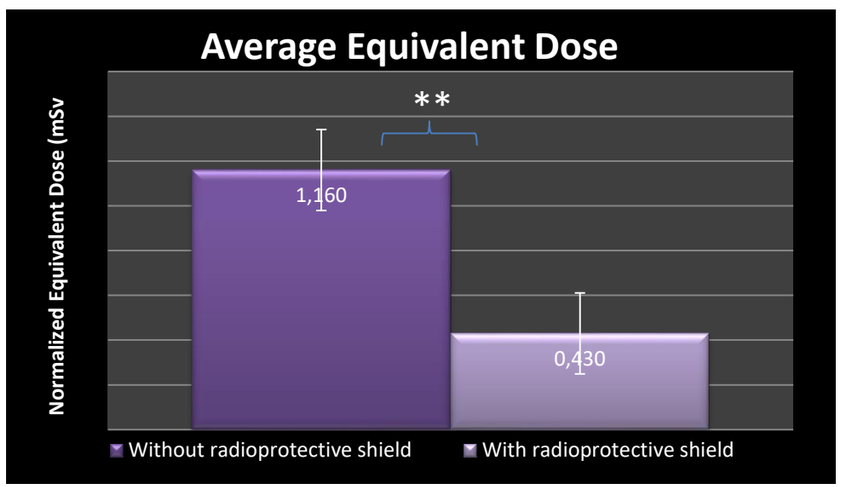
The measurements indicate that there is a statistically significant difference in the reduction of the dose.

3. Results

MONTHLY DOSIMETRIC DATA FOR CARDIOLOGIST 1 WITH AND WITHOUT RADIOPROTECTIVE SHIELDING / NEAR THE EYE DOSIMETER







* < 0.05
** < 0.005

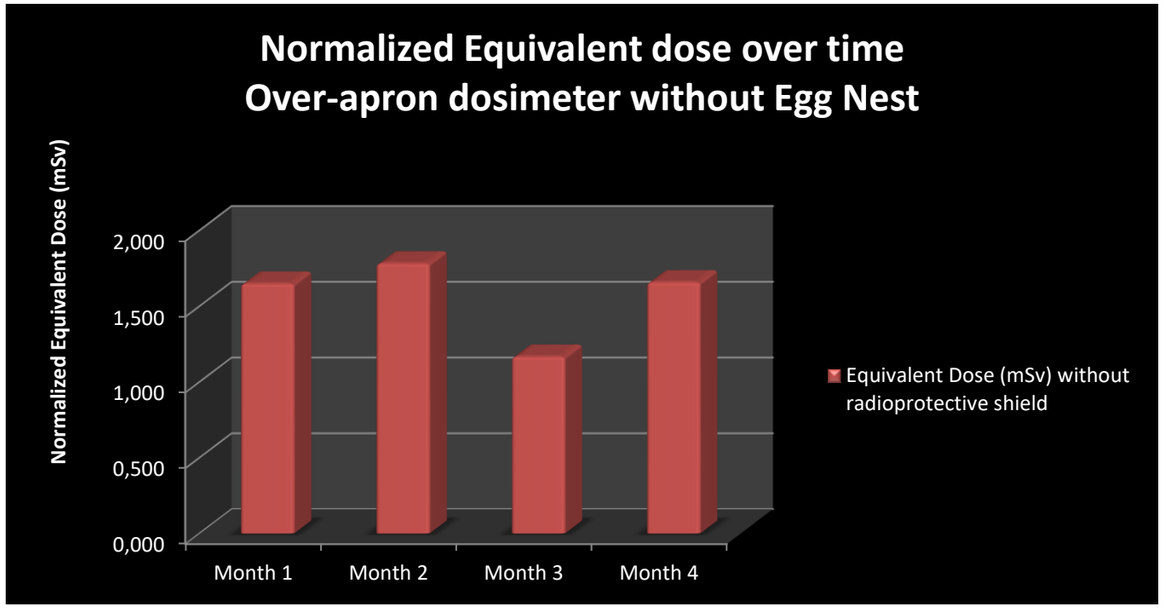
The cardiologist places the dosimeter underneath a face radioprotection mask, rather than on radioprotection glasses.

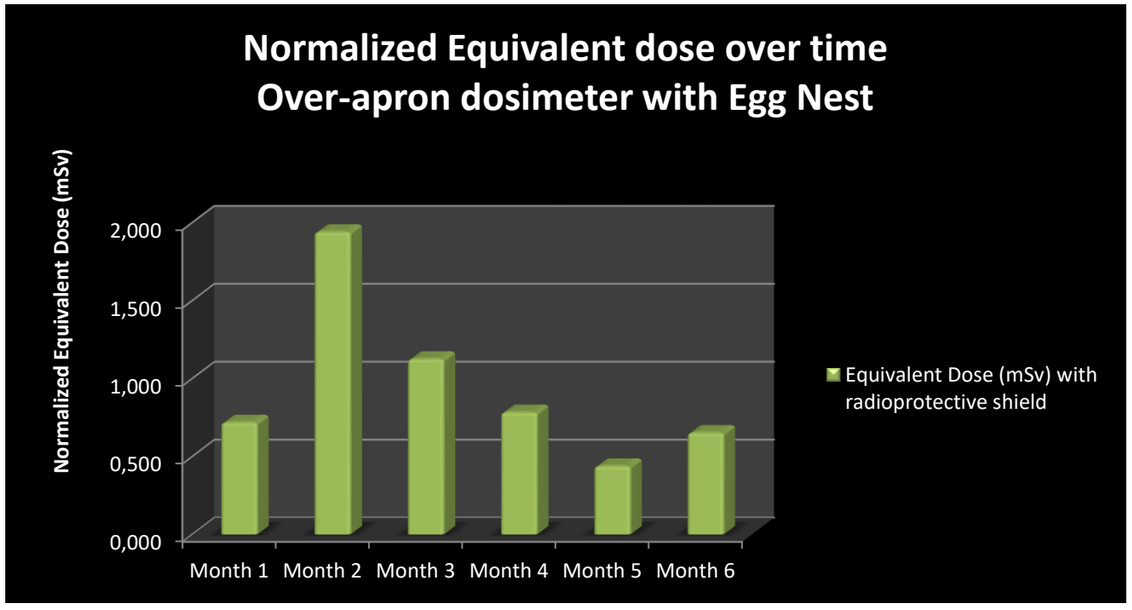
There is a reduction in the dose during the months when the protective shield is used, reaching up to **62,93%** of the value it had before.

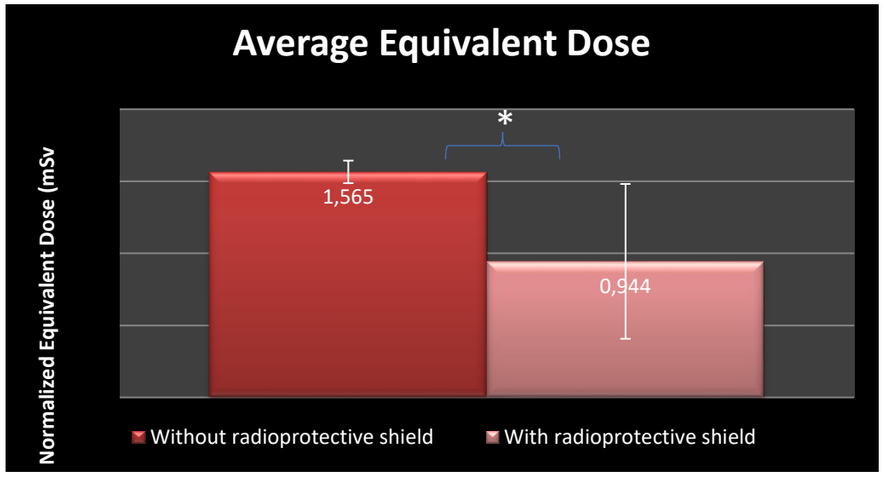
The measurements indicate that there is a statistically significant difference in the reduction of the dose.

3. Results

MONTHLY DOSIMETRIC DATA FOR CARDIOLOGIST 2 WITH AND WITHOUT RADIOPROTECTIVE SHIELDING / OVER-APRON DOSIMETER







* < 0.05
** < 0.005

There is a reduction in the dose during the months when the protective shield is used, reaching up to **50,07%** of the value it had before.

The measurements indicate that there is a statistically significant difference in the reduction of the dose.

4. Conclusions

- Shielding enhances radiation protection in interventional radiology, offering the opportunity to **mitigate potential acute or late health risks.**
- Integrating this approach with monthly dosimetry ensures comprehensive monitoring and optimization of radiation safety practices.

Egg Nest, shield leads to a dose reduction for personnel of **50.07% to 95.26%,** contingent upon the specific procedures employed by each cardiologist.

- The carbon fiber base platform and the modular shielding components make the **Egg Nest** suitable for C-arm systems, as they do not obstruct the movement of the arm.
- This ensures optimal imaging and positioning of the C-arm while simultaneously allowing an uninterrupted overall process, including patient placement.

5. References

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