



## Ejection experience in Serbian Air Force, 1990–2010

Napuštanje aviona izbacivim sedištem: analiza katapultiranja pilota Vojske Srbije u periodu od 1990. do 2010. godine

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### Abstract

**Background/Aim.** Ejection injuries are the problem for air forces. The present risk for injuries is still too high, approximately 30–50%. The aim of this study was to determine factors responsible for and contributing to injuries in the Serbian Air Force (SAF) in the last two decades. **Methods.** All ejection cases in the SAF between 1990 and 2010 were analyzed. The collected data were: aircraft type, ejection seat generation, pilots' age and experience, causes of ejection, aeronautical parameters, the condition of aircraft control and types of injuries. For ease of comparison the US Air Force Safety Regulations were used to define major injuries: hospitalization for 5 days or more, loss of consciousness for over 5 min, bone fracture, joint dislocation, injury to any internal organ, any third-degree burn, or second-degree burn over 5% of the body surface area. **Results.** There were 52 ejections (51 pilots

and 1 mechanic) on 44 airplanes. The ejected persons were from 22 to 46 years, average 32 years. Major injuries were present in 25.49% cases. Of all the ejected pilots 9.61% had fractures of the thoracic spine, 11.53% fractures of the legs, 3.48% fractures of the arms. Of all major injuries, fractures of the thoracic spine were 38.46%. None of the pilots had experienced ejection previously. **Conclusion.** Our results suggest that taking preventive measures is obligatory. Namely, magnetic resonance imaging (MRI) scan must be included in the standard pilot selection procedure and procedure after ejection, physical conditioning of pilots has to be improved, training on ejection trainer has to be accomplished, too.

### Key words:

aerospace medicine; military personnel; occupational exposure; accidents aviation; wounds and injuries; serbia.

### Apstrakt

**Uvod/Cilj.** Povrede nastale katapultiranjem predstavljaju problem za ratno vazduhoplovstvo. Rizik od nastajanja povreda još uvek je visok i kreće se od 30% do 50%. Cilj ove studije bio je da se odrede faktori koji doprinose povredama u vazduhoplovstvu (V) i protivvazdušnoj odbrani (PVO) Vojske Srbije u poslednje dve dekade. **Metode.** Analizirani su svi slučajevi katapultiranja u V i PVO Vojske Srbije u periodu 1990–2010. Prikupljeni podaci odnosili su se na: tip vazduhoplova, generaciju (tip) izbacivog sedišta, starost pilota, iskustvo sa katapultiranjem, uzrok katapultiranja, aerodinamičke parametre koji prethode katapultiranju (vazдушna brzina, visina, položaj vazduhoplova), stanje upravljivosti aviona, vreme iskakanja, težina povreda (teške telesne povrede – TTP; lake telesne povrede – LTP; bez povreda). Zbog mogućnosti lakšeg poređenja sa drugim zemljama, korišćena je klasifikacija Američkog ratnog vazduhoplovstva za teške telesne povrede koja podrazumeva: bolničko lečenje preko pet dana, gubitak svesti preko 5 minuta, prelome kostiju, iščašenje zglobova,

povrede unutrašnjih organa, sve opekotine III stepena, sve opekotine II stepena koje zahvataju preko 5% površine tela. **Rezultati.** U navedenom periodu bilo je 52 katapultiranja (51 pilot i jedan mehaničar letać), na ukupno 44 aviona. Starost pilota bila je u rasponu od 22 do 46 godina, prosečno 32 godine. Teške telesne povrede bile su zastupljene kod 25,49% pilota. Od svih katapultiranih pilota 9,61% imalo je prelome torakalne kičme, 11,53% prelome nogu, 3,48% prelome ruku. Od svih TTP prelom torakalne kičme bio je zastupljen kod 38,46% katapultiranih pilota. Niko od pilota nije imao prethodno iskustvo sa katapultiranjem. **Zaključak.** Naši rezultati ukazuju da je neophodno sprovođenje mera prevencije. Magnetna rezonanca mora biti uključena u standardnu proceduru selekcije pilota, kao i u proceduru nakon katapultiranja. Potrebno je podići nivo fizičke kondicije. Takođe, potrebno je vršiti obuku na trenazu izbacivog sedišta.

### Ključne reči:

medicina, vazduhoplovna; kadar, vojni; profesionalna izloženost; udesi, vazduhoplovni; rane i povrede; srbija.

**Introduction**

Emergency escape from aircraft has been of utmost importance to air force since its inception. Safety and survival of crewmembers have been a major thrust of the entire safety program.

Although survival rates, nature of injuries, and reasons for ejection have been investigated for various air forces and show different characteristics, ejection injuries are still the problem for air forces.

The present risk of injuries is too high, approximately 30–50%. The aim of this study was to determine factors responsible for and contributing to injuries in the Serbian Air Force (SAF) in the last two decades.

**Methods**

All ejection cases in the SAF between 1990 and 2010 were analyzed. The collected data were: type of aircraft, generation of ejection seat, pilots' age, pilots' experience, causes of ejection, aeronautical parameters, the condition of aircraft control types of injuries (major, minor, non-injury). For ease of comparison, the US Air Force Safety Regulations were used to define major injuries: hospitalization for 5 days or more, loss of consciousness for over 5 min, fracture of bone, dislocation of joint, injury to any internal organ, any third-degree burn, or second-degree burn over 5% of body surface area.

**Results**

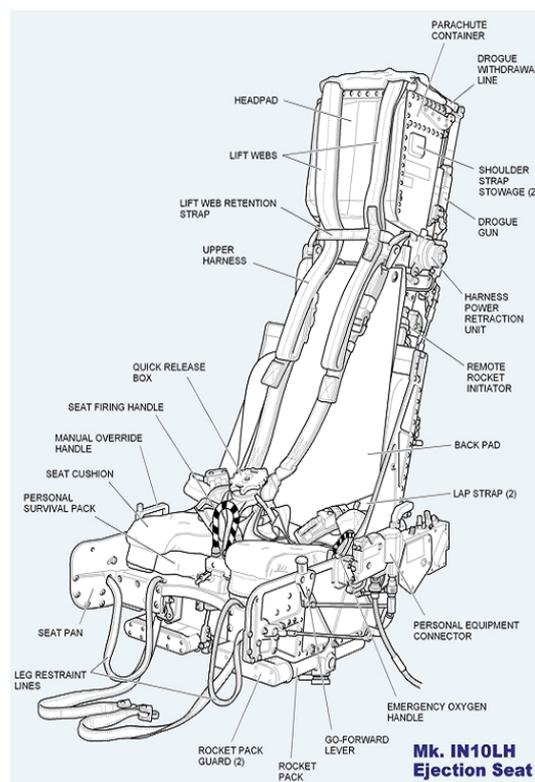
There were 52 ejections (51 pilots and 1 mechanic) on 44 airplanes. The ejected pilots were 22 to 46 years old, average 32 years. The pilots with major injuries had 32.8 years on the average. Emergencies that required ejection were: engine failure (3), control system failure (6), gear failure (5) mid-air collision (1) bird collision (2), and war action (23).

Seven different types of planes were used with five types different-generation ejection seat. Plane and ejection seat types with the major injuries were J/22 (Figure 1) and Martin Baker (MK/Y10) (Figure 2), respectively.

Involvement of Martin-Baker (MK-10) ejection seat in relation to all ejection seats was 53.8%, and involvement of MK-10 in the major injuries was 69.2%.



**Fig. 1 – The plain type J-22 (Orao in Serbian)**



**Fig. 2 – The ejection seat – Martin Baker 10**

Involvement of KM-1 seat in a total number of ejections was 13.46%, and in major injuries 22.22% (Table 1).

**Table 1**

Aircraft, ejection seat and injuries types in the Serbian Air Force ejection experiences during 1990–2010					
Plane type	Pilots (n)	Ejection seat type	Major injuries (n)	Minor injuries (n)	No injuries (n)
H- 62 (9)	11	Martin-Baker (MK-YU 10)	2	3	6
J - 22, HJ-22 (12)	17	MK-YU 10	7	2	8
Jl-17 (7)	7	KM-1	3	1	3
J – 21 (7)	7	Foland 1B	1	2	4
Jl –14 (2)	2	KM			2
Jl –18 (5)	5	K–36 ДМ		1	4
H– 60 (2)	2	Foland 1B			2
<b>Total: 44</b>	<b>51</b>		<b>13 (25.49%)</b>	<b>9 (17.64%)</b>	<b>29 (56.86%)</b>

It is obvious that major injuries were present in 25.49% cases suggesting that every fourth pilot had experienced major injury. Major injuries in war action were only 2, namely 15.3% of all major injuries. It should be noted that there was no major injuries with K-36DM, in spite of ejections in war actions.

A list of injuries included: *fractura fibulae l.sin.*; *frac. mal. lat. cruris. sin.*; *fractura oss nasale*; *fractura Th – IV*; *frac. subcapitis ossis methacarp. II manus dex. aperta*; *frac. Th – VIII*; *frac. tibiae*; *frac. costae X l. sin.*; *frac. compressiva Th – VIII*; *frac. Th - X – XII, cum fractura cruris sin. gr. I aperta*; *frac. Th - IX*, *spondilodesis Th -VII –XI*.

Of all the ejected pilots, 5 (9.61%) had fractures of the thoracic spine, 6 (11.53%) fractures of the legs, and 2 (3.48%) fractures of the arms. Two of them had united fractures.

Of all the major injuries, 38.46%, were related to fractures of thoracic spine, and 60% of them were inflicted on the plain J-22 (MK-10).

Minor injuries that should be mentioned were laceration of the face and burns of the arms.

Obesity (adipositas) was presented in 23.07% of the pilots with major injuries.

None of the pilots had previously experienced ejection.

### Discussion

Analysis done by foreign air forces for long periods of time, with different types of planes and generations of seats, revealed different degrees of fatal injuries during ejection. The highest degree of fatal injuries was recorded in the Japanese Air Force, 22.9% of mortal outcomes in a study for a period 1956–2004<sup>1</sup>. The main reason was the delay in making decision for ejection.

In the study on accidents from 1973 to 1985 US Air Force (USAF) presented a survival rate of 86%<sup>2</sup>. Swedes, in their study for a period 1967–1987 claimed 83 successful ejections and 9 fatal outcomes<sup>3</sup>. Finns, in the study from 1958 to 1991 quoted survival rate higher than 80%<sup>4</sup>. English, in the study of 232 cases of ejection, for a period 1973–2002, quoted the survival rate of 89.2%<sup>5</sup>. In our study there was no case of ejection with fatal outcome.

Compression a fracture of the spine is a common consequence of ejection. Finns quoted 18% of such cases in the total number of all major injuries, Swedes 25%, Italians 15%, USAF 6%, Japanese 63% and English 29.4% of all aircrew. Germans quoted 17.6% of spine fractures in their Air

Force, for a period from 1981 to 1997<sup>6</sup>. Americans quoted 6 spine fractures from 18 ejections in the “Desert Storm”<sup>6</sup>.

In our survey spine fractures were presented in 9.61% of all ejections. The incidence of spine injuries was 38.46% of the major injuries and 60% of all spine fractures was on plane J-22(MK-10).

In their study, English quoted that 44% of minor spinal compression fractures and injuries of spinal ligaments could not be diagnosed with classic Roentgen recording, but only with magnetic resonance<sup>5</sup>. This emphasizes the importance of examination with magnetic resonance of all aircrews after ejections.

Irregular seating position during ejection was accused to be the main reason for spinal fractures and a combination of accomplished highest acceleration and rate of onset. The injuries appeared in the moment of discharge, and acceleration upward. It was established that every reduction of acceleration in the moment of discharge reduces forces acting on the spine and the degree of spine injuries. It was concluded that acceleration reduction from 24 m/s to 18 m/s reduces rate of injuries<sup>5</sup>. The highest rate of injuries was on a plane Tornado, with Martin-Baker seats Mk-10A, with the speed of 20.7 m/s, compared with 19.5 m/s for other types of planes<sup>5</sup>.

In our case, the estimated speed for MK-YU10(MK-10) was 19.8 m/s.

It should be pointed out that a connection between spine fractures and anthropometric measures of pilots could not be established<sup>5</sup>.

In war action the rate of major injuries during ejection was lower than it could be expected. A possible reason was the participation of most experienced aircrews.

In their study Swedes quoted that two third of successfully ejected pilots returned to job after 1 week, others were absent for one year, and only 3.5% finished their flying career<sup>3</sup>.

### Conclusion

Risk of injuries during ejection still remains too high, approximately 30–50%, in our survey 25.49%. There were no ejections with fatal outcome in our study. The main reason for spine injuries was irregular position of the spine in the seat and a combination of the peak of acceleration and the rate of onset. Preventive measures must be promoted: MRI scan should be included in the standard selection procedure and procedure after ejection physical conditioning has to be improved, training on ejection trainer has to be accomplished, too.

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