

The epidemiology of proximal femur fractures during COVID-19 emergency in Italy: a multicentric study

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Abstract. *Background and aim:* After the first Italian case of Covid-19, the Government imposed the complete closure of all areas involved by the spread of the virus to contain transmissions. There was a massive reorganization of Hospitals, a stop of all elective activities and a conversion of many hospitals in "Covid Centers". AITOG (Associazione Italiana Traumatologia e Ortopedia Geriatrica) conducted a retrospective study on all proximal femur fractures surgeries that occurred in this period, to find out whether the pandemic and the correlated lockdown somehow changed the incidence of these events. *Methods:* 10 Italian orthopedic centers were involved in the study. Considering the geographic location, three groups were created (North, Centre and South). The considered period is the Italian "Phase 1" (February 23rd - May 3rd 2020). *Results:* the cohort is composed of 412 patients, 116 male and 296 female (mean age 81.1 ± 9.1 years). The same period of 2019 has been used as control group, with 558 patients, 156 male and 402 female (mean age 84.2 ± 8.0 years). In 2020 we counted 323 (78.4%) fractures occurred at home, 61 (14.8%) in retirement houses and 28 (6.8%) in different locations. We mainly treated fractures with intramedullary nails (n.237 57.5%). Among all patients we had 46 (11.1%) Covid-19 positive. The mortality rate within 30 days was of 51 patients (12.4%); 23 of these died because of complications related to Covid-19 while 31 of these were in treatment with anticoagulant/antiaggregant. *Conclusions:* AITOG analysis demonstrates a decrease in surgical interventions for proximal femur fractures from 2019 to 2020, a reduction in patients mean age and an increase in trauma occurred in domestic environment. We also registered a consistent difference between the North, Center and South of the Country. (www.actabiomedica.it)

Key words: Covid-19, Proximal femur fracture, Multi-center retrospective study, Italian Covid experience, Epidemiology, Anticoagulant, Antiaggregant

Introduction

At the beginning of 2020 the Italian and World population was forced to face one of the most massive health emergencies in recent history: the Coronavirus pandemic (2019 n-CoV or Sars-CoV-2) (1).

Starting in the city of Wuhan, China, it rapidly spread worldwide causing millions of victims along with a substantial social-economic crisis (2)

The first Italian case was registered on February 21st in a small town named Codogno (Lodi, Lombardia) in the Northern part of the country. Two days later, the Government approved emergency-laws, imposing the complete closure of all areas involved by the spread of the virus to contain transmissions (mainly involving Lombardia, Emilia Romagna and Veneto) (3).

As other Coronavirus (like SARS and MERS), Sars-Cov-2 generally presents itself as a self-limiting flu-like syndrome or, in the most complicated cases, as an Acute Respiratory Distress Syndrome (ARDS) (4,5); furtherly, most fragile patients, as elderlies and polipathological ones can develop a Multi Organ Failure (MOF) or even die (6). In fact, 66.8% of dead were affected by hypertension, while 30.1% suffered from diabetes. By time, we also learned that this specific type of Coronavirus can lead to thromboembolic complications, ending up in pulmonary embolism (7).

Data released by the Italian Superior Institute of Health (ISS) show that 85% of deaths regards patients over 70 years old (average age 80 years) and that Covid-19 impact on the patient is directly proportional to its age (<1% under 40 years, 31.8% between 70 and 79 years, 45.2% between 80 and 89 years, 49.8% over 90 years); 58.2% of dead patients was male, while 59.7% was affected by 3 or more pathologies. Literature extensively demonstrates that the most frequent complications are respiratory failure (96.8%), acute kidney injury (22,1%), bacterial superinfection (13.3%) and acute myocardial damage (10.9%) (8).

As proved by previous studies, after the pandemic explosion a massive reorganization of Hospitals and Private Clinics took place in the entire Italian territory (3,9). To stem the contagion increase, all elective activities of Orthopaedic Departments stopped, with a consistent drop of surgical procedures and an inevitable elongation of the waiting list, while Traumatology

continued its needful activities. Especially in Northern Italy, smaller hospitals were converted to "Covid Centers" to treat and manage infected patients in separated pathways; this choice led to a centralization of traumas in those major structures still in action, causing a paradoxical raise in accesses and surgical operations (10).

It was demonstrated an increase in complications during the postoperative period, particularly in elderlies presenting femur fractures (11).

The AITOG (Associazione Italiana Traumatologia e Ortopedia Geriatrica) is an Italian orthopedic / geriatric association, founded in 1996, aiming to promote scientific research about both physiopathology and potential clinical solutions to the problems of elderly patients affected by trauma or degenerative problems of the musculoskeletal system (12). Members of this association work and study throughout the country.

The study was conducted within some of the members of this organization to compare and analyze data concerning orthopaedic-traumatology cases and scenario between the first 10 weeks of the Covid-19 pandemic and the same period of time of the previous year. The aim of the study is to examine all proximal femur fractures operated in the period of Covid-19 outbreaks to find out whether the pandemic and the correlated lockdown somehow changed the incidence of these fractures, also considering the different spread of the virus among Italy.

Materials and Methods

We report a multi-center retrospective study which involves 10 Italian orthopedic centers: Milan, Pavia, Turin, Piacenza, Rome (with two hospitals: San Carlo and Gemelli), Naples, Foggia, Bari and Catania. The study was promoted by the Department of Orthopedics and Traumatology of Piacenza, also managing data collection and re-elaboration.

Considering the different spread of the virus throughout the country (Fig.1), we chose to divide the involved Centers in three groups, according to their geographic location. A first group with four centers of northern Italy (Milan, Pavia, Turin and Piacenza), a second group with the centers of central Italy (Rome,

with 2 hospitals) and a third group with the four centers of southern Italy (Naples, Bari, Foggia and Catania). Consequently, the study shows different aspects of the entire Italian scenario.

We retrospectively analyzed data of all proximal femur fractures operated during the “Phase 1” of the Italian Covid-19 emergency. Using their internal database, every participant Center provided data to the collecting Center (Piacenza). We focused the attention on the location where the trauma occurred (house, retirement house, other), type of surgery, possible positivity to Covid-19 tests (nasopharyngeal swab and/or chest CT), postoperative complications and mortality within 30 days from surgery. In addition, we collected information about possible anticoagulant/antiaggregant therapy of dead patients during the pandemic.

The considered period is the Italian “Phase 1”, starting from February 23rd to May 3rd 2020, for a total of 71 days. The same period of 2019 (February 23rd to May 4th, since 2020 is a leap year) was used as control group. The postoperative follow-up was 30 days for every patient.

Statistical analysis

Continuous variables were expressed by the mean and standard deviation (SD) and were evaluated by Student T-test or Mann-Whitney U test. The categorical data were expressed as number and percentage (%) and were evaluated by chi-square or Fisher’s exact test. The statistical test level was set at $p < 0.05$.

Results

2020 cohort is composed by 412 patients, 116 male and 296 female, with a mean age of 81.1 ± 9.1 years. On the other hand, 2019 cohort is characterized by 558 patients, 156 male and 402 female, with a mean age of 84.2 ± 8.0 years.

Evaluating data, we observed that in 2020 the total number of fractures occurred at home was 323 (78.4%), in retirement houses was 61 (14.8%), while in different locations was 28 (6.8%). If we consider the site of fracture, we recorded 166 fractures of medial proximal femur (40.3%) while 246 fractures of lateral proximal femur

(59.7%). Analyzing the type of treatment performed, we counted 237 intramedullary nails (57.5%), 50 total hip arthroplasty (THA) (12.1%), 101 hemiarthroplasty (HA) (24.5%), 16 cannulated screws (3.9%) and 8 Dynamic Hip Screws (1.9%). 140 (34.0%) patients were in treatment with anticoagulant/antiaggregant before the admission to the hospital. Concerning Covid-19 patients, we tested through nasopharyngeal swab and/or lung CT scan 181 (43.9%) patients, diagnosing 46 (11.1%) Covid-19 positive patients. 16 of them (3.9%) were tested positive before surgery, while 31 (7.5%) after it. The mortality rate within 30 days was of 51 patients (12.4%); 23 of these (45.1% of dead patients on 30th day; 5.6% of total cases) died because of complications related to Covid-19; 31 of these (60.8% of dead patients on 30th day; 7.5% of total cases) were in treatment with anticoagulant/antiaggregant.

About 2019, we registered that the total number of fractures occurred at home was 376 (67.4%), in retirement houses was 86 (15.4%), while in different locations was 75 (13.4%). If we consider the site of fracture, we recorded 251 fractures of medial proximal femur (45.0%) while 277 fractures of lateral proximal femur (55.0%). Analyzing the type of treatment performed, we counted 321 intramedullary nail (57.5%), 42 total hip arthroplasty (THA) (7.5%), 148 hemiarthroplasty (HA) (26.5%), 34 cannulated screw (6.1%) and 13 Dynamic Hip Screw (2.3%). 188 (33.7%) patients were in treatment with anticoagulant/antiaggregant before the admission to the hospital. The mortality rate within 30 days was of 24 patients (4.3%); 11 of these (2.0%) were in treatment with anticoagulant/antiaggregant.

Data of the individual groups are shown in tables 1,2,3,4.

Discussion

The analysis shows a decrease in surgical interventions for proximal femur fractures, in accordance with the difference of 146 surgeries between the two examined periods (-26.1%). We registered a drop of 122 surgeries in the North of the country (-37.8%) and a drop of 26 in the South (-17.1%), while there was an increase in Center hospitals (2 more surgeries in 2020, +2.4%). Describing the reduction of proxi-

mal femur fractures, it's important to underline that in 2020 people's activities have been very restricted, if compared to the previous year. In fact, the spread of virus forced people to remain inside houses/retirement houses/hospitals for multiple reasons related to the virus: movements limitations imposed by the Government; closure of all schools and universities, closure of many commercial activities, companies and factories; temporary stop of all sport/group activities; fear of contracting Covid-19 disease; quarantine or recovery subsequent to the infection. The different trend recorded between the macro-area we identified may be justified by the way the virus spread through Italy, rapidly expanding in the North, while barely hitting the Centre/South.

Analyzing these first results, we need to take into account an important variable that verified in some provinces of the Country: many hospitals and private clinics were closed and/or converted to "Covid Centers", where infected people would have been hospitalized until the recovery. Here, the reorganization led to an expansion of the catchment area of Traumatology Departments still active, with a centralization of traumatized patients. In light of this fact, although both the pandemic and the related restrictions determined a general and inevitable drop in the number of proximal femur fractures, these traumas paradoxical increased in

few centers. Catania represents the emblematic case (24 fractures in 2019, 36 in 2020); the two centers of Rome registered instead similar numbers (83 fractures in 2019, 85 in 2020).

The reduction in patients' mean age at the time of trauma (84.2 years in 2019, 81.1 years in 2020) can be explained considering the indications provided by the Government and the scientific community, who suggested to the elderly to remain at home and ask for the help of the younger. Further consequence was the change of the site of trauma, already reported by other studies (3,9). In our study we evaluated as site of trauma homes, retirement houses and other places. In 2020 we documented a rise in home environment traumas, from 67.4% in 2019 to 78.4% in 2020 (+11.0%), while those occurred in other places (such as the roadside) reduced from 13.4% to 6.8% (-6.6%). In the three geographic sub-cohorts the percentages of traumas occurred outside living places had a significant and comparable reduction, in particular -5.3% in Northern cohort (from 11.8% to 6.5%), -8.4% in Center cohort (from 10.8% to 2.4%) and -8.1% in Southern cohort (from 18.4% to 10.3%).

Trauma inside retirement houses maintain similar percentages (15.4% in 2019 to 14.8% in 2020), probably due to the fact that the pandemic didn't influence fall risk factors in this environments.

Table 1. Patient cohorts

	Home	Retirement House	Other Locations
2020 - Northern Italy	145 (72.1%)	43 (21.4%)	13 (6.5%)
2020 - Center Italy	72 (84.7%)	11 (12.9%)	2 (2.4%)
2020 - Southern Italy	106 (84.1%)	7 (5.6%)	13 (10.3%)
2019 - Northern Italy	236 (73.1%)	49 (15.2%)	38 (11.8%)
2019 - Center Italy	59 (71.1%)	15 (18.1%)	9 (10.8%)
2019 - Southern Italy	97 (63.8%)	27 (17.8%)	28 (18.4%)

Table 2. Location where the trauma occurred

	Patients	Male	Female	Mean Age
2020 - Northern Italy	201	49 (24.4%)	152 (75.6%)	81.8 ± 7.8
2020 - Center Italy	85	27 (31.8%)	58 (68.2%)	81.7 ± 8.6
2020 - Southern Italy	126	40 (31.7%)	86 (68.3%)	79.7 ± 9.0
2019 - Northern Italy	323	97 (30.0%)	226 (70.0%)	84.5 ± 8.3
2019 - Center Italy	83	18 (21.7%)	65 (78.3%)	85.9 ± 6.8
2019 - Southern Italy	152	41 (27.0%)	111 (73.0%)	82.9 ± 8.4

Table 3. Type of fracture and treatment

	Medial	Lateral	Intramedullary Nail	THA	HA	Cannulated Screws	DHS
2020 - Northern Italy	95 (47.3%)	106 (52.7%)	101 (50.2%)	26 (12.9%)	57 (28.4%)	10 (5.0%)	7 (3.5%)
2020 - Center Italy	26 (30.6%)	59 (69.4%)	59 (69.4%)	8 (9.4%)	15 (17.6%)	2 (2.4%)	1 (1.2%)
2020 - Southern Italy	45 (35.7%)	81 (64.3%)	77 (61.1%)	16 (12.7%)	29 (23.0%)	4 (3.2%)	0
2019 - Northern Italy	163 (50.5%)	160 (49.5%)	161 (49.8%)	32 (9.9%)	99 (30.7%)	20 (6.2%)	11 (3.4%)
2019 - Center Italy	28 (33.7%)	55 (66.3%)	65 (78.3%)	4 (4.8%)	13 (15.7%)	1 (1.2%)	0
2019 - Southern Italy	60 (39.5%)	92 (60.5%)	95 (62.5%)	6 (3.9%)	36 (23.7%)	13 (8.6%)	2 (1.3%)

Table 4. Mortality and Covid-19 positivity

	Covid Tests	Positive			Mortality	Covid Positive Death	Anticoagulant/ Antiaggregant	
		Total	Before Surgery	After Surgery			Total	Death
2020 - Northern Italy	89 (44.3%)	35 (17.4%)	12 (6.0%)	23 (11.9%)	35 (17.4%)	21 (60.0%)	73 (36.3%)	23 (65.7%)
2020 - Center Italy	12 (14.2%)	5 (5.9%)	1 (1.2%)	4 (4.7%)	3 (3.5%)	0	32 (37.6%)	0
2020 - Southern Italy	80 (63.5%)	6 (4.8%)	3 (2.4%)	3 (2.4%)	13 (10.3%)	2 (1.6%)	35 (27.8%)	8 (6.3%)
2019 - Northern Italy					10 (3.1%)		106 (32.8%)	2 (0.6%)
2019 - Center Italy					4 (4.8%)		24 (28.9%)	2 (2.4%)
2019 - Southern Italy					10 (6.6%)		58 (38.2%)	7 (4.6%)

About type of fracture, the percentage of medial fractures was lower in 2020 (45.0% in 2019, 40.3% in 2020, -4.7%), while the lateral fractures presented opposite trend (55.0% in 2019, 59.7% in 2020, +4.7%). Considering the osteosynthesis device, the most performed procedure was always the internal fixation with intramedullary nail, 57.5% both in 2019 and in 2020. The second most frequent type of surgery was the hemiarthroplasty, with a slight percentage reduction from 26.5% in 2019 to 24.5% in 2020 (-2.0%); instead, we registered a raise in the number of THAs implanted, with a growth of 4.6% (from 7.5% in 2019 to 12.1% in 2020) (13). Both these increases can be justified by taking into account the drop in the mean age of patients at the moment of trauma.

The overall mortality rate radically changed, rising from 4.3% in 2019 (24 deaths on 558 trauma patients) to 12.4% in 2020 (51 deaths on 412 trauma patients). In specific, North cohort registered an increase of 14.3% (from 3.1% to 17.4%), Center cohort a drop of 1.3% (from 4.8% to 3.5%) and South cohort an increase of 6.7% (from 6.6% to 13.3%). The high percentage we recorded in the North cohort can be certainly explained by considering the huge expansion

of the virus in this area. On May 3rd 2020, the total number of Italian cases was 210717, 80.0% of these (equal to 168648) was represented by patients of Northern area (Figure 1).

Our data are coherent with many studies in literature that demonstrated the impact of Covid-19 on mortality rate (14,15). As well as the spread of the virus, the increase in the mortality rate recorded in the South of the Country is lower compared to the Northern one.

The Center, instead, registered a paradoxical reduction of the mortality rate. Our hypothesis bases on two factors: first, the higher number of nasopharyngeal swab allowed the selection of infected trauma patients and their attribution to the most appropriate path, limiting contagions between patients; secondly because of the high surgical risk, surgeons choose the conservative treatments for some critical patients with many comorbidities.

We count that 45.1% of 2020 deaths can be related to Covid-19, even to 23 patients out of 51. This percentage might not reflect the actual situation since, as we said before, not all patients underwent Sars-Cov-2 swab and, as a consequence, some infected

PCM-DPC dati forniti dal Ministero della Salute

Region	Update May, 3 rd 2020 - 17:00									
	Tested positive to n-CoV				Discharged or Recovered	Death	Total cases	Total cases increase (compared to previous day)	Total swab	Tested cases
	Hospitalized with symptoms	Hospitalized in I.C.U.	Home isolation	Currently positive citizens						
Lombardia	6.609	532	29.785	36.926	26.371	14.231	77.528	+ 526	410.857	247.176
Piemonte	2.496	169	12.973	15.638	8.640	3.152	27.430	+ 251	172.208	121.176
Emilia Romagna	1.997	197	6.851	9.045	13.329	3.642	26.016	+ 166	197.075	131.047
Veneto	955	103	6.241	7.299	9.503	1.516	18.318	+ 94	378.202	220.598
Toscana	513	112	4.703	5.328	3.363	872	9.563	+ 38	150.914	114.354
Liguria	627	68	2.856	3.551	3.599	1.209	8.359	+ 47	54.492	34.613
Lazio	1.346	95	2.944	4.385	1.916	508	6.809	+ 53	150.912	117.796
Marche	400	43	2.755	3.198	2.194	927	6.319	+ 21	64.412	42.281
Campania	455	30	2.241	2.726	1.394	364	4.484	+ 25	86.498	47.027
Trento	136	17	1.094	1.247	2.571	429	4.247	+ 66	41.095	24.085
Puglia	410	40	2505	2.955	765	424	4.144	+ 11	66.443	64.781
Sicilia	383	29	1.791	2.203	795	242	3.240	+ 27	85.955	78.409
Friuli V.G.	131	6	950	1.087	1.688	297	3.072	+ 13	74.990	48.041
Abruzzo	300	16	1.552	1.868	798	330	2.996	+ 32	40.699	29.788
Bolzano	109	11	545	665	1.590	281	2.536	+ 1	44.240	20.166
Umbria	58	13	112	183	1.143	68	1.394	0	38.823	26.973
Sardegna	92	10	587	689	511	119	1.319	+ 4	27.737	24.662
Valle d'Aosta	74	2	33	109	895	138	1.142	+ 6	8.100	6.046
Calabria	95	4	603	702	324	88	1.114	+ 2	38.835	36.874
Basilicata	48	3	143	194	167	25	386	+ 6	14.210	14.210
Molise	8	1	172	181	98	22	301	0	7.075	6.808
TOTALE	17.242	1.501	81.436	100.179	81.654	28.884	210.717	+ 1.389	2.153.772	1.456.911

Currently positive	100.179
Total recovered	81.654
Total death	28.884
Total cases	210.717

Figure 1: The spread of Sars-Cov-2 in Italy updated to May, 3rd 2020

were not correctly identified, also among dead. At the beginning of the pandemic, hospitals didn't have any official protocol to follow, having to adapt to the situation, as too many patients to test for a limited number of available swabs or reagents, healthcare workers to perform and process swabs. The city of Piacenza, the most stricken city of the Northern of the Country in term of number of infected people on total amount of population, represents the perfect example of this circumstance: considering 73 operated patients, only 8 of them underwent preoperative swabs (11.0%), 4 tested positive (5.5%); instead, 9 swabs (12.3%) were performed in the postoperative period, 6 positive results (8.2%). Consequently, only 17 patients on 73 were subjected to nasopharyngeal swab (23.3%), we have a 76.7% of patients that were not tested for Sars-Cov-2

and potentially positive.

Analyzing our data, one more interesting element came to our attention. In fact, evaluating personal therapies of dead patients we found that in 2019 45.8% (11 on 24) of deads were in therapy with anticoagulant and/or antiplatelet, while in 2020 this percentage raised to 60.8% (31 on 51). Since fractured patients, once admitted to the E.R., usually suspend the anticoagulant and/or antiplatelet therapies in order to reduce the hemorrhagic risk and Covid-19 infection relates to an increased risk of thromboembolism, the traumatized patient both infected by Sars-Cov-2 and assuming these drugs was submitted to a double thrombotic risk. This condition could explain the increase in 2020 deaths.

Conclusion

Covid-19 had a devastating effect on our population, particularly on the elderly category. AITOG analysis demonstrates a decrease in surgical interventions for proximal femur fractures from 2019 to 2020, which, at least in part, can be explained by both the restrictions on people's daily activities and the fear of contracting the virus. For the same reasons, we recorded a reduction in patients mean age and an increase in trauma occurred in domestic environment. We also registered a consistent difference between the macro-areas we identified for the study (North, Center, South): Northern area shows a way more consistent spread of the virus compared to Centre and South.

We are aware that further studies are certainly necessary to better comprehend this new and complicated disease and to improve our ability in facing it.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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