

Investigation on Hospitalization of Cervical Spondylosis among Military Pilots, 2010 - 2019

Hong-xing Zhang (✉ 1337896065@qq.com)

Air Force General Hospital PLA <https://orcid.org/0000-0001-9505-0323>

Yu-Fei Chen

Air Force General Hospital PLA

Ye Peng

Air Force General Hospital PLA

Jing-yuan Li

Air Force General Hospital PLA

Xiao-gang Huang

Air Force General Hospital PLA

Jin-ping Tian

Air Force General Hospital PLA

Jun-jie Du

Air Force General Hospital PLA

Research

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1 **Investigation on Hospitalization of Cervical Spondylosis** 2 **among Military Pilots, 2010 - 2019**

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4 **Ethical Approval and Consent to participate:**Not applicable;

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20 **Authors' information:**

21 **Author:**Hong-xing Zhang^{1,2}, Yu-Fei Chen¹, Ye-Peng¹, Jing-yuan Li^{1,2},

22 Xiao-gang Huang¹, Jin-ping Tian¹, Jun-jie Du^{1,2,*}

23 **Affiliations:** ¹Department of Orthopaedics, Air Force Medical Center of PLA, Beijing,
24 ²People' s Republic of China;Clinical Medical College of Air Force, Anhui Medical
25 University, Hefei,People' s Republic of China ;

26 **Correspondence:** * Jun-jie Du

27 Department of Orthopaedics, Air Force Medical Center of PLA, 30 Fucheng Road,
28 Beijing, P. R. China, 100142

29 E-mail: dujunjie205@hotmail.com FAX: +86 10 66928452 Phone: +86 10 66928452

30 **ABSTRACT**

31 **Objective:** To investigate and analyze the situation of hospitalization and medical
32 appraisal of cervical spondylosis in military pilots.

33 **Methods:** A single-center retrospective study was conducted on the active military
34 pilots hospitalized for cervical spondylosis in our center from January 2010 to
35 December 2019.After inclusion and exclusion criteria, descriptive statistics and
36 analysis were made on age, sex, flight type, flight time, disease type, diagnosis and
37 treatment and medical identification results of the included subjects.

38 **Results:** During January 2010 to December 2019, 166 military pilots with cervical
39 spondylosis were admitted to our center, accounting for 17.61% of the total
40 orthopaedic diseases, ranking the second place.The hospitalization rate of military
41 pilots with cervical spondylosis in orthopedics department decreased from 2015 to
42 2019, but the hospitalization rate (193 person-times) was in an increasing trend
43 compared with that in 2010-2014 (148 person-times) ($P < 0.05$).The average age of
44 the pilots with cervical spondylosis was 37.37 ± 7.37 years old, and there was no

45 significant difference in the age of the pilots of different aircraft types. Compared
46 with the age of other active servicemen in the same period (39.72 ± 8.98 years), the
47 incidence of the pilots tended to be younger ($P < 0.05$). The average incidence of
48 cervical spondylosis in flight crew was 2597.09 ± 1954.50 h, and fighter pilots were
49 more likely to have cervical spondylosis in early flight than those who flew helicopter,
50 transport aircraft and trainer aircraft ($P < 0.05$). 4 cases (2.41%) received surgical
51 treatment, which was significantly lower than that of non-aircrew members (12.09%)
52 ($P < 0.05$). Among the 166 cases, 87 cases (52.41%) were qualified and returned to
53 work, 53 cases of military pilots temporary unqualified flight, 26 cases of military
54 pilots unqualified flight, unable to continue to fly.

55 **Conclusion:** Cervical spondylosis of pilots account for the forefront of orthopedic
56 disease spectrum, and the onset age is younger, the treatment is relatively simple, and
57 the qualified rate of flight after treatment is low.

58 **Keyword:** cervical spondylosis, military pilots, medical appraisal, hospitalization

59 **BACKGROUND**

60 Training related muscular-skeletal disorders among service members are the
61 most common cause of dysfunction, early withdrawal, disability, and discontinuance
62 from military service in different military populations around the world, with a
63 steadily increasing incidence rate^[1-2]. In addition to daily training, the improvement of
64 aircraft performance and high-intensity flight training make it easier for military pilots
65 to be exposed to muscular-skeletal disorders in the training process^[3].

66 Cervical spondylosis is very common in the muscular-skeletal disorders of

67 military pilots, and the incidence of cervical spondylosis is in the forefront^[4-5].The
68 particularity of the working nature of military pilots has very strict requirements on
69 physical functions. The symptoms such as nerve root pain, somatosensitive numbness,
70 hypoalgesia or hyperalgesia caused by cervical spondylosis will greatly interfere and
71 restrict the flight of military pilots.Secondly, frequent medical visits may lead to the
72 failure of normal flight training, which may limit their deployment and training,
73 resulting in a burden on the base units.At present, cervical spondylosis is still a
74 disease of special attention and research by domestic and foreign military medical
75 scholars. The purpose of this study is to conduct descriptive statistics and analysis on
76 the flight data, disease types, diagnosis and treatment, and flight identification results
77 of the subjects through the investigation on the hospitalization of cervical spondylosis
78 among military pilots in service in our hospital from January 2010 to December 2019.

79 **METHODS**

80 **Inclusion and exclusion**

81 **Inclusion criteria** :(1) Patients hospitalized for treatment or modified flight
82 conclusion from January 2010 to December 2019;(2) Active military pilots of the
83 navy, land and air forces (including pilots, navigators, communicators, mechanics and
84 other air service personnel);(3) Clinically diagnosed as cervical spondylosis.

85 Subjects should meet all of the above requirements simultaneously.

86 **Exclusion criteria** :(1) Patients who were not hospitalized during the study period for
87 treatment or modified flight conclusions;(2) Non-active military pilots and pilot
88 cadets;(3) Other military pilots(including air broadcast controller, photographer, flight

89 attendant, etc.);(4)Cervical spondylosiss caused by fractures, tumors, tuberculosis, etc.

90 Satisfying any of the above will be excluded.

91 **Research methods**

92 A single-center retrospective study was conducted to evaluate hospitalization and
93 recovery forcervical spondylosis in active service pilots.Search the in-patient data
94 database of our center for the military pilots hospitalized forcervical spondylosis in
95 January 2010 and December 2019. Through inclusion and exclusion criteria, collect
96 the in-patient on-duty military pilots to consult the case information in detail, and
97 record the relevant information of the patients.General data (age, gender), flight data
98 (aircraft type, flight time), disease classification, diagnosis and treatment and flight
99 identification results were included, and statistical analysis was conducted on the
100 collected data.The relevant data of the research subjects have been examined and
101 approved by the confidentiality experts of our hospital, and there is no confidentiality
102 related behavior.

103 **Statistical method**

104 Statistical software SPSS 24.0 was used for statistics and analysis, in which the
105 number of pilot cases, gender, surgical patients and other statistical data were
106 represented by N /%, the measurement data, such as age, hospital stay and flight
107 duration, were represented by $\bar{X} \pm S$,Chi-Square test was used to compare the
108 counting data of the two groups, and T-test was used to compare the measurement
109 data of the two groups, ANOVA was used to compare the data of multiple groups, and
110 LSD test was used to compare the multiple data after the event.The $P < 0.05$ difference

111 was statistically significant.

112 RESULTS

113 Annual hospitalization of cervical spondylosis among military pilots

114 Among 166 cases of cervical spondylosis in military pilots, the number of
115 hospitalizations due to cervical spondylosis (341) and hospitalization ratio (17.61%)
116 were significantly higher than that of non-air military personnel (104) and
117 hospitalization ratio (4.43%) during 2010-2019, shown in Table 1. The proportion of
118 patients with cervical vertebra disease in the orthopedics department of military pilots
119 decreased from 2015 to 2019, but the number of patients with cervical vertebra
120 disease was on the increase compared with that of 2010-2014, $P < 0.01$, shown in
121 Table 2.

Table 1 Annual Hospitalization of Cervical spondylosis among Military Personnel (Time/Ratio)

Year	military pilots	Non-airmen
2010	20 (16.95%)	8 (4.73%)
2011	13 (12.62%)	7 (3.89%)
2012	26 (18.38%)	7 (5.93%)
2013	34 (34.34%)	8 (3.49%)
2014	55 (23.21%)	3 (1.28%)
2015	51 (21.89%)	11 (4.30%)
2016	37 (17.42%)	15 (5.23%)
2017	35 (13.57%)	12 (5.02%)
2018	36 (13.24%)	16 (5.81%)
2019	34 (12.69%)	17 (5.21%)
Total	341 (17.61%)	104 (4.43%)

122

Table 2 Change of hospital visits for cervical spondylosis among military pilots

Year	Cervical spondylosis (time)	Other orthopaedic diseases (time)
2010-2014	148(21.36%)	545(78.64%)
2015-2019	193(15.53%)	1050(84.47%)
\bar{X}		10.420
P		0.001

123 General characteristics

124 166 patients with cervical spondylosis were included in the study, including 147
 125 in the Air Force and 19 in the Army. The mean age of the first hospitalized patients
 126 was 37.37 ± 7.37 years old. Among the inpatients, there were 37 cases of cervical
 127 spondylosis, 59 cases of radiculotype cervical spondylosis, 6 cases of cervical
 128 spondylotic myelopathy, 62 cases of mixed cervical spondylopathy, and 2 cases of
 129 other types. Among them, 159 pilots received conservative treatment such as massage
 130 and physiotherapy bonesetting, and 4 pilots received surgical treatment, as shown in
 131 Table 3.

Table 3 Basic characteristics of hospitalization of military pilots

Characteristics	Number
Military pilots(n)	166
Personnel category(n/%)	
Pilot	156
other	10
Sex(n/%)	
Male	160
Female	6
Model(n/%)	
Air force	147
Navy	19
Age	37.37 ± 7.37
Mean flight time(H)	2597.09 ± 1954.50
Classification of cervical spondylosis	
Cervical spondylosis	37
Cervical spondylotic radiculopathy	59
Cervical spondilotic myelopathy	6
Mixed cervical spondylopathy	62
Others	2
Treatment	
Conservative	162
Surgical	4

132 **Analysis of disease related factors**

133 **Age**

134 The age of the pilots at the first hospitalization of cervical spondylosis was

135 mainly distributed between 26 and 45 years old, accounting for 83.74% of the total
 136 number. The age distribution of military pilots of different aircraft types was compared.
 137 There was no difference in age among the groups ($F=1.18$, $P=0.321$). Compared with
 138 other servicemen in the same period, the age of first hospitalization of cervical
 139 spondylosis in military pilots was lower, and the difference was statistically
 140 significant ($P=0.031$), shown in table 4.

Table 4 Age distribution of cervical spine diseases in pilots

	Helicopter	Conveyor	Fighters	Trainer	Others	military pilots	Non-airmen
Num	42	29	32	31	32	166	91
Age	38.33±7.25	39.55±8.97	35.75±6.47	38.13±6.95	35.00±6.56	37.37±7.37	39.72±8.98
F			2.174				2.173
P			0.074				0.031

141 **Time of flight**

142 The average flight time is 2597.09±1954.50h, when analyzing the flight time of
 143 flight crew of different aircraft types, one-way ANOVA ($F=2.440$, $P=0.019$), it can be
 144 seen that the variance is not uniform. Brown-Forsythe is more suitable than ANOVA
 145 to judge whether the mean is equal. The Sig of Brown-Forsythe is 0.007 <
 146 0.05m. After multiple comparison (LSD), there were statistical differences in flight
 147 time between fighters and helicopters ($P=0.041$) and transport aircraft ($P=0.001$),
 148 while there were differences between other types of fighters and transport aircraft
 149 ($P=0.004$). It indicates that the pilots of fighters are more prone to Cervical
 150 spondylosis than those of helicopters, transport planes and trainers during
 151 flight, shown in table 5.

Table 5 Flight duration of different types of pilots is distributed

Helicopter	Conveyor	Fighters	Trainer	Others
------------	----------	----------	---------	--------

Num	42	29	32	31	32
Time(H)	2824.10±1955.21	3517.24±2850.95	1905.31±955.59	2665.65±1582.83	2090.63±1724.00
F			3.497		
P			0.009		

152 **Results of medical appraisal**

153 All the military pilots were in a state of temporary flight disqualification before
154 admission. After the last hospitalization, a total of 87 pilots were allowed to fly and
155 return to work ,53 cases temporarily unqualified, 26 cases unqualified.According to
156 the classification of cervical spondylosis, the flight disqualified flight crew were
157 analyzed, and the cervical spondylosis of flight disqualified flight crew was mainly
158 distributed in nerve root type and mixed type of cervical spondylosis, accounting for
159 82.28% of the total disqualified flight crew.The disqualification rate was different in
160 different types of cervical spondylosis. The symptoms of cervical spondylosis
161 improved obviously after treatment, and the disqualification rate was the
162 lowest.Cervical spondylotic myelopathy accounted for a small proportion in all types
163 of cervical spondylotic diseases, but the rate of disqualification was the highest,
164 shown in table 6.

165 According to the classification of aircraft types, although the number of
166 hospitalized fighters due to cervical spondylosis ranks second, the failure rate is the
167 lowest among all aircraft types.There was no significant difference in flight failure
168 rates among pilots flying other types of aircraft after cervical spine treatment,shown
169 in table 7.

Table 6 The relationship between cervical spondylosis classification and medical identification results

Disease types(n)	Qualified	Temporarily not qualified	No-qualified	No-qualified ratio
Cervical spondylosis	30	5	2	18.92%

Cervical spondylotic radiculopathy	31	22	6	47.46%
Cervical spondilotic myelopathy	0	4	2	100%
Mixed	25	22	15	59.68
Others	1	0	1	50.00%
Total	87	53	26	47.59%

170

Table 7 Medical identification results of different aircraft pilots

Type	Qualified	Temporarily not qualified	No-qualified	No-qualified ratio
Helicopter	23	9	10	45.24%
Conveyor	15	9	5	48.28%
Fighters	19	9	4	40.63%
Trainer	25	22	15	48.39%
Others	14	15	3	56.25%
Total	87	53	26	47.59%

171

172 **DISCUSS**

173 Cervical spondylosis is more common in active military diseases, with a
 174 incidence of 1.79/1000 persons/year^[6]. In the past ten years, our center has treated 341
 175 military pilots with cervical spondylosis, accounting for 19.31% of the total number
 176 of military pilots with orthopedic diseases, ranking the second among orthopedic
 177 diseases. Studies have reported that high +Gz forces^[7,8], postural^[9], helmet system
 178 equipment^[10] and other risk factors can easily lead to cervical intervertebral disc
 179 cartilage endplate injury, reduced penetration ability to the nucleus pulposus, reduced
 180 disc elasticity, reduced water content, and eventually lead to annulus fibrosus rupture,
 181 nucleus pulposus extrusion, annulus fibrosus protrusion and compression of the spinal
 182 canal or nerve root^[11].

183 Military pilots' cervical vertebrae may have a greater risk of degenerative lesions
 184 with age than in the general population. Studies have reported that the onset age of
 185 cervical spondylosis in military pilots is earlier than that of ordinary people, and the

186 incidence of cervical spondylosis increases significantly after the age of 30. In this
187 study, the onset of cervical spondylosis was earlier in military pilots, and the cervical
188 cervical "premature senescence" was most obvious in the early stage of military
189 pilots's career^[12]. In the study of the risk factors of cervical vertebra disease among
190 military pilots of different aircraft classes, there was no difference in the age of onset
191 of cervical vertebra disease among different aircraft classes, and age may not be a risk
192 factor affecting the incidence of cervical vertebra disease among different aircraft
193 classes. It was found that among the military pilots suffering from cervical
194 spondylosis, the average flight time of military pilots of fighter aircraft was
195 1953.74 ± 1546.11 hours. Significantly lower than the helicopter (2847.85 ± 1928.31
196 hours), transport aircraft (3040.61 ± 1834.76 hours), and training aircraft
197 (2894.23 ± 1795.01 hours) pilots. This suggests that pilots flying high-performance
198 fighters may be more prone to cervical spondylosis during early flight.

199 In this study, the cervical spondylosis of military pilots was mainly cervical type
200 (37 cases), nerve root type (59 cases) and mixed type (62 cases), accounting for
201 95.18% of the total number of people. Conservative treatment was preferred in the
202 early stage of the disease, and only 4 (2.41%) pilots chose surgical treatment in the
203 later stage, among which 3 pilots chose surgery when they were near the maximum
204 flying age.

205 At the last follow-up, 87 (52.41%) of the pilots passed the flight and returned to
206 work. 53 cases (31.93%) of military pilots temporarily unqualified, 26 cases (16.66%)
207 of military pilots unqualified. According to the analysis of military pilots who are

208 unqualified (including temporary unqualified, unqualified and grounded), the cervical
209 spondylosis of flight unqualified is mainly distributed in nerve root type and mixed
210 type cervical spondylosis, accounting for 82.28% of the total unqualified. Cervical
211 spondylosis has a lower degree of degenerative disease and mild symptoms. After
212 conservative treatment, the symptoms are significantly improved, and the flight
213 failure rate is the lowest. It is suggested that flight attendants with cervical
214 spondylosis should seek medical treatment early so that they may return to work
215 earlier. Cervical spondylotic myelopathy accounted for a small proportion in all types
216 of cervical spondylotic diseases, but the rate of disqualification was the highest. In this
217 study, there was little difference in the number of unqualified pilots flying each type
218 of aircraft. Although the number of hospitalized fighters due to cervical spondylosis
219 ranked second, the unqualified rate was the lowest among all types of aircraft. The
220 reason may be that the cervical spondylosis of fighter military pilots accounts for a
221 large proportion of cervical spondylosis, accounting for 35.14% of the total types.

222 In the last follow-up, the disqualification rate of military pilots (including
223 temporary disqualification and disqualification) reached 47.59%, which seriously
224 affected the normal flight training of military pilots and the combat effectiveness of
225 China's aviation armed forces. The professional duty of a military surgeon is to advise
226 pilots on the risks and benefits of surgery and realistic expectations of the possible
227 effects of surgery on their military careers. Of the 166 military pilots treated in our
228 center, only 4 patients received surgical treatment, with an operative rate of 2.41%,
229 significantly lower than that of non-flight military personnel. Foreign studies have

230 reported the return rate of flight crews after cervical spine surgery. A 1964 study at
231 Lackland Air Force Base reported that 5 flight crews returned to work after anterior
232 cervical fusion, but no other details were provided^[13]. Miller^[14] conducted a
233 single-center retrospective study on active pilots in the US military who received
234 ACDF or CTDR from January 2010 to June 2017. The proportion of military pilots
235 returning to active flight status after anterior cervical surgery was 84.6%. They think
236 that military pilots with symptomatic cervical spondylosis could return to flight status
237 after receiving anterior cervical discectomy and fusion (ACDF) or total disc
238 replacement (TDR) .

239 One of the most important indicators of military pilots treatment in military
240 medicine is the ability to return to flight status. Our study analyzed the hospitalization,
241 diagnosis and treatment of cervical spondylosis and flight disqualification of military
242 pilots. It is expected to provide help for military doctors, provide data support for
243 those military pilots considering surgery, and have certain guiding significance for
244 improving flight working environment of military pilots and specific prevention
245 strategy research. Retrospective, limited follow-up time, and small studies limit our
246 ability to apply the results to the entire pilot population. Retrospective review may
247 introduce selection bias because our population is limited to flight crews found in the
248 study design. These are the shortcomings of our research. Future prospective
249 randomized controlled trials are needed to further clarify these conditions as to what
250 is the best treatment for active duty military pilots.

251 **CONCLUSION**

252 Based on the investigation of the hospitalization of cervical spondylosis in
253 military pilots in recent ten years, the following conclusions are drawn. First, cervical
254 spondylosis in military pilots ranks in the forefront of the spectrum of orthopedic
255 diseases in pilots, which still needs to be paid attention to; Furthermore, the treatment
256 of cervical vertebra diseases in military pilots is relatively simple, and most of them
257 did not show significant remission after conservative treatment, leading to a low rate
258 of return to work; Finally, the operation rate of military pilots hospitalized for cervical
259 spondylosis is low, and there is no relevant clear standard of medical identification
260 evaluation after surgery, which has a certain impact on the diagnosis and treatment of
261 military pilots.

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