MUSCULOSKELETAL SURGERY (2022) 106:407–426
https://doi.org/10.1007/s12306-021-00715-w

ORIGINAL ARTICLE

Covid-19 orthopedic trauma patients characteristics and management during the first pandemic period: report from a single institution in Italy

C. Faldini[1,2] · A. Mazzotti[1] · A. Arceri[1] · E. Broccoli[1,3] · E. Barbagli[3] · A. Di Martino[1,2]

Received: 19 April 2021 / Accepted: 24 May 2021 / Published online: 2 June 2021

Abstract

Purpose COVID-19 disease is a declared pandemic, affecting all aspects of healthcare, including orthopedics. The aim of this study is to describe the COVID-19 orthopedic trauma patients characteristics and management in a dedicated Orthopedic and Traumatology Hospital in Italy during the first pandemic period.

Material and methods A cohort of 25 consecutive patients with suspected or confirmed COVID-19 infection were retrospectively analyzed. Health system rearrangement, patients' clinical presentation, diagnostic tools role, laboratory finding, treatment and outcomes were evaluated.

Results Health system rearrangement was fast. There was no clear prevalence of comorbidity or surgery type between confirmed and suspected COVID-19 cases. Nine positive swabs tests and 14 cases with only suspected CT scan findings were recorded. Several laboratory changes have been reported since the onset of symptoms: anemia, leukocytosis, lymphopenia, coagulation abnormalities, alkaline phosphatase, liver enzymes and C-reactive protein alterations. Nineteen patients were treated by oxygen supplement, three patients were administered antivirals, eight antibiotic therapy, and nine hydroxychloroquine. The number of discharges reported in this study was greater than 52% and the number of deaths reached 20%.

Conclusion To our experience, the development of patient management algorithms allows the differentiation of the clinical pathways of negative and suspected/positive patients, reducing exposure, and virus spreading. The execution of swabs on all patients allows an early diagnosis and a more adequate management. Considering the different therapy patterns used, there were no significant differences, but anti-thromboembolic prophylaxis administered to all the orthopedic patients may have contributed to complications and mortality rates reduction.

Keywords COVID-19 · Patient management · Coronavirus · Pandemic · Orthopedic · Trauma

Introduction

The severe acute respiratory syndrome Coronavirus (SarS-CoV-2 or COVID-19) has developed in China since December 2019, and quickly spread across the world, until the WHO declared it pandemic on March 11, 2020. China, Italy, Iran, USA, and Spain were among the most affected countries, currently overcome by the involvement of the American continent [1].

Since the beginning of the pandemic, the Italian National Health System (NHS) had to deal with several critical issues, including the need for an increase of intensive care unit (ICU) and standard hospital beds [2]. Beginning of March 2020, the regional governments decided to centralize all COVID-19 patients affected by acute diseases to selected hubs [2]. Emergency and trauma cases were centralized to dedicated hospitals, while the elective surgical activity was suspended, to support the needs of the NHS [3–5]; the rearrangement was fast, although all the changes were not simultaneous, and current protocols are the result of a continuous process of reorganization [6].

✉ A. Mazzotti
antonio.mazzotti@ior.it

1 1St Orthopaedic and Traumatologic Clinic, IRCCS Istituto Ortopedico Rizzoli, Via Giulio Cesare Pupilli 1, 40136 Bologna, Italy

2 Department of Biomedical and Neuromotor Sciences, University of Bologna, 40123 Bologna, Italy

3 Istituto Ortopedico Rizzoli Covid-Ward, IRCCS Istituto Ortopedico Rizzoli, Via Giulio Cesare Pupilli 1, 40136 Bologna, Italy

Emergency orthopedic patients, especially elderly subjects with fractures or tumors, have a high risk of developing complications related to hospitalization, with negative effects on functional recovery [7, 8]. Pulmonary infections are common causes of morbidity and mortality in hospitalized patients, and the severe acute respiratory syndrome caused by COVID-19 on these patients impacts on clinical outcomes and survival [9]. Sharing patients and hospitalization characteristics, and related outcomes, may improve the management of COVID-19 infection in trauma wards, and contribute to improve the standard of care worldwide.

The aim of this study is therefore to contribute to the knowledge of the scientific community by describing the experience of a single Italian Orthopaedic center in the treatment of suspected and positive COVID-19 patients during the first pandemic period. Patient's clinical presentation, course and comorbidities, role of swab tests and CT scan, main laboratory findings, ICU access and clinical outcomes, are reported.

Material and method

Study design and participants

A retrospective study was conducted on a cohort of consecutive patients admitted between February 27 and April 28, 2020, with suspected or confirmed COVID-19 infection, at the Authors' Institution.

Patients' management

Beginning of February 2020, suspected or confirmed COVID-19 patients were managed according to the institutional guidelines done by a dedicated task force. At the admission to the Emergency Orthopedic Department all the patients were provided with a surgical mask. COVID-19 was suspected after a clinical evaluation based on epidemiological criteria including (1) history or residence in China, (2) travel in areas of known epidemic outbreak, (3) close contact to a suspected/confirmed COVID-19 patient, and (4) working/attending a healthcare facility where COVID-19 infected patients are hospitalized. Clinical symptoms including fever, cough, dyspnea and body temperature, and peripheral blood saturation values are considered. A dedicated pathway was created for suspected/positive COVID-19 patients to reduce the risk of viral contamination.

In face of a suspected case, the Public Hygiene Service took charge of the patient and gave instructions on how to proceed further, defining different pathways on the base of the risk of infection. Patients that the Public Hygiene Service considered at low risk were regularly taken in charge at the standard ward, while suspected cases underwent further diagnostic investigations, including chest X-rays, high-resolution computed tomography (HRCT), swabs. Depending on tests' results, patients were placed on a COVID-19 or a standard ward. However, in case of severe respiratory distress, patients were transferred to a COVID-19 reference hospital (Fig. 1).

Patients with suspected or confirmed COVID-19 infection were managed in a separate dedicated ward, hosting all COVID-19 suspected or positive subjects, and not

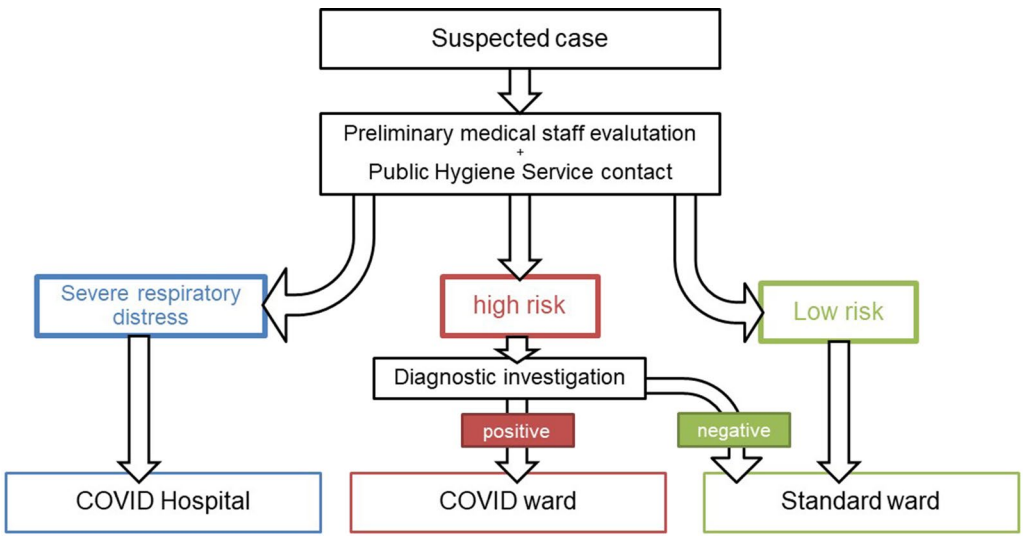

Fig. 1 Management of one suspected case

transferred to COVID-19 hospitals because of requirement of orthopedic operation.

A separate pathway and dedicated operating theater were setup for suspected or positive patients who required surgical procedure.

For patients that developed respiratory symptoms during hospitalization, two different protocols were utilized at different times during the pandemic. During the month of March, in the event of a sudden onset of respiratory symptoms, the ward doctor evaluated the COVID-19 suspected criteria and provided hygiene measures (Table 1). Thereafter, depending on Internal Medicine and Infectiology specialist evaluations, imaging tests and NasoPharyngeal (NP) and OroPharyngeal (OF) swab for SARS-CoV-2 RNA were performed to characterize the patient as a probable or confirmed case.

Beginning of April, NP and OP swabs were performed in all patients before hospitalization, thus allowing an early diagnosis also for asymptomatic patients.

In suspected and probable patients, NP and OP swabs tests were carried out with high frequency (every one or two days), and the diagnosis of COVID-19 was excluded only upon the negative outcome of three consecutive swabs on the same patient. All the patients were considered highly suspected for COVID-19 infection if HRCT showed interstitial disease or other typical signs of viral infection (ground-glass opacities in specific areas of the lung).

All patients transferred to postoperative rehabilitation center or discharged at home received NP and OP swabs. When tested positive, the patient was placed in isolation and a transfer was planned in a healthcare facility dedicated to COVID-19 patients.

Data collection

The data considered in this study were retrospectively retrieved from patients' charts and include orthopedic diagnosis and comorbidities, signs and symptoms related to the infection, timing and modalities of the suspected COVID-19 infection and eventual evidence of COVID disease, serial laboratory tests, type of orthopedic treatment, COVID-19 infection treatment, clinical course and outcome, and characteristics of the deceased patients.

Results

Patients' characteristics and comorbidities

Twenty-five suspected or confirmed COVID-19 patients (11 males and 14 females) were included in the study. The age range was between 34 and 96 years old, with an average of 76.48. Sixteen of 25 patients were in hospital for a fracture that required surgical procedure: 14 at the femoral neck, one at the distal epiphysis of the radius, and one pathologic fracture of a lumbar vertebra. Three patients had oncological diseases: one case of chordoma, one case of paraplegia due to acute compression of the medullary canal by metastasis, and one patient affected by osteosarcoma, in-hospital for chemotherapy. The other six patients were, respectively, affected by a recurrent hip prosthesis dislocation, one surgical wound dehiscence, one lumbar disk herniation, one chronic osteomyelitis of the ankle, and one thoracic myelopathy requiring surgical decompression. All the patients had one or more comorbidities: among them the most frequent were hypertension, chronic obstructive pulmonary disease, heart disease, and malignancy (Table 2).

Table 1 Definition and therapeutic measures of suspected, probable, and confirmed cases

	Definition
Initial hygiene protocols (Hand hygiene and surgical mask wearing; Droplets contact precaution; Healthcare professionals must wear appropriate PPE)	
Suspect case	A person with acute respiratory infection (sudden onset) **and** at least one of the epidemiological criteria
	OR
	Evidence of interstitial-alveolar pneumonia in HRCT
	OR
	Appearance of clinical finds (RF > 25 acts/minute and/or SO_2 < 95%) compatible with diagnosis of pneumonia
Probable case	Suspect case whose test result for SARS-CoV-2 is doubtful or inconclusive using specific RT-PCR protocols for SARS-CoV-2
Confirmed case	Case with a laboratory confirmation of SARS-CoV-2 infection, regardless of clinical signs and symptoms

Table 2 Patient's characteristics

Patient No.	Sex	Age	BMI	Comorbidity	Home therapy	Smoke	Orthopedic diagnosis
No. 1	F	67	35.2	GERD	PPIs, atorvastatin, Gaviscon	No	Secondary DDH osteoarthritis
No. 2	M	58	33.2	HBP, BPH	Valsartan, Cardioasa, Manidipine, Dutasteride, Alfuzosin	No	Sciatica in lumbar disk herniation
No. 3	F	90		HBP, ischemic heart disease, hypothyroidism	Ticlopidine, bisoprolol, levothyroxine, mirtazapine, duloxetine, Zolpidem, Clorazepam, PPIs, Vit D, Calcium, furosemide	NR	Closed femur fracture
No. 4	F	49	25.3	Sarcoidosis, COPD, DM, osteoporosis, polyneuropathy, depressive syndrome	Prednisolone, Unipril/Diur, PPIs, Trazodone, Vitamin D, pregabalin, nebivololo	Yes (4/day)	Chronic osteomyelitis of the ankle
No. 5	F	90	20.8	HBP, myeloproliferative syndrome	Sertraline, simvastatin, oncocarbide, lysine acetylsalicylate, metoprolol, PPIs, amlodipina, formoterol, heparin	No	Recurrent hip dislocation
No. 6	M	94	26.2	Ischemic cardiopathy post-AMI, AF, COPD, CKD, rectal K	Bisoprolol, furosemide, methylprednisolone, allopurinol, coumadin	Ex-smoker	Basicervical closed femur fracture
No. 7	F	89	24.4	MI, AF, DM 2, dementia, COPD	Anticoagulant, Glicazide, venlafaxine, PPIs, metoprolol	No	Pertrochanteric closed femur fracture
No. 8	F	96	21.6	AV block, cognitive impairment, operated K breast	Triazolam, antisthamine, PPIs	No	Pertrochanteric closed femur fracture
No. 9	F	84	26.1	HBP, MI, TIA, COPD, CKD, DM type 2, essential tremor	CardioASA, pregabalin, furosemide, Sertraline, bisoprolol, pramipexolo, fenobarbital, Simvastatin, glycopyrronium bromure, PPIs, Rivotril, LTOT	Ex-smoker	Intertrochanteric closed femur fracture
No. 10	M	89		HBP, AF, hypothyroidism	Anticoagulant, bisoprolol, digoxin, levothyroxine, sertraline, ramipril, furosemide, lorazepam	No	Exposed distal radius fracture
No. 11	F	74	31.2	COPD, HPB, reentrant PSVT, hyperinsulinism, adrenal hyperplasia, osteoporosis, brest K	Anticoagulant, verapamil; furosemide; PPIs, umeclidinium bromide, fluticasone/vilanterol; albuterol sulfate	Yes	Midcervical closed femur fracture
No. 12	M	58	25.8	Osteosarcoma	Olpress, PPIs	No	Osteosarcoma
No. 13	M	34	26.9	Bipolar disturb	Valproic acid chrono, olanzapine, lamotrigine	No	Wound dehiscence after treatment for calcaneal fracture
No. 14	F	89	28.5	COPD, HPB, stroke, hypercholesterolemia, Major neurocognitive disorder	ACE-iHCT, verapamil, olanzapine, atorvastatin, cardioAsa, promazine	No	Basicervical closed femur fracture
No. 15	F	70	24.4	Choreic syndrome, depressive syndrome, hypothyroidism, breast cancer, lung cancer	Sertralina, furosemide, levothyroxine, Vit D	Yes	Pertrochanteric closed femur fracture
No. 16	F	87		COPD, dementia	NR	Yes (30/day)	Basicervical closed femur fracture
No. 17	F	76	27.2	COPD, HBP, depressive syndrome	Paroxetine, bisoprolol, pregabalin, tapendalol, heparin	Yes	Relapsed chordoma at the dorsal spine
No. 18	M	73	24.1	HBP, AF, DM, renal cell carcinoma (nephrectomy) with lung and bone metastasis	Anticoagulant, allopurinol, levothyroxine, PPIs, amlodipine, bisoprolol, metformin, atorvastatin, nivolumab	No	Pathological fracture

Table 2 (continued)

Patient No.	Sex	Age	BMI	Comorbidity	Home therapy	Smoke	Orthopedic diagnosis
No. 19	M	74	22.2	Idiopathic pulmonary fibrosis, carotid artery disease, bipolar syndrome	Nintedanib, LTOT, lithium, quetiapine, lorazepam, cardioAsa, PPIs, vit D, mirtazapine	No	Basicervical closed femur fracture
No. 20	F	90	25.5	HBP, unstable angina with PTCA and stent, Alzheimer disease	Flecainide, metoprolol, lysine acetylsalicylate, PPIs	No	Closed femur fracture
No. 21	M	85	31	COPD, OSA, HBP, POA, AAA, prostatic adenoK, CKD, thrombophilia due to fVII alteration	Anticoaugulant, ARBs (sartano), Bisoprolol, doxazosin, PPIs, tamsulosin, furosemide, trazodone, allopurinol	No	Basicervical closed femur fracture
No. 22	M	79	24.2	HBP, COPD, dementia	Lisinopril, paroxetina	NR	Intertrochanteric closed femur fracture
No. 23	M	83	24.5	HBP, AF, BHP, MGUS	Anticoagulant, ramipril, bisoprolol, furosemide, finasteride, pregabalin	No	T6-T7 myelopathy in hyper kyphosis
No. 24	F	69	22.2	HBP, hemidiaphragmatic paralysis	LTOT 2L	No	Pertrochanteric closed femur fracture
No. 25	M	65	23.5	HBP, thyroid carcinoma with lung and vertebral metastases	Perindopril + amlodipine, levothyroxine, PPIs	No	Paraplegia; ASIA C
TOT	11 M 14 F	76.48	26.09		7		

AAA abdominal aortic aneurysm, AF atrial fibrillation, BPH benign prostatic hyperplasia, COPD chronic obstructive pulmonary disease, CKD chronic kidney disease, DM diabetes mellitus, GERD Gastro-esophageal reflux disease, HBP high blood pressure, LTOT Long time oxygen therapy, MGUS Monoclonal gammopathy of undetermined significance, MI myocardial infarction, OSA Obstructive sleep apnea, POA Peripheral obliterative arteriopathy

Clinical presentation

Out of the 25 cases, seven were defined as suspected before hospitalization. Of these, six had respiratory symptoms. Three reported a direct contact with Covid-19 positive patients (Fig. 2).

Eighteen patients had no typical symptoms at hospital admission. Sixteen out of 18 developed symptoms during the hospital stay, while two remained asymptomatic. One patient become symptomatic after discharge, requiring admission to a COVID hospital. Another patient (#12) was diagnosed for COVID disease while performing a thoracic CT scan for the study of an underlying disease (Osteosarcoma) (Fig. 2).

The most frequently reported symptoms included: fever, cough, dyspnea, and diarrhea, recurrent in 18, 13, 12, and five cases, respectively. Nineteen severe episodes of desaturation requiring oxygen therapy were recorded. All signs and symptoms are reported in Table 3.

Role of swab tests and CT scan

Seventeen of the 18 non-suspected patients were placed in the standard orthopedic ward. One patient before hospitalization had CT signs of pulmonary fibrosis despite a negative swab test but was hospitalized in the COVID-19 ward as a precaution. Figure 3 describes the access management to the COVID-19 ward. The timing of each patient's relocation based on tests results is shown in Table 4.

From a diagnostic perspective, only two of 25 cases were positive to the NP and OP swabs without having a suspected CT picture; seven of 25 patients resulted positive to NP and OR swab tests while showing a typical CT scan (on the 50% of the cases, the positive outcome of the swab test followed the suspected CT outcomes), 14 of 25 patients had only a suspected CT scan and were negative to the swabs tests, a single case had negative results in both tests, while only one had not in hospital screening and he was identified after discharge. Three of 25 patients were diagnosed or suspected before surgical procedure.

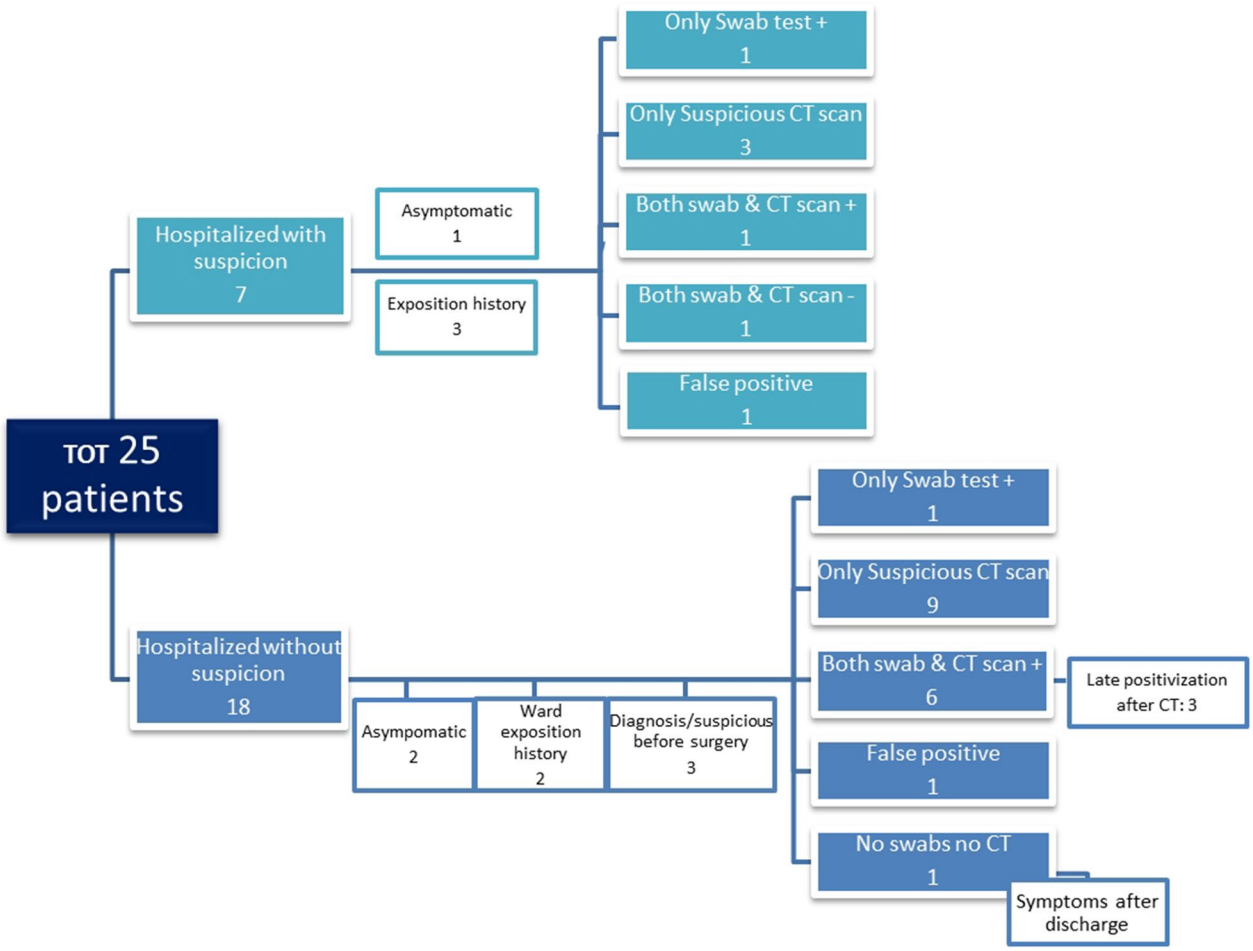

Fig. 2 Comprehensive flowchart concerning patient's management

Table 3 Sign and symptoms

	Sign and Symptoms strat	Fever	Cough	Sore throat	Dyspnea	Dysgeusia	Headache	Dizziness	Diarrhea	Abdominal pain	Vomiting	Nasal Congestion	SA02 Pre-op	SA02 Post-op	T Pre-op	T Post-op
No. 1	2 Mar	Yes	yes from 7 march					Yes				Yes	97% AA	98% AA	No	Yes
No. 2	10 Mar	Yes			Yes					Yes			97% AA	90% AA—> 96% 2L O2	No	Yes
No. 3	9 Mar	Yes												94% 2L O2	No	Yes
No. 4	18 Mar	Yes		Yes									98% AA	96% AA	Yes	Yes
No. 5	14 Mar	Yes											83% AA—> 2L O2	95% 2L O2	No	No
No. 6	30 Mar	No	Yes		Yes								98% AA	98% 2L O2	No	No
No. 7	asymptomatic												98% AA	95% AA	No	No
No. 8	23 Mar	Yes	Yes		Yes				Yes				95% AA	96% 3L O2	No	No
No. 9	21 Mar	37,6	Yes		Yes (sometimes)								98%	95% 2L O2	No	No
No. 10	21 Mar				desaturation						Yes			94% AA		
No. 11		Yes	Yes		Yes								85% AA—> 98% 2L O2	97% 2L O2—> 95% 3L O2	No	No
No. 12	asymptomatic												98% AA		No	
No. 13	27 Mar	Yes	Yes										97% AA	94% AA	No	No
No. 14	27 Mar	Yes	Yes		Yes				Yes				98% AA	98% AA	No	Yes
No. 15		No	Yes (some days before admission)						Yes				93% AA	98% 2L O2	No	No
No. 16	30 Mar	Yes											84% AA—> 92% 4L O2		No	
No. 17	10 Apr	Yes	Yes		Yes (22 apr)				Yes				94% AA	100% 3L O2	No	No

Table 3 (continued)

	Sign and Symptoms strat	Fever	Cough	Sore throat	Dyspnea	Dysgeusia	Headache	Dizziness	Diarrhea	Abdominal pain	Vomiting	Nasal Congestion	SA02 Pre-op	SA02 Post-op	T Pre-op	T Post-op
No. 18	06 Apr	Yes, when come back from TIPO	Yes		Yes								96% AA	88% AA—> 97% 3L O2	No	Yes
No. 19		No			Yes (post-op)								72% AA—> 93% 6L O2	93% 7-8L O2	No	No
No. 20	31 Mar	Yes			No								94% AA	100% 4L O2—> 97% AA	No	No
No. 21		Yes	Yes		No	Yes	Yes						97% AA	97% 2L O2	No	No
No. 22	12 Apr	Yes			Yes—Sa02 80% 6L O2								91% AA	97% 2L	No	No
No. 23	4 Apr	Yes	Yes		Yes				Yes	Yes			94% 3L O2		Yes	
No. 24	asymptomatic												93% 2L O2	88% 4L O2	No	No
No. 25		occasional	Yes										98% AA	100% 2L O2	No	No
TOT		**18**	**13**	**1**	**12**	**1**	**1**	**1**	**5**	**2**	**1**	**1**				

AA ambient air

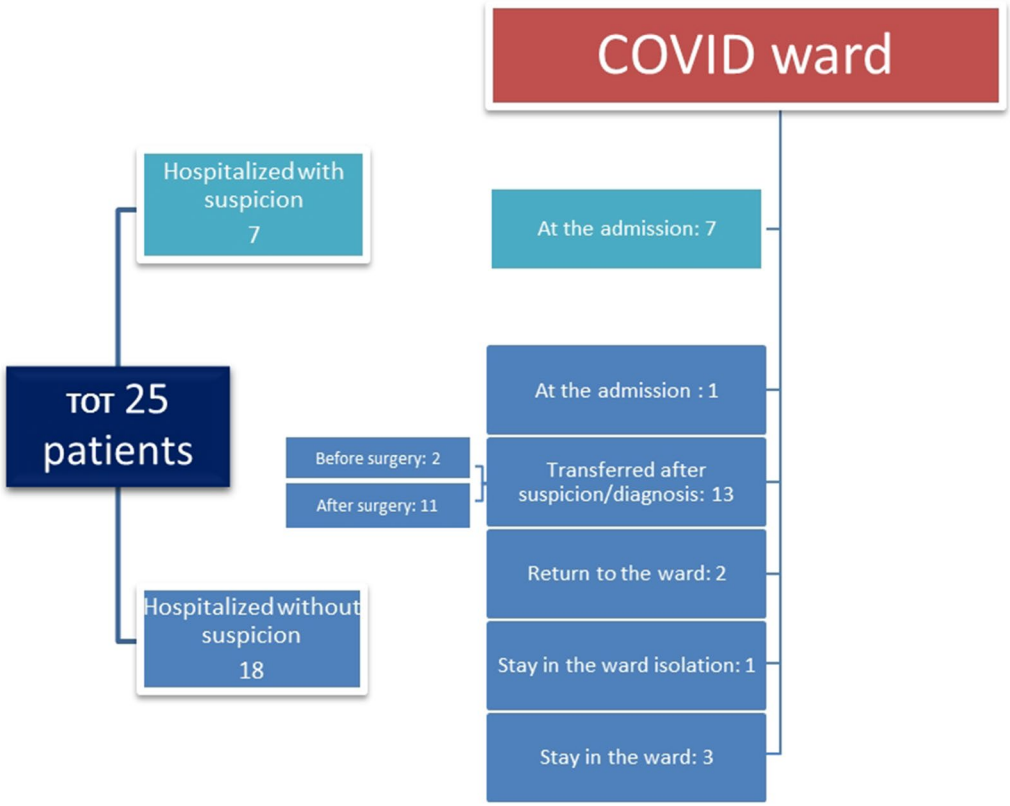

Fig. 3 Accesses to COVID ward

Out of the 25 cases, two false positives were found; in particular, out of the 14 cases with suspected CT findings, in two cases the diagnosis changed over time: one diagnosis lead to a cardiopulmonary congestion, another to a chronic obstructive pulmonary disease (COPD) exacerbation.

In total there were nine positive swabs tests and 14 cases with suspected CT scan findings with a negative swab test (Table 5).

In detail, among the nine confirmed COVID-19 positive patients, female gender prevails in a ratio of 6:3. The average age was 71.3 years (range 34–96), and a tendency toward overweight was found (average BMI 27.6; range 20.8–35.2). The 14 patients with a suspected CT scan had similar gender distribution (7:7) with an average age of 78.3 years (range 34–96) and average normal weight (24.8 BMI; range 21.6–26.9). The time to formulate the COVID-19 infection diagnosis by CT scan was about four days faster than the one with utilized of swabs. The time to onset of symptoms from admission or surgical procedure was similar between the first and the second group. There was no clear prevalence of comorbidity or pathology or surgical procedure type between the two groups, but surgical time was longer in confirmed positive COVID-19 patients.

Main laboratory findings

The laboratory results are shown in Table 6. Reported data refer to the day of the NP and OP swab test positive outcome or, for those patients with negative swabs tests, to the day of the CT examination with suspected results.

Several laboratory changes have been reported during hospitalization since the onset of symptoms (Table 7): anemia ($n = 24$), persisting over 5 days [10] in 15 patients (threshold refers to the anemia low peak usually occurring after three–four postoperative days), leukocytosis ($n = 5$), with an increase in neutrophils in all patients, and of monocytes in three; 13 patients had lymphopenia, four had numerical alteration of platelets (one thrombocytosis and three thrombocytopenia), two showed coagulation abnormalities, three showed an increase in the levels of alkaline phosphatase, three patients presented an increase in liver enzymes, while all had an increase in C-reactive protein.

The laboratory changes reported in the confirmed COVID-19 cases occurred in a period ranging from the first postoperative day (POD) to the eleventh, with an average of 3.3 days, while in the suspected COVID-19 group blood tests alterations occurred earlier, already from the first POD.

Table 4 Timing and modality of diagnosis and evidence of COVID-19

	EXPOSURE HISTORY	SUSPECTED AT THE ADMISSION	PRE-OP DIAGNOSIS	DAY SINCE ADMISSION TO SYMPTOMS	DAY SINCE SURGERY TO SYMPTOMS	DAY SINCE ADMISSION TO DIAGNOSIS/SUSPECT	DAY SINCE SURGERY TO DIAGNOSIS/SUSPECT	WARD BEFORE SURGERY	WARD AFTER SURGERY	SARS-COV QUANTITATIVE RT-PCR	TYPICAL SIGNS OF VIRAL INFECTION ON CT
# 1	NR	no	no	4	5	13	12	orthopedic ward	orthopedic ward (isolation)	positive	bilateral
# 2	NR	no	no	6	1	11	6	orthopedic ward	orthopedic ward -> COVID section	positive	bilateral
# 3	NR	no	no	0	-1	8	7	orthopedic ward	orthopedic ward (isolation)	positive	bilateral
# 4	NR	no	only for second operation	8	7	13	12	orthopedic ward	COVID section -> orthopedic ward	Positive	negative
# 5	exposure to suspected case	yes	yes	0	-3	3	diagnosis pre-op: 1 day before the first operation	COVID section	COVID section	positive	negative
# 6	NR	no	no	15	11	4 (only CT suspected)	CT suspect same days of surgery	orthopedic ward	COVID section	negative	bilateral
# 7	NR	no	no	/	\	no	no	orthopedic ward	orthopedic ward	not done	not done
# 8	NR	no	no	6	5	6 (only CT suspected)	5 (CT suspect)	orthopedic ward	COVID section	negative	bilateral
# 9	NR	no	no	3	2	3 (symptoms suspeted)	2 (CT suspect)	orthopedic ward	orthopedic ward	negative	bilateral -> rectified in BPCO flare
# 10	exposure to relevant environment	yes	suspect	0	-3	1 (only CT suspected)	Ct suspect pre-op: 2 day before surgery	COVID section	COVID section	negative	bilateral
# 11	NR	yes	yes	0	-2	2	Diagnosis pre-op:1 day before surgery	COVID section	COVID section	positive	bilateral
# 12	NR	yes	\	\	\	1 (only CT suspected)	\	COVID section	\	negative	Bilateral
# 13	contact with healthcare staff swab positive	no	no	2	0	5 (only CT suspected)	3 (CT suspect)	orthopedic ward	COVID section -> orthopedic ward	negative	bilateral
# 14	NR	no	no	1	1	4 (symptoms suspected)	4 (CT suspect)	orthopedic ward	COVID section	negative	monolateral
# 15	NR	no	suspect	0	-2	1 (only CT suspected)	Diagnosis pre-op: 2 day before surgery	orthopedic ward	orthopedic ward -> COVID section	negative	monolateral
# 16	NR	no	suspect	2	-7	2 (only CT suspected)	7 (CT suspect)	orthopedic ward -> COVID section	COVID section	Negative	monolateral
# 17	exposure in ICU with pt covid +	no	no	11	7	12	8	orthopedic ward	orthopedic ward (isolation) -> COVID section	positive	bilateral

Table 4 (continued)

# 18	NR	no	no	6	4	8	5	orthopedic ward	COVID section	positive	monolateral
# 19	NR	yes	suspect	1	1	same day (symptoms & CT suspected)	same day (CT suspect)	COVID section	COVID section	negative	bilateral
# 20	NR	yes	suspect	0	-1	same day (symptoms & CT suspected)	CT suspect pre-op: 1 day before surgery	COVID section	COVID section	negative	monolateral -> rectified in cardiopulmonary congestion
# 21	exposure to relevant environment	yes	suspect	0	-2	same day (only symptoms suspected)	only symptoms suspected pre-op: 2 days before surgery	COVID section	COVID section	Negative	Negative
# 22	NR	no (negative swab do at aid of origin)	suspect	10	9	10 (only CT suspected)	9 (CT suspect)	COVID section	COVID section -> transferred in orthopedic ward cause no Covid suspect-> return to COVID section cause clinical worsening	negative	bilateral
# 23	NR	no	\	1	\	1 (only clinical & CT suspected)	\	orthopedic ward -> COVID section	\	negative	bilateral
# 24	NR	no	no	\	\	1 (only CT suspected)	1 (CT suspected)	orthopedic ward	COVID section	negative	bilateral
# 25	NR	no	no	0	0	1	1	orthopedic ward	COVID section	positive	monolateral
TOT	5	7	7 suspect – 2 diagnosis							9	19 + 2 false positive
AVERAGE				3.4	1.5	4.6	3.3				

Orange: positive swab and CT scan; Red: only positive swab; White: only CT scan compatible; Cyan: false positive; Grey: no tests; Purple: both negative tests

Table 5 Comparison among confirmed and suspected COVID-19 cases

	Confirmed cases: 9	Suspected cases: 14
Gender	3 M—6 F	*7 M—7 F*
Age	71.3	*78.3*
BMI	27.6	*24.8*
Day since admission to symptoms	3.88	*3.45*
Day since surgery to symptoms	2	*1.3*
Day since admission to diagnosis/suspect	7.88	*2.78*
Day since surgery to diagnosis/suspect	5.44	*2.16*
Surgery time (h)	02:45	*01:10*

Average values

Patients' management and ICU access

Patients were operated on orthopedic pathology as reported in Table 8. Fifteen patients received antibiotic therapy in relation to postoperative protocols or for infective complication other than COVID-19. Intensive care recovery was required for three patients during the first postoperative period for monitoring clinical conditions. All the patients underwent anti-thromboembolic

Table 6 Laboratory results

Laboratory test	Blood sample day	Red blood cells ($\cdot 10^{12}$/l)	Hb (g/dl)	White blood cell count ($\cdot 10^{9}$/l)	Neutrophil count ($\cdot 10^{9}$/l)	Lymphocyte count ($\cdot 10^{9}$/l)	Monocyte count ($\cdot 10^{9}$/l)	Platelet count ($\cdot 10^{9}$/l)	Aptt (s)	Pt (s)	Alt (u/l)	Ast (u/l)	Alp (u/l)	Urea (mmol/l)	Creatinine (µmol/l)	Pcr (mg/l)
CASE 1	10 Mar	3,37 <	9,3 <	6,1	4,62	1,06 <	0,29	285			15	19			0,48	4,27
CASE 2	14 Mar	3,64 <	11,5 <	5,59	3,77	1,32	0,48	178	1,05	1	30	23	48		0,07	18,03 >
CASE 3	12 Mar	3,65 <	10, 2 <	14,42 >	5,45	8,21 >	0,67	235			24	32	185 >		0,73	15, 59 >
CASE 4	21 Mar	3,60 <	10,3 <	7,65	5,06	1,83	0,44	411 >	0,72 <	1	23	11	81	66 >	0,74	1,71
CASE 5	19 Mar	2,85 <	9 <	7,05	5,23	0,8	0,31	242	1,38 >	1,07	9	17		22	0,53	
CASE 6	19 Mar	3,29 <	9,6 <	10,34 >	8,73 >	0,71 <	0,57	261	1,56 >	1,49 >	3	13			2,37 >	13,21 >
CASE 7	17 Mar	4,39	13,4	16,07 >	14,24 >	0,88 <	0,91 <	276								
CASE 8	23 Mar	3,34 <	9,3 <	12,07 >	10,08 >	1,09 <	0,68	248	1,35	1,13	9	20			0,66	9,45 >
CASE 9	20 Mar	3,03 <	8,3 <	6,41	5,11	0,73 <	0,32	129 <	1,09	1,17	7	17	130 >	73 >	1,19	0,07—> **9,65**
CASE 10	22 Mar	3,86 <	11,1 <	11,46 >				171	1,03	1,15	12	26	49	55 >	1,19	
CASE 11	26 Mar	4,02	13	10,64 >	9,50 >	0,80 <	0,26	213	0,77	0,96	33	24	100		0,73	7
CASE 12	25 Mar	3,86 <	11,9 <	3,24 <		1,96	0,26 <	0,89	242		23	25				0,77
CASE 13	28 Mar	4,29 <	12 <	12,43 >	9,81 >	1,46	0,98 >	199	0,93	1,01	28	18		25	0,79	8,99 >
CASE 14	08 Apr	3,34 <	10,8 >	12,41 >	8,04 >	2,95	1,13 >	563 >	0,9	1,03	25	36		30	0,63	23,53
CASE 15	28 Mar	3,53 <	9,8 <	15,68 >	11,84 >	2,58	1,12 >	514 >	1,11	1,09	11	17	125 >	17 <	0,58 <	3,89 >
CASE 16	02 Apr	3,86 <	9,9 <	7,83	6,69	0,40 <	0,72	289	0,95	1,32 >	61 >	129 >		90 >	0,73	23,6
CASE 17	11 Apr	3,14 <	9,8 <	7,77				326							0,84	
CASE 18	07 Apr	4,63	10,6 <	4,12	3,21	0,48 <	0,34	158	1,53 >	1,25 >	12	42		59 >	1,55 >	30,63
CASE 19	31 Mar	3,77 <	12,9	14,65 >	11,43 >	2,4	0,57	175	1,17	1,28 >	14	17	79		0,89	**24**
CASE 20	31 Mar	3,1 <	9,8 <	5,8	3,48	1,24	0,66	123 <	1,29	1,13	12	18		65	0,91	4,1 >—> 19,53
CASE 21	02 Apr	3,26 <	9,2 <	8,14	5,44	1,31	0,68	240	1,28	1,17	6	8	87	150	3,06 >	15- > 17 >
CASE 22	06 Apr	2,84 <	8,4 <	5,57	3,97	0,86 <	0,4	138 <	1,17	1,12	33	54 >			0,91	19,37 >
CASE 23	04 Apr	4,49	12,8	5,58	3,86	1,08 <	0,5	184	1,03	1,1	12	18				12,29 >
CASE 24	05 Apr	3,43 <	10,7 <	10,99 >	8,84 >	1,48	0,53	281	1,17	1,14	9	22	128 >	27	0,74	12,54 >
CASE 25	11 Apr	5,80 >	16,4	11,7 >	10,67 >	0,88	0,14	277	0,71	1	21	21	58	48 >	0,8	0,25

Normal range:RBC 3,90 to 5,15 × 10^{12}/L. HB 12 to 15,4 g/dL. WBC 4,50 to 11,40 × 10^{9}/L. NE 1,70 to 7,90 × 10^{9}/L. LY 1,20 to 5 × 10^{9}/L. MO 0,10 to 0,95 × 10^{9}/L. PLT 170 to 400 × 10^{9}/L. APTT 0,82 to 1,25 s. PT < 1,20 s. ALT < 45 U/L. AST < 60 U/L. ALP 30 to 120 U/L.. Urea 17 to 43 mmol/L. Creatinine 0,50 to 1,20 mmol/L. RCP < 0,50 mg/L)

Table 7 Orange: positive swab and CT scan; Red: only positive swab; White: only CT scan compatible; Cyan: false positive; Gray: no tests; Purple: both negative tests

LABORATORY TEST	ANEMIA POST-OP OVER 5 DAYS	LEUKOCYTOSIS	LYMPHOCYTOSIS	LINFOPENIA	THROMBOCYTOSIS	THROMBOCYTOPENIA	COAGULATION DISORDERS	LIVER ENZYME CHANGES	INCREASE IN ALP
# 1	yes			from 11 POD					
# 2	yes			2 POD					
# 3	yes		from 6 POD					from 6 POD	From 4 POD
# 4	yes				from 1 POD				
# 5				from 1 POD					
# 6		from 1 POD		from 1 POD			from 1 POD		
# 7									
# 8	yes	from 1 POD		from 1 POD					
# 9				1 POD					From 1 POD
# 10									
# 11	yes			from 1 POD				from 4 POD	
# 12									
# 13									
# 14	yes	from 1 POD	from 1 POD						
# 15									
# 16				pre-op with symptoms					
# 17	yes			from 1 POD					
# 18				from 3 POD		from 3 POD	from 3 POD		
# 19									
# 20	yes					from 1 POD			
# 21									
# 22	yes	from 1 POD		from 1 POD					
# 23	yes (no surgery)			yes (no surgery)					
# 24									From 1 POD
# 25		from 1 POD		yes (same day of surgery)		2-3 POD		from 9 POD	
TOT	11	5	2	13	1	3	2	3	3

prophylaxis according to the institutional protocols. Twelve patients received blood transfusions.

Nineteen patients were treated by oxygen supplement, seven of these required continuous positive airway pressure (CPAP), and no patients required invasive mechanical ventilation outside the postoperative intensive care. Glucocorticoids were administered in two patients. Three patients were administered antivirals, eight with antibiotic therapy, and nine with hydroxychloroquine (Plaquenil®); those who were administered antiviral therapy were at the same time treated by antibiotic, hydroxychloroquine, or both. The pharmacology therapy utilized are specified in Table 9.

Clinical course and outcomes

Final outcomes were: five dead patients, seven transferred to COVID-19 hospital, nine discharged at home after 14 days of isolation in the dedicated ward, three discharged at home or in nursing home in isolation, one discharged, and then readmitted to the COVID-19 reference hospital. Complications occurred in 16 patients. One patient developed a postoperative infection (Table 10).

With regard to the deceased patients, the following common features were identified: All patients were over 74 years old with multiple comorbidities, all were tested negative for NP and OP swabs, four out of five had suspected CT

Table 8 Patients management and ICU access

	Orthopedics surgery	Date of operation	Surgery time (h)	Antibiotics post-op	Need for pre-op ICU	Need for post-op ICU	LMWH use	Transfusion
No. 1	Total hip arthroplasty	28/02/2020	2:20	Cefamezin (for cooling symptoms)			Yes	1
No. 2	Herniectomy and posterior vertebral arthrodesis L3-L4	09/03/2020	2:53		No	No	Yes	No
No. 3	Hip hemiarthroplasty	10/03/2020	1:20	Tazocin (for urinary infection)	No	No	Yes	No
No. 4	Lleg amputation and revisions	11 & 27/03/2020 & 14–04-2020	01:30 & 00:20 & 01:00	Tazocin	No	No	Yes	No
No. 5	Cotile reimplantation	17 & 20/03/2020	01:55 & 1:20	No	No	No	Yes	6 bag post-op
No. 6	Hip hemiarthroplasty	19/03/2020	1:40	Tazocin—> Klacid—> Meropenem	No	No	Yes	4
No. 7	Osteosynthesis intramedulary rod	17/03/2020	0:50	No	No	No	Yes	No
No. 8	Osteosynthesis intramedulary rod	18/03/2020	1:07	Tazocin + claritromicina	No	No	Yes	2
No. 9	Osteosynthesis intramedulary rod	19/03/2020	1:10	Tazocin	No	No	Yes	3
No. 10	Distal radius external fixator	24/03/2020	1:44	clindamicina—> levoxacin	No	No	Yes	No
No. 11	Total hip arthroplasty	26/03/2020	1:07	No	No	No	Yes	No
No. 12	CT osteosarchoma	24/03/2020			No	No	Yes	No
No. 13	Surgical wound revision	27/03/2020	0:23	Tazocin + clindamicina	No	No	Yes	No
No. 14	Hip hemiarthroplasty	26/03/2020	1:00	Tazocin + claritromicina	No	No	Yes	No
No. 15	Osteosynthesis intramedulary rod	30/03/2020	0:40	Tazocin + Claritromicina	No	No	Yes	1
No. 16	Osteosynthesis intramedulary rod	06/04/2020	1:34		No	No		
No. 17	Posterior artrodesis 5 levels	03/04/2020	4:40	Tazocin for suspected **HAP**—> Azitromicina	No	Yes, orthopedic reason, 3 days	Yes	2

Table 8 (continued)

	Orthopedics surgery	Date of operation	Surgery time (h)	Antibiotics post-op	Need for pre-op ICU	Need for post-op ICU	LMWH use	Transfusion
No. 18	Embolization & arthrodesis 3 levels lumbar spine	01–02/04/2020	7:27	Tazocin	No	Yes, orthopedic reason, for 4 day	Yes	No
No. 19	Total hip arthroplasty	31/03/2020	0:30	Tazocin + azitromicina + Linezolid	No	No	Yes	2 bag post-op
No. 20	Hip hemiarthroplasty	01/04/2020	1:07	azitromicina + ceftriaxone – ceftriaxone > Meropenem	No	No	Yes	2
No. 21	Hip hemiarthroplasty	03/04/2020	2:20	No	No	No	Yes	2
No. 22	Plate and screws osteosynthesis	03/04/2020	1:12	No	No	No	Yes	2
No. 23	Not done							
No. 24	Osteosynthesis intramedullary rod	04/04/2020	1:12	No	No	No	Yes	2
No. 25	Decompression and arthrodesis post 4 levels	11/04/2020	1:40	Tazocin + Linezolid	No	Yes, orthopedic reason, 2 days	Yes	No
TOT				15		3 for orthopedic	24	12

outcomes, although all had typical symptoms, especially desaturation requiring oxygen therapy, and in two patients also to CPAP. For this reason, four patients underwent antibiotic therapy, but none underwent a specific therapy for COVID-19. Laboratory data showed a common tendency to lymphopenia. Moreover, all the patients that died had the infection during March 2020.

Discussion

This study describes the characteristics of suspected and confirmed COVID 19 patients managed at a dedicated Orthopedic and Traumatology facility in Italy. Patients are a consecutive cohort of emergency and trauma patients, managed according to the institutional guidelines produced at the beginning of the pandemic.

Patient's characteristics and comorbidities

The majority of the positives patients were women. This characteristics may be related to the fact that among the 25 patients there were more women than men. Patients analyzed in this study showed an advanced age and multiple comorbidities. Most of them were affected by fractures. The association of these factors alone may increase the risk of complications and mortality [11]. Considering that COVID-19 affected this patient's category, the coexistence of patient characteristics, fracture and infection may have led to an exponential increase in mortality [12]. The most represented comorbidities among COVID-19 patients reported in this study are the same described by the literature: hypertension, cardiovascular diseases, diabetes mellitus, smoking, COPD, malignancy, and chronic kidney disease [13].

Clinical presentation

There was no difference in symptoms between confirmed positive and suspected CT scan patients. Symptoms reported in this study were similar to those described by the literature [12]. However, fever, cough, and dyspnea are common features in any type of pneumonia, which would explain the high prevalence of interstitial pneumonia on CT scan in an orthopedic ward. As a matter of fact, it should be considered that postoperative pneumonia in patients operated for femoral fracture occurs in about 4.9% of cases [14], probably due to the inflammatory stress that depresses the immune system [15].

Table 9 COVID-19 treatment

COVID treatment	Oxygen inhalation	Niv	Imv	Antiviral therapy	Antibacterial therapy	Hydroxy-chloroquine therapy	Steroid therapy
No. 1				Oseltamavir	Claritromicina		
No. 2	Yes	Yes			Tazocin + levoxacin		
No. 3	Yes	Yes					
No. 4							
No. 5	Yes	Yes					
No. 6	Yes	Yes	Yes				
No. 7							
No. 8	Yes	Yes	Yes				
No. 9	Yes	Yes	Yes				
No. 10	Yes	Yes					
No. 11	Yes	Yes	Yes			Plaquenil	
No. 12							
No. 13					Claritromicina	Plaquenil	
No. 14						Plaquenil	
No. 15	Yes	Yes				Plaquenil	
No. 16	Yes	Yes			Levoxacin + clari-tromicina—> Levoxa-cin + Meropenem		
No. 17	Yes	Yes	Yes	Darunavir		Plaquenil	Yes
No. 18	Yes	Yes	Yes	Rezolsta	Azitromicina	Plaquenil	
No. 19	Yes	Yes with resevoire					
No. 20	Yes	Yes					
No. 21	Yes	Yes					
No. 22	Yes	Yes	Yes		Tazocin + linezolid		
No. 23	Yes	Yes			Tazocin + azitromicina	Plaquenil	
No. 24	Yes	Yes			Azitromicina + tazocin	Plaquenil	
No. 25	only in post-op	Yes			No	Plaquenil	Yes
Total	19	19	7	3	8	9	2

Considering the 14 femoral fractures, out of the suspected COVID-19-related pneumonia, only two patients had positive swabs, while eight had suspect CT scan; two had false positive CT scan, being affected by COPD exacerbation and cardiopulmonary congestion. Other two suspected patients had not a positive confirmative test; therefore, half of the cases with femoral fractures may have developed a postoperative pneumonia [14].

Predictive role of swab tests and CT scan

Swab tests performed were positive only in nine patients, while CT scans suspected for COVID-19 pneumonia were 22 (considering whole suspected CT scans, including the simultaneous presence of the positive swab). This discrepancy may be related to a lower swabs test sensitivity compared to the one reported by the literature (about 97%) [16] or to a tendency to over-diagnose COVID-19 pneumonia utilizing HRCT [17].

Those who reported a history of exposure to COVID-19 patients, or those who were considered as suspected at the ER evaluation, did not necessarily developed a positive swab. The time required to make the diagnosis was quite variable, ranging from one to 13 days, with a delay in the diagnosis greater for patients confirmed by the swab test, although attributable to a longer time needed for the swab's response compared to CT. In 13 patients the diagnosis was suspected or confirmed only after surgical procedure, since a greater exposure to the inflammatory stress intrinsic to operation could depress the immune system, so as to expose subjects to a greater risk of COVID -19 transmission or promoting the development of symptoms in infected patients.

Table 10 Clinical course data. Deaths are highlighted in Italic

	Date of admission	Date of discharge	Lenght of stay (day)	Other compliances during hospitalization	Clinical outcome
No. 1	27/02/2020	11/03/2020	13	Hyperglycemia episode	Stable conditions, transferred to COVID hospital
No. 2	04/03/2020	15/03/2020	11	No	Stable conditions, transferred to COVID hospital
No. 3	09/03/2020	18/03/2020	9	Urinary infection	Stable conditions, transferred to COVID hospital
No. 4	10/03/2020	28/04/2020	49	Stamp necrosis	Good condition, transferred to orthopedic ward cause 2 negative buffer and no symptoms after 14 days of isolation, after discharge at home
No. 5	14/03/2020	23/03/2020	9	Other hip dislocation	Good condition, discharge in another COVID unit
No. 6	15/03/2020	/	29	Vertebral fracture L1. Heart failure, acute renal failure (ARF) on CKD	*Died on 13 April cause of cardiac arrest*
No. 7	16/03/2020	23/03/2020	7	No	Good condition at discharge, but develops symptoms and is admitted to COVID hospital
No. 8	17/03/2020	01/04/2020	15	Urinary infection (E.Coli)	Good condition, discharge in nursing home
No. 9	18/03/2020	31/03/2020	13	BPCO flare	Good condition, discharge at home
No.10	21/03/2020	27/03/2020	6	Episode of desaturation in the emergency room for which he is hospitalized	Good condition, isolation at home
No. 11	24/03/2020	01/04/2020	8	post-op anemia with ischemic ECG alterations	Good condition, discharge in another COVID unit
No.12	24/03/2020	25/03/2020	1	No	Good condition, after negative swab discharge at home
No.13	25/03/2020	24/04/2020	30	No	Asymptomatic for more 14 days from symptoms, discharge at home
No. 14	26/03/2020	14/04/2020	19	No	Asymptomatic after spent 14 days of isolation, discharge at home isolation
No. 15	28/03/2020	24/04/2020	27	No	Asymptomatic after spent 14 days of isolation, transferred to nursing home
No. 16	28/03/2020	/	10	Silent AMI (cardiac marker positive)	*Died on 07 April cause of respiratory failure and AMI*
No. 17	30/03/2020	23/04/2020	24	Deep vein thrombosis (DVT) for which caval filter is positioned pre-op	Stable conditions, transferred to COVID Hospital
No. 18	31/03/2020	09/04/2020	10	Renal function impairment during ICU and fever	Good condition, discharge in another COVID unit
No. 19	31/03/2020	/	7	Phases of AF rhythm, multiple episodes of desaturation	*Died on 06 April cause of respiratory distress*
No. 20	31/03/2020	09/04/2020	10	AF rhythm	Good condition, discharge in nursing home
No. 21	01/04/2020	/	3	No	*Died on 04 April cause of cardiac arrest*
No. 22	02/04/2020	/	21	Multiple atrial fibrillation episode, psychomotor agitation and multiorgan worsening	*Died on 23 April cause of psychophysical decay*
No. 23	03/04/2020	20/04/2020	17	No	Asymptomatic after spent 14 days of isolation, discharge at home

Table 10 (continued)

	Date of admission	Date of discharge	Lenght of stay (day)	Other compliances during hospitalization	Clinical outcome
No. 24	04/04/2020	20/04/2020	16	No	Asymptomatic after spent 14 days of isolation, discharge at home
No. 25	11/04/2020	/	in progress		Stable conditions
TOT				16	*Five died*

Main laboratory findings

Laboratory data analysis showed that COVID-19 patients had anemia, leukocytosis, neutrophilia, lymphopenia, and thrombocytosis. Furthermore, sporadic alterations in coagulation and in liver and kidney function have been observed. However, anemia is a common condition in surgically treated orthopedic patients, and alterations of the leukocyte formula were reported even before surgical procedure and in correspondence to the symptoms in three patients.

Many studies converge on the uniqueness of the laboratory data, also proposing to utilizing blood results as a diagnostic support for rt-PCR, observing recurrent alterations in positive patients [18], including WBC, CRP, AST, and ALT [19]. In our study, all the nine positive swabs patients showed with alterations such as those reported in the other studies. Moreover, swabs positive patients showed alterations in LY, PLT, and ALP, especially lymphopenia recurred in seven of nine patients with positive swab test, while it was found in six of the 16 suspected cases. Zeng et al. took these parameters into account stating that severe COVID-19 patients had more neutrophils and fewer lymphocytes cells [20].

Patient's management and ICU access

Elderly patients with hip fractures and multiple comorbidities take advantage of being subjected to surgery as soon as possible, within 48 h: this allows for early mobilization, reduced bed rest, better pain control, and reduced complications including deep vein thrombosis, pneumonia, and overall mortality [21, 22]. In this cohort of consecutive trauma patients, surgical procedure was performed in hemodynamically stable subjects, with an oxygen saturation higher than 90%. The performance of this selection, as suggested by some recent studies [23, 24], may have contributed to obtain a favorable outcome, comparable to non-COVID patients.

The institutional protocol of anti-thromboembolic prophylaxis, administered to all the orthopedic patients at the authors' institution could have contributed to the reduction of mortality rates and complications of the COVID-19 infection, as suggested by a recent study [25].

Considering the different therapy patterns utilized among the 25 patients, there were no significant differences on the time taken for symptom regression (ranging from three to 14 days) or on the negative turn of the swab (more than 14 days). In particular, therapy with hydroxychloroquine or azithromycin did not show advantages over other drugs or pharmacological therapeutic abstention, in agreement with the most recent randomized studies [26, 27].

Clinical course and outcomes

Three patients had delayed surgical procedure (beyond three days from admission) because of respiratory symptoms onset. Out of these, two died at first and 25th days after surgical procedure, respectively. The other three deaths occurred at first, seventh, and 20th days from surgical procedure. This variability does not allow to establish whether surgical procedure was significant to influence the prognosis, but according to the results of this study (Table 5), surgical procedure may represent a risk factor for COVID-19 infection to become symptomatic, by depressing the immune system [15]. Deceased patients had several risk factors of poor outcome including age, type of fracture, and multiple comorbidities [12]. Moreover, since all the five patients had negative test for swabs and the diagnosis of COVID-19 was performed on the evidence of interstitial-alveolar pneumonia by HRCT, doubts may arise on the role of COVID-19 infection.

The number of discharges reported in this study is greater than 52% compared to the literature. On the other hand, the number of deaths reach 20%, compared to 5% of the international studies [28].

In the current report, 18 of the 25 patients developed a presumed nosocomial COVID-19 infection (Fig. 2). A possible risk factor may have been the initial unpreparedness of the staff in patient's management, denounced by the fact that most of the cases date back to the month of March (first period). In these patients, the long time required to make the diagnosis, which in 13 cases was carried out after surgical procedure, may have played a role.

Strengths of this study are represented by the consecutive patient's enrollment, of which a complete set of data is retrieved by the medical charts. Main limitations are the relatively small group of patients, the absence of control group, the heterogeneity of comorbidities, and the lack of a standard for pharmacology treatment.

Conclusions

This present paper reports the clinical and laboratory characteristics of suspected and diagnosed consecutive COVID 19 patients managed at a single institution during the first pandemic period. This present study may contribute to the ability of doctors in approaching such patients. The development of a patient management algorithms allows the differentiation of the clinical pathways of negative and suspected/positive patients, reducing exposure, and virus spreading. Patient management protocols implemented beginning late April allowed an earlier diagnosis, since the swabs were performed to all new admitted patients. Further research is required to optimize treatment strategies, establish shared protocols and gain a better understanding on COVID-19 patient's characteristics and possible risk factors related to trauma surgery.

Acknowledgements The authors acknowledge all the nurses and health care staff who took care of patients during this dramatic period.

Funding No funding was received for this study.

Data availability Code availability Not applicable.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Consent to participate and publication All the patients provided their informed consent at admission on data collection and reporting.

References:

1. Cucinotta D, Vanelli M (2020) WHO declares COVID-19 a pandemic. Acta Bio-Medica Atenei Parm 91:157–160. https://doi.org/10.23750/abm.v91i1.9397
2. Paterlini M (2020) On the front lines of coronavirus: the Italian response to covid-19. BMJ 368:m1065. https://doi.org/10.1136/bmj.m1065
3. Zagra L, Faraldi M, Pregliasco F et al (2020) Changes of clinical activities in an orthopaedic institute in North Italy during the spread of COVID-19 pandemic: a seven-week observational analysis. Int Orthop. https://doi.org/10.1007/s00264-020-04590-1
4. Grassi A, Pizza N, Tedesco D, Zaffagnini S (2020) The COVID-19 outbreak in Italy: perspectives from an orthopaedic hospital. Int Orthop. https://doi.org/10.1007/s00264-020-04617-7
5. Leti Acciaro A, Montanari S, Venturelli M et al (2021) Retrospective study in clinical governance and financing system impacts of the COVID-19 pandemic in the hand surgery and microsurgery HUB center. Musculoskelet Surg. https://doi.org/10.1007/s12306-021-00700-3
6. Faldini C (2020) Reorganization of the Rizzoli Orthopaedic Institute during the COVID-19 outbreak. Musculoskelet Surg 104:227–228. https://doi.org/10.1007/s12306-020-00688-2
7. Chughtai M, Gwam CU, Mohamed N et al (2017) The Epidemiology and Risk Factors for Postoperative Pneumonia. J Clin Med Res 9:466–475. https://doi.org/10.14740/jocmr3002w
8. Abdelmalek A, Crowther M (2021) Olecranon fractures in the elderly during the COVID-19 pandemic: Is non-operative treatment reasonable? Review of the current evidence. Musculoskelet Surg. https://doi.org/10.1007/s12306-021-00699-7
9. Rothe C, Schunk M, Sothmann P et al (2020) Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. N Engl J Med 382:970–971. https://doi.org/10.1056/NEJMc2001468
10. Chen Z-Y, Wu H-Z, Zhu P, Feng X-B (2015) Postoperative changes in hemoglobin and hematocrit in patients undergoing primary total hip and knee arthroplasty. Chin Med J (Engl) 128:1977–1979. https://doi.org/10.4103/0366-6999.160620
11. Lizaur-Utrilla A, Lopez-Prats FA (2020) Hip attack for hip fractures: is ultra-early surgery necessary? Lancet Lond Engl 395:661–662. https://doi.org/10.1016/S0140-6736(20)30156-2
12. Zhu Y, Chen W, Xin X et al (2020) Epidemiologic characteristics of traumatic fractures in elderly patients during the outbreak of coronavirus disease 2019 in China. Int Orthop. https://doi.org/10.1007/s00264-020-04575-0
13. Emami A, Javanmardi F, Pirbonyeh N, Akbari A (2020) Prevalence of underlying diseases in hospitalized patients with COVID-19: a systematic review and meta-analysis. Arch Acad Emerg Med 8:e35
14. Lv H, Yin P, Long A et al (2016) Clinical characteristics and risk factors of postoperative pneumonia after hip fracture surgery: a prospective cohort study. Osteoporos Int J Establ Result Coop Eur Found Osteoporos Natl Osteoporos Found USA 27:3001–3009. https://doi.org/10.1007/s00198-016-3624-5
15. Zhang P, Xia G, Dai L et al (2019) Laryngoscope-assisted and cotton ball wiping methods in prevention of oral and pulmonary infection in patients receiving mechanical ventilation and the influence on hypersensitive C-reactive protein and procalcitonin. Exp Ther Med 18:531–536. https://doi.org/10.3892/etm.2019.7614
16. Castro R, Luz PM, Wakimoto MD et al (2020) COVID-19: a meta-analysis of diagnostic test accuracy of commercial assays registered in Brazil. Braz J Infect Dis Off Publ Braz Soc Infect Dis 24:180–187. https://doi.org/10.1016/j.bjid.2020.04.003
17. Hernigou J, Cornil F, Poignard A et al (2020) Thoracic computerised tomography scans in one hundred eighteen orthopaedic patients during the COVID-19 pandemic: identification of chest lesions; added values; help in managing patients; burden on the computerised tomography scan department. Int Orthop. https://doi.org/10.1007/s00264-020-04651-5
18. Ferrari D, Motta A, Strollo M et al (2020) Routine blood tests as a potential diagnostic tool for COVID-19. Clin Chem Lab Med. https://doi.org/10.1515/cclm-2020-0398
19. R, Ahmadi Vasmehjani A, Zali F, et al (2020) Laboratory Parameters in Detection of COVID-19 Patients with Positive RT-PCR; a Diagnostic Accuracy Study. Arch Acad Emerg Med 8:e43
20. Zeng F, Li L, Zeng J, et al (2020) Can we predict the severity of coronavirus disease 2019 with a routine blood test? Pol Arch Intern Med 130:400–406. https://doi.org/10.20452/pamw.15331
21. Ravi B, Pincus D, Wasserstein D et al (2018) Association of overlapping surgery with increased risk for complications following hip surgery: a population-based, matched Cohort Study. JAMA Intern Med 178:75–83. https://doi.org/10.1001/jamainternmed.2017.6835
22. Merloz P (2018) Optimization of perioperative management of proximal femoral fracture in the elderly. Orthop Traumatol Surg

Res OTSR 104:S25–S30. https://doi.org/10.1016/j.otsr.2017.04.020
23. Mi B, Chen L, Xiong Y et al (2020) Characteristics and Early Prognosis of COVID-19 Infection in Fracture Patients. J Bone Joint Surg Am 102:750–758. https://doi.org/10.2106/JBJS.20.00390
24. Catellani F, Coscione A, D'Ambrosi R et al (2020) Treatment of proximal femoral fragility fractures in patients with COVID-19 during the SARS-CoV-2 outbreak in Northern Italy. J Bone Joint Surg Am. https://doi.org/10.2106/JBJS.20.00617
25. Tang N, Bai H, Chen X et al (2020) Anticoagulant treatment is associated with decreased mortality in severe coronavirus disease 2019 patients with coagulopathy. J Thromb Haemost JTH 18:1094–1099. https://doi.org/10.1111/jth.14817
26. Rosenberg ES, Dufort EM, Udo T et al (2020) Association of treatment with hydroxychloroquine or azithromycin with in-hospital mortality in patients with COVID-19 in New York State. JAMA. https://doi.org/10.1001/jama.2020.8630
27. Mahévas M, Tran V-T, Roumier M et al (2020) Clinical efficacy of hydroxychloroquine in patients with covid-19 pneumonia who require oxygen: observational comparative study using routine care data. BMJ 369:m1844. https://doi.org/10.1136/bmj.m1844
28. Li L-Q, Huang T, Wang Y-Q et al (2020) COVID-19 patients' clinical characteristics, discharge rate, and fatality rate of meta-analysis. J Med Virol. https://doi.org/10.1002/jmv.25757