

## PROIZVODNJA RENDGEN APARATA U SRBIJI

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### SAŽETAK

Rendgen dijagnostika ima nezamenljivo mesto u okviru radiologije i pored drugih savremenih dijagnostičkih metoda. Zato je proizvodnja savremenih rendgen aparata strateški bitna za svaki zdravstveni sistem. Srbija ima tradiciju dugu preko 70 godina u proizvodnji rendgen aparata. Od prvog aparata, proizvedenog u Srbiji 1953. godine, u tehničko-tehnološkom pogledu, išlo se u korak sa svetom. Rendgen aparate je proizvodila državna kompanija Jugorendgen iz Niša. Nažalost, kompanija Jugorendgen je zaustavila proizvodnju pre nego što je uspela da napravi digitalni rendgen aparat. Poslednjih 17 godina, ove uređaje proizvodi kompanija *Visaris*. *Visaris* je privatna kompanija iz Beograda, koja se bavi razvojem i proizvodnjom digitalnih rendgen aparata i softverskih sistema od 2003. godine. Njen značaj došao je do izražaja u vreme pandemije SARS-CoV-2 infekcije, kada je u kratkom vremenskom roku zdravstvenom sistemu Srbije bilo potrebno više stacionarnih i mobilnih rendgen aparata.

**Ključne reči:** rendgen aparat, proizvodnja, zdravstveni sistem

### Uvod

Rendgen dijagnostika je opstala i razvija se i pored razvoja drugih savremenih dijagnostičkih metoda koje se primenjuju u medicinskoj praksi. Stanje se verovatno neće promeniti u skoroj budućnosti, s obzirom na dostupnost, brzinu, kvalitet i cenu rendgen dijagnostike u odnosu na druge dijagnostičke metode. Savremene tehničke inovacije u proizvodnji rendgen aparata omogućavaju minimalno zračenje pacijenata i profesionalno izloženih lica u odnosu na period odmah posle otkrića X-zraka, uz visoku dijagnostičku vrednost. Sve to pomaže očuvanju zdravlja ljudi.

Doza jonizujućeg zračenja koja je potpuno bezopasna ne postoji, kao što ne postoji zaštitno sredstvo, koje bi u potpunosti otklonilo štetan efekat X-zraka (1). Opravdanost upotrebe X-zraka u medicini postoji kada je šteta koju može prouzrokovati manja u odnosu na koristi koju donosi po zdravlje pacijenta. Ovo pravilo se primenjuje i na skrining programe (2). Jedan od preduslova za poštovanje pomenutog pravila, odnosno pravilan

izbor i sprovođenje radiološke procedure je posedovanje kvalitetnih rendgen aparata. Ulaganjem u razvoj i proizvodnju rendgen aparata svaka država obezbeđuje svom stanovništvu optimalno izlaganje X-zracima, ukoliko je to potrebno u cilju izlječenja pojedinaca ili periodične provere zdravstvenog stanja stanovništva (3).

### Istorijat proizvodnje rendgen aparata u javnom sektoru Srbije

Neposredno po završetku II svetskog rata uvidela se potreba za nabavkom novih ili rezervnih delova za stare rendgen aparate. Već 1947. godine, uspostavljena je saradnja sa firmom Simens (*Siemens*) iz Nemačke. Napravljen je dogovor o preuzimanju postrojenja za kompletnu proizvodnju rendgenskih cevi, radio-cevi i aparata, što je rezultiralo formiranjem Instituta za proizvodnju radio-opreme i rendgenskih aparata 1948. godine i kompanije RR Zavod Niš, koji je 1950. prerastao u Elektronsku industriju (Ei) Niš. Pri Elektronskoj industriji u Nišu

## MANUFACTURE OF X-RAY APPARATUS IN SERBIA

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### SUMMARY

X-ray diagnostics has an irreplaceable place in radiology despite other modern diagnostic methods. That is why the production of modern X-ray machines is strategically important for every health system. Serbia has a tradition of over 70 years in the production of X-ray machines. From the first device manufactured in Serbia in 1953, it kept pace with the world in technical and technological terms. X-ray machines were produced by the state company Jugorendgen from Nis. Unfortunately, the company Jugorendgen stopped production before it managed to make a digital X-ray machine. For the past 17 years, these devices have been manufactured by Visaris. Visaris is a private company from Belgrade, which has been developing and manufacturing digital X-ray machines and software systems since 2003. Its importance came to the forefront during the pandemic SARS-CoV-2 infection when the health system of Serbia needed more stationary and mobile X-ray machines in a short time period.

**Key words:** X - ray machine, production, health system

### Introduction

X-ray diagnostics has survived and is developing despite the development of other modern diagnostic methods applied in medical practice. The situation is unlikely to change in the near future, given the availability, speed, quality, and cost of X-ray diagnostics compared to other diagnostic methods. Modern technical innovations in the production of X-ray machines enable minimal radiation of patients and professionally exposed persons compared to the period immediately after the discovery of X-rays and possess a high diagnostic value. All this helps to preserve people's health.

There is no dose of ionizing radiation that is completely harmless, just as there is no protective agent that would completely eliminate the harmful effect of X-rays (1). The justification for using X-rays in medicine exists when the damage it can cause is less than its benefits to the patient's health. This rule also applies to the screening program (2). One of the preconditions for respecting the mentioned rule, i.e., the correct choice and

implementation of the radiological procedure, is the presentation of quality X-ray machines. By investing in the development and production of X-ray machines, each country provides its population with optimal exposure to X-rays, if necessary, in order to cure individuals or periodically check the health of the population (3).

### History of X-ray machine production in the public sector of Serbia

Immediately after the end of World War II, there was a need to purchase new or spare parts for old X-ray machines. As early as 1947, cooperation was established with Siemens from Germany. An agreement was made to take over the plant for the complete production of X-ray tubes, radio tubes, and apparatus, which resulted in the formation of the Institute for the production of radio equipment and X-ray apparatus in 1948 and the company "RR Zavod Nis," which in 1950 grew into the Electronic Industry Nis. At the Electronic Industry in Nis, the

Institut za proizvodnju rendgen aparata od 1952. godine posluje kao samostalna radna jedinica Jugorendgen. Prvi radnici ove fabrike obučavali su se u Simensovim pogonima u Nemačkoj. Dobijena Simensova licenca bila je temelj proizvodnje rendgen aparata u Srbiji.

Pored pomenute licence fabrika je posedovala i kvalitetan visokoškolski kadar, tako da je ulaganje u razvoj dovelo do toga da je Srbija bila jedina zemlja na Balkanu koja je proizvodila rendgen aparate polovinom prošlog veka. Prva rendgenska cev u Nišu proizvedena je 1952. godine, dok je prvi rendgen aparat proizveden i instaliran 1953. godine. Aparat je nosio naziv Moravica, i proizveden je u 1.500 primeraka. Pored jugoslovenskog tržišta, ovaj rendgen aparat je plasiran i u zemljama u okruženju. Zbog razvoja proizvodnje kompleksnih rendgen aparata i osvajanja novih tržišta kompanija je saradivala sa vodećim svetskim proizvođačima rendgen aparata i zapošljavala je oko 700 radnika (4,5). U jednom trenutku većina (oko 75%) rendgen aparata koji su se koristili u Srbiji u okviru medicinske radiologije, bila je proizvedena u Jugorendgenu.

Sve do 1992. godine, kada je uveden embargo Srbiji (tada SR Jugoslaviji) od strane Saveta bezbednosti Ujedinjenih nacija, u Nišu su se proizvodili rendgen aparati za ceo svet. Najviše se izvozilo u Francusku, Poljsku, Holandiju, Rusiju, Australiju i Afriku. Stanje se međutim vrlo brzo promenilo, zbog ratova i ekonomske krize koji su zadesili državu, kao i druge domaće velike kompanije i Jugorendgen krajem XX veka stagnira. Na samom početku XXI veka bilo je više pokušaja da se kompanija reorganizuje uz nove strateške partnere iz inostranstva, međutim svi ti pokušaji su bili kratkog daha (6). Ispostavilo se da su gubici bili nenadoknadivi, tako da je kompanija Jugorendgen zaustavila proizvodnju rendgen aparata pre nego što je uspela da napravi digitalni rendgen aparat. To znači da nije uspela da uhvati korak sa konkurencijom na svetskom tržištu.

### Proizvodnja rendgen aparata u privatnom sektoru Srbije

U novonastalim okolnostima, u Srbiji je 2003. godine osnovana privatna kompanija *Visaris* koja se bavi razvojem i proizvodnjom digitalnih rendgen aparata i softverskim rešenjima za prateće uređaje u okviru radiološke dijagnostike (7).

Rendgen aparati koje proizvodi ova firma primenjuju se za dijagnostiku i upotpunjeni su informatičkim rešenjima za kompletno elektronsko poslovanje radioloških odeljenja. Potpuno je robotizovano kretanje uređaja, razvijeni su digitalni prihvat i akvizicija slike, upravljački softveri i napredni alati za obradu dijagnostičkih snimaka. Na taj način, u duhu tradicije duge pola veka, kompanija *Visaris* u potpunosti prati svetske trendove i standarde Sertifikovanjem svojih proizvoda. Zahvaljujući ovoj kompaniji proizvodnja rendgen aparata u Srbiji je izašla iz nacionalnih okvira. Kompanija je uspela da uspostavi saradnju sa preko 30 zemalja u svetu (8).

Pored toga, kompanija *Visaris* je postala i nastavna baza za studente Studijskog programa za strukovne medicinske radiologe sa Visoke zdravstvene škole strukovnih studija iz Beograda.

Studenti tradicionalno svake godine u okviru predmeta Aparati za radiološku dijagnostiku odlaze u *Visaris*, gde su u prilici da prisustvuju procesu proizvodnje rendgen aparata (slika 1).

U vreme pandemije SARS-CoV-2 infekcije 2020. godine kompanija *Visaris* je pokazala ogroman potencijal kada je u kratkom vremenskom roku zdravstvenom sistemu Srbije obezbedila više stacionarnih i mobilnih rendgen aparata. Ovi aparati bili su namenjeni kako velikim centrima koji su bili najviše opterećeni tokom pandemije, tako i drugim manjim centrima u Srbiji (9,10).

### Perspektiva proizvodnje rendgen aparata u Srbiji

Perspektiva proizvodnje rendgen aparata u Srbiji, gledano iz društveno-političkog i ekonomskog aspekta, je da se najverovatnije rendgen aparati neće proizvoditi u javnom sektoru. Izuzetak mogu da budu, eventualno, neki pojedinačni delovi potrebni za sklapanje rendgen aparata. S druge strane, malo je verovatno da će se pojaviti još neka domaća ili strana privatna kompanija za proizvodnju rendgen aparata, s obzirom na potrebne resurse da bi se pokrenula proizvodnja i uspostavio neophodan nivo. U prilog ovoj pretpostavci je i činjenica da je Srbija malo tržište i za *Visaris*, kao trenutno jedina kompanija koja u Srbiji proizvodi rendgen aparate.

Analizom podataka o zastupljenosti rendgen aparata u Srbiji i podataka kompanije *Visaris* o zastupljenosti rendgen aparata na srpskom tržištu

Institute for the Production of X-ray machines has been operating as an independent working unit of Jugorendgen since 1952. The first workers of this factory were trained in Siemens' plants in Germany. The obtained Siemens license was the basis for the production of X-ray machines in Serbia.

In addition to the mentioned license, the factory also had quality higher education staff, so that the investment in development led to the fact that Serbia was the only country in the Balkans that produced X-ray machines in the middle of the last century. The first X-ray tube in Nis was produced in 1952, while the first X-ray machine was manufactured and installed in 1953. The device was called "Moravica" and was produced in 1,500 copies. In addition to the Yugoslav market, this X-ray machine has also been marketed in the surrounding countries. Due to the development of complex X-ray machines and the conquest of new markets, the company cooperated with the world's leading manufacturers of X-ray machines and employed about 700 workers (4.5). At one point, most (about 75%) of X-ray machines used in Serbia in medical radiology were manufactured in Jugorendgen.

Until 1992, when the United Nations Security Council imposed the embargo on Serbia (then FR Yugoslavia), X-ray machines for the whole world were produced in Nis. Most were exported to France, Poland, the Netherlands, Russia, Australia, and Africa. However, the situation changed quickly due to the wars and economic crisis that hit the country and other large domestic companies, and Jugorendgen stagnated at the end of the 20<sup>th</sup> century. At the very beginning of the 21<sup>st</sup> century, there were several attempts to reorganize the company with new strategic partners from abroad, but all these attempts were short-lived (6). It turned out that the losses were irreparable, so the company Jugorendgen stopped the production of X-ray machines before it managed to make a digital X-ray machine. This means that it failed to catch up with the competition on the world market.

### Production of X-ray machines in the private sector of Serbia

In the new circumstances, a private company Visaris was founded in Serbia in 2003, which deals with developing and producing digital X-ray machines and software solutions for ancillary devices within radiological diagnostics (7).

The X-ray machines produced by this company are used for diagnostics and are complemented by IT solutions for the complete electronic business of radiology departments. The device's movement is completely robotized, while digital image reception and acquisition, control software, and advanced tools for processing diagnostic images have been developed. In this way, in the spirit of a half-century-long tradition, Visaris fully follows world trends and standards by certifying its products. Thanks to this company, the production of X-ray machines in Serbia has gone beyond the national framework. The company has managed to establish cooperation with over 30 countries worldwide (8).

In addition, the company Visaris has become a teaching base for students of the Study Program for Professional Medical Radiologists from the College of Health Professional Studies in Belgrade.

Students traditionally go to Visaris every year as part of the Radiological Diagnostic Apparatus course, where they have the opportunity to attend the X-ray apparatus production process (Figure 1).

At the time of the pandemic SARS-CoV-2 infection in 2020, the company Visaris showed huge potential when in a short time, it provided the health care system of Serbia with more stationary and mobile X-ray machines. These devices were intended for large centers that were the busiest during the pandemic and other smaller centers in Serbia (9,10).

### Prospects for the production of X-ray machines in Serbia

The perspective of X-ray machine production in Serbia, seen from the socio-political and economic aspect, is that most likely, X-ray machines will not be produced in the public sector.

Exceptions may be some individual parts required for assembling the X-ray machine. On the other hand, it is unlikely that another domestic or foreign private company will appear for the production of X-ray machines, given the resources needed to start production and establish the necessary level. In support of this assumption is that Serbia is a small market for Visaris, as the only company currently producing X-ray machines in Serbia.

An analysis of data on the presence of X-ray machines in Serbia and data from Visaris on the



Slika 1. Studenti Odseka visoke zdravstvene škole u kompaniji *Visaris*

došlo se do saznanja da je 2018. godine samo oko 7% rendgen aparata koji se koriste u Srbiji u okviru medicinske radiologije proizvedeno u *Visaris-u* u Beogradu. Ako se uzme u obzir starost tj. period montaže rendgen aparata u Srbiji (od ukupnog broja rendgen aparata u Srbiji, 40-50% je montirano u poslednjih 15 godina) onda se može reći da je oko 15% rendgen aparata koji se koriste u Srbiji, a mlađi su od 15 godina, proizvedeno u *Visaris-u* (11). Interesantan je podatak da je kompanija *Visaris* mnogo više svojih rendgen aparata izvezla u inostranstvo nego što je plasirala na domaće tržište. *Visaris* je 2018. godine obeležio 15 godina uspešnog poslovanja, o čemu govore rendgen aparati ove kompanije na kojima je urađeno oko 1.000.000 ekspozicija.

### Zaključak

Proizvodnja rendgen aparata u Srbiji ima dugu tradiciju. Tradicija se nije prekidala od 1953. godine bez obzira na ozbiljne društveno-političke i ekonomske probleme na prostoru naše zemlje i u bliskom okruženju. Pola veka od prvog proizvedenog rendgen aparata u Srbiji u korak sa svetom rendgen aparate proizvodila je državna kompanija Jugorendgen iz Niša. Poslednjih 17 godina rendgen aparate proizvodi privatna kompanija *Visaris*. Obe kompanije su svojim kvalitetom dostigle svetsko tržište, što je od ogromnog značaja za samu državu Srbiju. Zahvaljujući dugoj tradiciji proizvodnje kvalitetnih rendgen aparata u Srbiji građani Srbije

imaju uvek dostupnu rendgen dijagnostiku. Njihov značaj posebno je uočen tokom pandemije SARS-CoV-2 infekcije.

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**Figure 1.** Students of the Department of Higher Health School in the company Visaris

presence of X-ray machines on the Serbian market revealed that in 2018 only about 7% of X-ray machines used in Serbia in medical radiology were manufactured at Visaris in Belgrade. If we take into account age, i.e., period of installation of X-ray machines in Serbia (of the total number of X-ray machines in Serbia, 40-50% have been installed in the last 15 years), then it can be said that about 15% of X-ray machines used in Serbia are younger than 15 years, produced in Visaris (11). It is interesting to note that Visaris has exported many more of its X-ray machines abroad than it has placed on the domestic market. In 2018, Visaris marked 15 years of successful business, which is evidenced by the X-ray machines of this company, on which about 1,000,000 expositions were made.

## Conclusion

The production of X-ray machines in Serbia has a long tradition. The tradition has not been interrupted since 1953, regardless of the serious socio-political and economic problems in our country and the immediate vicinity. Half a century since the first X-ray machine was produced in Serbia, in step with the world, X-ray machines have been produced by the state company Jugorendgen from Nis. For the last 17 years, X-ray machines have been produced by the private company Visaris. Both companies have reached the world market with their quality, which is of great importance for Serbia itself. Thanks to the long tradition of

producing quality X-ray machines in Serbia, the citizens of Serbia always have X-ray diagnostics available. Their importance was especially noticed during the pandemic of SARS-CoV-2 infection.

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