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Spondylolysis, spondylolisthesis, and degenerative changes of facet joint- low progression but high psychological burden: result of assessing lumbar imaging in a one-year follow up

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Abstract

Background and aim: Spondylolysis and spondylolisthesis are believed to be related to low back pain (LBP) and causes several sufferings for the patients. The condition may be more severe in some occupations. The aim of our study was to investigate the change of spondylolysis/spondylolisthesis and facet joint osteoarthritis in military and non-military cases. As a secondary aim we assessed the psychological burden of these disorders.

Method: Two similar groups including 85 military and 85 non-military spondylolysis/spondylolisthesis cases were enrolled. All the patients underwent imaging and Dayan grading for spondylolysis/spondylolisthesis and Goda score for facet joint degenerative changes were assessed. The patients were followed for a duration of one year. and the changes were assessed and compared between the two study groups. Moreover, to assess the psychological effect and the posed disability, beck anxiety index (BAI) and Oswestry Disability Index (ODI) questionnaires were used.

Results: Totally 82 cases in the military group and 84 cases in non-military group were assessed at the end of follow up. Only Dayan score in military group showed significant increase at the end of follow up ($p=0.008$). Regression analysis showed no relationship between being military and Goda ($p=0.180$) or Dayan scores ($p=0.184$). Furthermore, although there were no significant changes in ODI score at end of follow up in both military ($p=0.136$) and non-military groups ($p=0.612$), BAI significantly increased at the end of follow up in both military ($p<0.001$) and non-military groups ($p<0.001$).

Conclusion: The role of military occupation in spondylolysis/spondylolisthesis or facet joint osteoarthritis changes is still under question. However, it seems that the condition poses anxiety on patients.

INTRODUCTION

Globally, seven to eight out of ten cases in general population experience low back pain (LBP) during a time of their lives (1). It is reported that LBP is the second cause of outpatient visits after a common cold, accounting for around 30% of referrals to these centers (2). The global disability-adjusted life years (DALYs) for LBP is reported to be 63.7 million (3). The condition is not only a problem in high income countries, but also can affect middle- and low-income countries. The most recent study in case of assessing the prevalence of LBP in Iran reported that around one out of every four Iranians suffer from LBP (4).

Although it is believed as a rule that LBP should be usually found in old adults, studies reported that around 40% of the cases age ≤ 55 years old. Several risk factors are believed to be related to the LBP including long-time standing, heavy work, smoking, and even low household income (5). Some imaging correlates with this regard are also proposed. It is reported that in adult patients aged less than 50 years old presence of Modic

type 1 change, disc extrusion, disc bulge, spondylolysis, and spondylolisthesis are imaging risk factors for LBP (6).

Spondylolysis is defined as a defect or fracture in par-interarticularis and is considered to be a stress fracture. However, the condition can be congenital, too (7). When the slippage of the vertebrae happens, it is time that spondylolisthesis begins. There are few reliable studies in case of epidemiology of spondylolysis. A meta-analysis showed that the prevalence of spondylolysis and spondylolisthesis in general population is 3-10% and 2-6%, respectively (8). A study in Iran also reported the prevalence of spondylolysis and spondylolisthesis among patients with chronic LBP is 13 and 8.6 percent respectively (9).

As spondylolysis and thus spondylolisthesis is considered to be a stress fracture; it may be higher in some specific populations. Rossi et al. assessed the radiologic presence of spondylolysis in athletes and reported that 13.9% of the patients suffer from spondylolysis and 47.45% of spondylolysis cases had concomitant spondylolisthesis. Diving, wrestling, and weight lifting were the top listed sports with this regard according to the prevalence (10).

Moreover, the role of occupation in development of spondylolysis/lysthesis is also investigated. Chen et al. (11) proposed being taxi driver as a risk factor for spondylolysis. Another group which is at a high risk of spondylolysis development are military forces. However, studies rarely investigated the condition in this group. Celtikci et al. (12) reported that around 35 percent of the commandos may have bilateral pars-interarticularis fracture. Libson et al. (13) also reported that around one out of every ten asymptomatic cases had spondylolysis.

Moreover, it is proposed that the presence of spondylolysis is associated with higher rate of degenerative change of lumbar facet joints (14). Furthermore, the presence of osteoarthritis in veterans is 19-fold higher than normal population (15). However, no studies focused on the degenerative changes of facet joints in military forces. The aim of our study is to first assess the changes of the severity of spondylolysis/spondylolisthesis and second assess the facet joint degenerative changes in these patients during one-year follow up. Moreover, both spondylolysis/spondylolisthesis severity changes and facet joint degenerative changes were assessed in non-military cases and compared with military group.

It is also proposed that LBP can be a cause of stress, anxiety, and change of quality of life (16, 17). However, there is a lack of knowledge with this regard in case of spondylolysis and spondylolisthesis cases. As a secondary aim, we tried to investigate the psychological burden of spondylolysis and spondylolisthesis and the effect of these disorders on daily life using beck anxiety index (BAI) and Oswestry Disability Index (ODI) questionnaires.

Material and methods

Study design and sample

This multi-center study was conducted on a cohort of male spondylolysis and spondylolisthesis cases, who referred with chief complaint of LBP to the military hospitals of Tehran, Iran. All the included cases should age between 18 to 50 years old. The patients were classified into two groups. The military cases with at least a service time of one year and non-military cases for comparison. Both groups comprised a number of 85 patients according to the sample size calculation using Goda et al. study (14). The both groups were similar in case of gender and were age and body mass index (BMI) matched. Those who had a history of vertebrae fracture, infections (like brucellosis), and spine surgeries were excluded.

Data gathering

Demographic and anthropometric data including age, weight, height, and BMI were recorded for both military and non-military groups. Moreover, the type of work in military service (combat group or office group) was assessed in military group. Office group was comprised of the patients who had administrative works and combat group were involved in training and other martial affairs. In case of imaging data, all the images were assessed by two radiologists in case of making a consensus; however, when there was no same opinion, a third party resolved the problem. All the data were compared between the two study groups and in a before-after manner at the end of follow-up.

Spondylolysis/spondylolisthesis grading

The grading of the spondylolysis/spondylolisthesis severity was according to the degree of vertebrae slippage and the presence of symptoms, as presented in Dayan et al. study (18). In case of slippage of spondylolisthesis, there was four radiologic grading according to the Meyerding grading system (19), grade 1 (<25% slip), grade 2 (25-50% slip), grade 3 (50-75% slip), and grade 4 (75-100% slip).

Facet joint degeneration grading

The radiologic facet joint degeneration grading was calculated according to the Goda et al. study (14). The presence of narrowing, sclerosis, osteophyte, and bone cyst were assessed. Each of these radiologic findings scored one and thus facet osteoarthritis degree scored as 0 to 4. The changes were assessed after the follow up.

Beck anxiety index (BAI) and Oswestry Disability Index (ODI) questionnaires

In order to assess the functional limitation that spinal disorders have posed for our studied sample Oswestry Disability Index (ODI) questionnaire was used. The validity and reliability of the Persian were confirmed in a previous study (20). Moreover, in order to assess the psychological burden of spondylolysis and spondylolisthesis, Beck anxiety index (BAI). The reliability and validity of BAI index Persian version was also investigated and proposed in a study (21).

Ethics

The patients in both groups were provided with written informed consent and were free to leave the study whenever they want. All the gathered data were anonymized and coded in order to be confidential. All the steps of the study were in accordance with Helsinki's declaration and is confirmed by ethics committee of AJA university of medical sciences.

Analysis

SPSS software was used for statistical analysis. The mean, median, standard deviation, and interquartile range were measured for quantitative data. In addition, independent sample t-test was used to compare quantitative data between the two study groups, if normal, and Mann-Whitney test was used, otherwise. Moreover, qualitative data were compared using chi-square and fisher's exact tests. Moreover, multivariate linear regression test was used to determine the factors affecting the severity of osteoarthritis and spondylolysis / spondylolisthesis grading. P values less than 0.05 were considered significant.

Result

Patients' enrolment and follow up

A total of 170 male patients with spondylolysis / spondylolisthesis were included in the study, of which 85 were in the military group and 85 were in the non-military group. However, 3 cases in military group and one case in non-military group were lost to follow up. With this regard, the final analyses were conducted on 82 cases in the military group and 84 cases in non-military group. Figure 1 shows the flow chart in case of patients' enrollment. One patient in military group underwent surgery and thus was excluded and the other two did not consent to follow the study. The only lost to follow up case of non-military group was unfortunately deceased.

Comparison of demographic, anthropometric and baseline radiologic data between the two study groups

Table 1 compares age, BMI, and baseline radiologic data between the two study groups. There was no significant difference regarding age (p=0.604), BMI (p=0.231), Meyerding grade (p=0.267), Goda score (p=0.135), and Dayan score (p=0.110) between the two military and non-military groups at baseline. Moreover, all the variables were compared between office and combat groups. Combat group had significantly higher median Goda score (2.0 vs 0.0; p<0.001) and higher median Dayan score (5.0 vs 3.0; p<0.001) at baseline.

Table 1. comparison of age, BMI, and baseline radiologic data between the two study groups

Feature		**Group**		**p value**
		Military	**Non-military**	
Age (year; median (IQR))		33.50 (44.00 28.00)	38.00 (44.00 27.00)	*0.604
BMI (kg/m^2; median (IQR))		25.61 (26.81 24.69)	25.30 (26.26 24.48)	*0.231
Type N (%)	Spondylolysis	52 (63.4)	61 (72.6)	**0.203
	Spondylolisthesis	30 (36.6)	23 (27.4)	
Meyerding grade	1	12 (40.0)	15 (65.2)	**0.267
	2	8 (26.7)	5 (21.7)	
	3	7 (23.3)	2 (8.8)	
	4	3 (10.0)	1 (4.3)	
Goda score	Median (IQR)	1.0 (1.0 0.0)	0.0 (1.0 0.0)	*0.135
	Mean±SD	0.90±1.01	0.64±0.78	
Dayan score	Median (IQR)	3.0 (4.0 3.0)	3.0 (4.0 3.0)	*0.110
	Mean±SD	3.62±0.91	3.38±0.69	

*Mann-Whitney test was used; **Chi-square test was used

Assessing the changes of radiologic finding after one-year follow up

The comparison of Goda score and Dayan score between baseline and after one-year showed that only Dayan score in military group showed significant increase after one year. Table 2 showed the details of this comparison. The analyses were conducted separately according to the office and combat groups. Only Dayan score in combat group showed a significant increase at the end of follow up (p=0.008).

Table 2. comparison of Goda score and Dayan score between baseline and after one-year

Feature			**Time**		**p value**
			Baseline	**After one year**	
Non-military	Goda score	Median (IQR)	0.0 (1.0 0.0)	0.0 (1.0 0.0)	*0.317
		Mean±SD	0.64±0.78	0.65±0.78	
	Dayan score	median (IQR)	3.0 (4.0 3.0)	3.0 (4.0 3.0)	*0.157
		Mean±SD	3.38±0.69	3.40±0.76	
Military	Goda score	Median (IQR)	1.0 (1.0 0.0)	1.0 (1.0 0.0)	*0.083
		Mean±SD	0.90±1.01	0.93±0.99	
	Dayan score	Median (IQR)	3.0 (4.0 3.0)	3.0 (4.0 3.0)	*0.008

		Mean±SD	3.62±0.91	3.70±1.08	

*Wilcoxon test was used

Comparison of Goda score and Dayan score between the two study groups at the end of follow up

Table 3 compares Goda score and Dayan score between the two study groups at the end of study. There was no significant difference in case of Goda score (p=0.080) and Dayan score (p=0.104) between military and non-military groups. However, combat group had significantly higher median Goda score (2.0 vs 0.0; p<0.001) and higher median Dayan score (5.0 vs 3.0; p<0.001) at the end of study. Moreover, there was no changes in Meyerding grading during the one-year follow up.

Table 3. comparison of Goda score and Dayan score between the two study groups at the end of study

Feature		**Group**		**p value**
		Military	**Non-military**	
Goda score	median (IQR)	1.0 (1.0 0.0)	0.0 (1.0 0.0)	*0.080
	Mean±SD	0.93±0.99	0.65±0.78	
Dayan score	median (IQR)	3.0 (4.0 3.0)	3.0 (4.0 3.0)	*0.104
	Mean±SD	3.70±1.08	3.40±0.76	

*Mann-Whitney test was used

Assessment of ODI and BAI scores

The difference in case of BAI and ODI scores were significant between both study groups at baseline and after one year. Table 4 shows the results with this regard. Table 5 also compares of ODI score and BAI score between baseline and at the end of follow up in both military and non-military cases. As it is evident BAI score increased in both military and non-military groups at the end of follow up (p<0.001). However, ODI score showed no significant change.

Table 4. comparison of ODI score and BAI score between the two study groups at the baseline and end of study

Feature			**Group**		**p value**
			Military	**Non-military**	
Baseline	ODI	Median (IQR)	8.8 (22.0 6.6)	8.0 (10.0 6.3)	*0.018
		Mean±SD	14.32±10.09	10.46±6.58	
	BAI	Median (IQR)	11.5 (18.0 9.0)	10 (15.0 7.0)	*0.008
		Mean±SD	13.73±5.94	11.65±5.14	
After one year	ODI	Median (IQR)	8.8 (22.0 6.6)	8.0 (10.0 6.3)	*0.008

		Mean±SD	14.40±10.31	10.59±7.07	
	BAI	Median (IQR)	13.0 (19.0 10.0)	11.0 (17.0 8.0)	*0.014
		Mean±SD	14.64±6.02	12.57±6.05	

* Mann-Whitney test was used

Table 5. comparison of ODI score and BAI score between baseline and at the end of follow up in both military and non-military cases

Feature			**Group**		**p value**
			Baseline	**After one year**	
Military	ODI	Median (IQR)	8.8 (22.0 6.6)	8.8 (22.0 6.6)	0.136
		Mean±SD	14.32±10.09	14.40±10.31	
	BAI	Median (IQR)	11.5 (18.0 9.0)	13.0 (19.0 10.0)	<0.001
		Mean±SD	13.73±5.94	14.64±6.02	
Non-military	ODI	Median (IQR)	8.0 (10.0 6.3)	8.0 (10.0 6.3)	0.612
		Mean±SD	10.46±6.58	10.59±7.07	
	BAI	Median (IQR)	10 (15.0 7.0)	11.0 (17.0 8.0)	<0.001
		Mean±SD	11.65±5.14	12.57±6.05	

Multivariate linear regression

The relationship of different variables with Goda osteoarthritis score were assessed via multivariate linear regression analysis. The best fitted model is demonstrated in table 6. The calculated adjusted R^2 was 81.9 percent. There was a significant direct relationship between age (p<0.001), BMI (p<0.001), Dayan score (p=0.004), and BAI score (p=0.046) with Goda osteoarthritis score.

Table 6. multivariate linear regression model in order to assess the relationship of different variables with Goda osteoarthritis score

Feature	**Beta**	**95% confidence interval**	**p value**
Age	0.032	(0.041 0.024)	<0.001
BMI	0.124	(0.174 0.073)	<0.001
Dayan score	0.324	(0.543 0.105)	0.004
ODI	0.014	(0.032 -0.004)	0.134
BAI	0.019	(0.037 0.000293)	0.046
Group (non-military)	-0.086	(0.040 -0.212)	0.180

Table 7 also shows the multivariate linear regression model in order to assess the relationship of different variables with Dayan osteoarthritis score. The adjusted R^2 was 88.4 percent. Only, the study group (military vs. non-military) had no significant relationship with Dayan score (p<0.184).

Another model was also performed on only military cases, entering age, BMI, ODI, BAI, and subgroups (office vs. combat). ODI (Beta=0.51; 95%CI= (0.065 0.037); p<0.001), BAI (Beta=0.037; 95%CI= (0.058 0.016); p=0.001), and being in office group (Beta=-0.352; 95%CI= (-0.170 -0.533); p<0.001) were significantly related with Dayan score.

Table 7. multivariate linear regression model in order to assess the relationship of different variables with Dayan osteoarthritis score

Feature	**Beta**	**95% confidence interval**	**p value**
Age	0.009	(0.015 0.003)	0.004
BMI	0.054	(0.089 0.019)	0.003
ODI	0.059	(0.069 0.050)	<0.001
BAI	0.032	(0.044 0.019)	<0.001
Group (non-military)	0.060	(0.150 -0.029)	0.184

Discussion

The progression of spondylolysis and spondylolisthesis has been a controversial matter since many years ago. Seitsalo et al. (22) conducted a study on 272 spondylolisthesis pediatric cases and followed the patients for a mean duration of 14.8 years. The mean progression of slip was 3.5 percent in those cases who treated non-operatively. However, the progression rate in those who had operation was higher and was an average of 4.4 percent. However, the natural history of spondylolysis and spondylolisthesis in children may be different from adults, because this group usually develop the condition as a congenital defect, but spondylolisthesis, which is diagnosed in adults, is usually due to factors like trauma or degeneration (23). Matsunga et al. (24) conducted a study on adults with spondylolisthesis. After a follow up of 10 years, they found an average slippage of 15.6% ranging between 7 to 29 percent. Denard et al. (25) also proposed that the slip progression percentage during five-year follow up was 5 to 10 percent. They also proposed that older age and having a history of physical activity during leisure time was a risk factor for the presence of spondylolisthesis.

Our results similarly proposed no changes in slippage according to the Meyerding radiologic grading. Moreover, even the changes in Dayan score, which is a combination of radiology and clinical finding, was not significant during our follow up time in non-military group. However, Dayan score significantly increased in military group. This shows that the higher activity of military group compared to the non-military group may be a reason of higher Dayan score.

We found that higher Age and BMI were risk factors for higher Dayan degree according to the regression analysis. Similarly, He et al. (26) proposed that advanced age and higher BMI are risk factors for spondylolisthesis. Gum et al. (27) also proposed that active spondylolysis cases according to the single-photon emission computed tomography (SPECT) have significantly higher BMI. Moreover, Copenhagen Osteoarthritis Study demonstrated that age and BMI are related with spondylolisthesis (28). However, a study conducted by Kim et al. (29) on young spondylolysis cases showed that there is no

significant relationship between age and BMI with spondylolysis severity of symptoms. However, this study suffered from low sample size and retrospective manner.

Another part of our study was assessment of facet joint degeneration. Wilder et al. (30) proposed that the progression rate of facet joint osteoarthritis, defines as ≥1 score increase, is 8 cases per 100 person-years of observation. We also found no significant change in Goda score after one-year of follow up in both military and non-military groups. It should be considered that facet joint osteoarthritis is insidious. However, further imaging studies should be conducted.

We found that higher age and BMI are risk factors for facet joint osteoarthritis. In a previous study, higher BMI was reported to be related to the higher grade of facet joint degeneration (31, 32). The risk of lumbar facet joint osteoarthritis in lumbar CT scans is reported to be almost three-fold higher in overweight cases (BMI 25–30 kg/m^2) and fivefold higher in obese individuals (BMI 30–35 kg/m2) compared to the normal BMI cases (33). However, it seems that BMI has a small role in cervical facet joint degeneration, as another study reported that one unite increase in BMI results in only 2% higher risk of facet joint degeneration (34). In fact, it can be hypothesized that there is a higher weight burden on lumbar vertebrae than cervical vertebrae.

Age is another strong risk factor for facet joint osteoarthritis and the prevalence of this condition increases with age (35). We also found that age had a direct relationship with the grade of osteoarthritis according to the Goda score. In fact, through the aging process, bone denticity decreases and the lower bone density is a risk factor for facet osteoarthritis. Decrease in bone density results in onuniform increase of facet joint loading and thus increases the biomechanical load on these joints (36). Moreover, the rate of spondylolisthesis is higher in old ages and this is another risk factor for facet joint degeneration (37).

The role of military occupation should not be missed. Although regression analysis showed no relationship between study groups (military vs. non-military) with Goda and Dayan scores, another model in cases of combat versus office demonstrated that being in a combat group is related with higher Dayan score. The role of occupation in spondylolysis and spondylolisthesis has been investigated (11); however, the literature lacks sufficient number of studies in military cases. In line with our finding Celtikci et al. (12) proposed that commandos had significantly higher frequency of spondylolysis and they related the veterans' condition to their heavy payload. More studies are needed in this field.

As a secondary purpose, we assessed the effect of spondylolisthesis on patients' daily activity pain and the psychological burden posed to the patient. We found no significant change in daily activity pain according to the ODI score after one year follow up in both military and non-military groups. However, the anxiety score according to the BAI questionnaire increased at the end of follow up. This shows that the condition poses psychological effect on the patients, although no significant change in the amount of their experienced pain happened. Chen et al. (38) also proposed that spondylolisthesis cases have higher rate of depression and anxiety. Low back pain itself is another source of this anxiety. Hong et al. (17) also reported that patients with low back pain have higher anxiety according to the BAI questionnaire.

Our study had some limitation like any other studies. First, the short time of follow up should be mentioned. We followed our cases for a duration of one year; however, higher follow up time may result in more accurate findings. Secondly, we only assessed one ethnicity and the results may be different in African-Americans. However, the prospective manner of our study can be pointed as a strength. Also, we had an appropriate sample size and this should be addressed as another strength of this investigation.

Conclusion

Spondylolysis and spondylolisthesis have limited radiologic progression during one year follow up. However, when Dayan scoring, as a combination of symptoms and radiologic finding was used, a significant increase in Dayan score in military group was found. This shows that clinician should address a combination of clinical and radiological finding for better management of spondylolysis and spondylolisthesis cases. In fact, radiologic

finding itself has a minor value. Moreover, facet joint degeneration progression was not also notable in both military and non-military groups. However, in both Goda score grading and Dayan score grading, older age and higher BMI was found as a risk factor. Although the progression of the condition was low, it posed an increased anxiety for the patients. With this regard, clinicians should work on this part and make the patients sure about their condition. Also, being in military service may be a risk factor for higher grade of spondylolisthesis; but this is mainly for those who are involved in combat and not office group. Further studies with higher follow up duration and involvement of other ethnicities are needed for a final conclusion.

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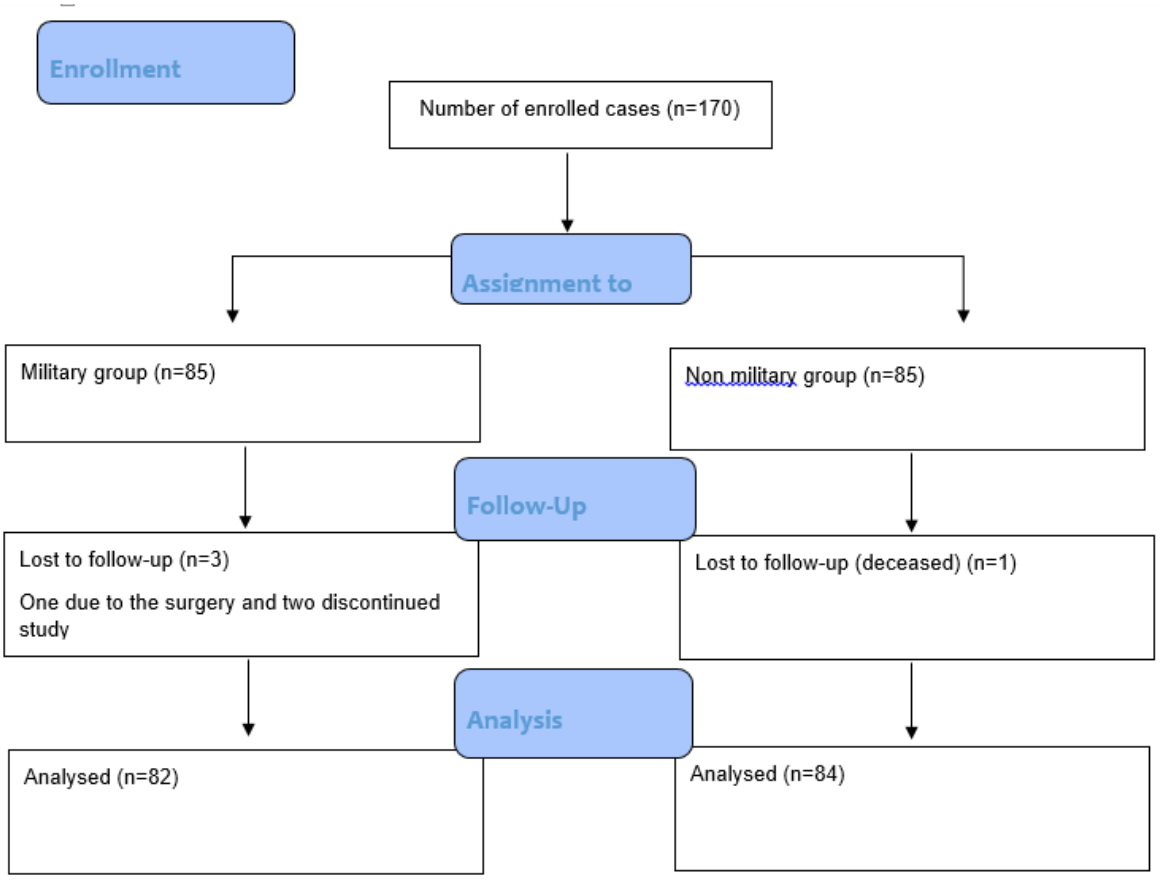

Figure 1. flow chart of participant enrollment