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RESEARCH ARTICLE

Acute Effect of Combined Manual Therapy and Therapeutic Exercise *versus* Short-Acting Bronchodilator on Ventilatory Function in Patients with COPD

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ARTICLE HISTORY

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Abstract: ***Background***: Manual Therapy has recently gained popularity and interests from health care providers in the field of Pulmonary Rehabilitation programs for COPD patients as it has proved to have great health and clinical benefits. Additional benefits in clinical outcomes may be obtained by adding therapeutic exercise to manual therapy.

Objective: The aim of this research was to study the acute effect of combined myofascial release based-manual therapy for pectoralis minor muscle and therapeutic strengthening exercises for shoulder depressors and scapular adductors, compared to the effect of a single administration of short-acting bronchodilator in COPD patients.

Method: Fifty four male patients with COPD were equally divided into two groups; group A (n=27) received one physiotherapy treatment session combining pectoralis minor muscle myofascial release and therapeutic strengthening exercises for shoulder depressors & scapular adductors, while group B (n=27) received an inhaled short-acting bronchodilator for one time. Measurement included ventilatory function as the main outcome, and chest expansion & Verbal Descriptor Scale (VDS) of muscle pain as secondary outcomes.

Results: FEV_1, FVC, MVV, chest expansion, and VDS of pectoralis minor muscle tightness pain significantly improved only in group A ($P < 0.05$). Nevertheless, there was no statistically significant difference between the two groups except for VDS.

Conclusion: a single physiotherapy intervention of myofascial release-based manual therapy combined with therapeutic exercise has succeeded to induce some clinical benefits in patients with COPD. This protocol may represent an alternatively novel physiotherapy intervention that can be included in pulmonary rehabilitation programs for COPD patients.

Keywords: COPD, manual therapy, myofascial release, pulmonary rehabilitation, therapeutic exercise, ventilatory function.

1. INTRODUCTION

In Egypt, chronic Obstructive Pulmonary Disease (COPD) is a real health problem associated with a growing prevalence of morbidness and an increased number of deaths [1]. COPD patients show continuous use of accessory muscles of respiration as a compensatory mechanism to overcome their feeling of breathlessness, which leads to shortening and tightness of these muscles in the long-term. The pectoralis minor muscle as an example, though seems insignificant; the shortening of which with consequent tightness of the adjacent cervicothoracic fascia can lead to significant abnormalities in chest wall mechanics such as forward head position, protraction of shoulders and increased thoracic kyphosis [2-4]. This further leads to more shortening and tightness of pectoralis minor muscle and fascia.

Recently, manual therapy has proved to be very beneficial in improving many health outcomes in COPD patients [5-12]. Myofascial release based-manual therapy might have contributed to producing clinically remarkable improvements in ventilatory function and subjective feelings of dyspnea and fatigue in COPD patients [11, 12]. Myofascial release based-manual therapy for pectoralis minor has not been included before in manual therapy protocols implemented for COPD patients.

Furthermore, the addition of manual therapy to exercise therapy led to better improvements in dyspnea, forced vital

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Table 1. Baselines of patients' characteristics in the two groups.

Variables	Group A (Physiotherapy Intervention Group) (n=27)	Group B (Bronchodilator Intervention Group) (n=27)
Age (yrs)	50 ± 3	50 ± 2.9
BW (kg)	68.98 ± 7.7	68.5 ± 7.9
BMI (kg/m^2)	24.2 ± 1.7	24 ± 1.8
FEV_1 (litres)	1.45 ± 0.4	1.2 ± 0.27
FVC (litres)	2.3 ± 0.5	1.99 ± 0.40
MVV (litres/min)	49.6 ± 14.6	45.95 ± 10.89
Chest Expansion (Cm)	1.52 ± 0.75	1.40 ± 0.50
VDS Pain	4.96 ± 1.65	4.9 ± 1.7

All data are presented as means ±standard deviation. BW, Body Weight ; BMI, Body Mass Index; FEV1, Forced expiratory volume in the first second; FVC, Forced vital capacity; MVV, Maximum voluntary ventilation; VDS, Verbal Descriptor Scale

capacity, and walking distance in patients with COPD [13]. Drug therapy interventions such as beta 2 agonist bronchodilators have been clinically used to increases in forced expiratory flow, and to relieve symptoms of dyspnea and exercise intolerance in patients with COPD [14].

Therefore, the main purpose of this study was to investigate the acute effect of physiotherapy session composed of myofascial release based-manual therapy for pectoralis minor muscle and therapeutic exercise for shoulder depressors and scapular adductors in patients with stage I and II COPD; on ventilatory function, chest expansion, and Verbal Descriptor Scale (VDS) of pectoralis minor muscle tightness pain. The secondary purpose was to compare the effect of this physiotherapy session to the effect induced by bronchodilator therapy on the same outcomes.

2. METHODS

This study had started in December 2016 and ended in October 2017. It was conducted in the Department of Chest Diseases at the Hospital of Banha University, Qalyubia Governorate, Egypt.

2.1. Ethical Consideration

The protocol of this study was approved by the Ethics Committee of Human Scientific Research of the Faculty of Physical Therapy, Cairo University. Patients provided their consents for participation at the beginning of the study.

2.2. Subjects

Fifty-four patients diagnosed with COPD were enrolled in this research by referral from Department of chest disease at the Hospital of Banha University, Qalybia, Egypt. The patients included in the study were males with stage I or II COPD patients determined according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria (*i.e.* Stage I: $FEV_1 \geq 80\%$ predicted, stage II: $50\% \leq FEV_1 < 80\%$ predicted) [15], and/or with clinically stable conditions. The patients of stage III or IV COPD (*i.e.* $FEV_1 < 50\%$ predicted) were excluded. The patients were also excluded if they were obese, having any contraindication to spirometry, having cognitive disability that might affect their understanding of the measurement or intervention procedures, and/ or neuromuscular or musculoskeletal disease affecting respiratory muscles.

Patients who were eligible for this research were allocated by convenience and equally divided into two groups; group A or the physiotherapy intervention group (n=27). This group received a single session of myofascial release for pectoralis minor muscle plus strengthening exercises for shoulder depressors and scapular adductors. The second group is group B or the drug intervention group (n=27). This group did receive a single administration of inhaled bronchodilator. Baselines of patients' characteristics in the two groups are listed in Table **1**.

2.3. Measurements

2.3.1. Demographic Data

Ages of patients were obtained.

2.3.2. Anthropometric Characteristics

Body weight (BW), and height were measured. The Body Mass Index (BMI) was calculated as follows: BMI = Body weight / height in meters squared [16].

2.3.3. Ventilatory Function (Primary Outcome)

Spirometry was performed according to guidelines described by Moore, 2012 [17]. Measurements of forced expiratory volume in the 1st second (FEV_1), forced vital capacity (FVC) and maximum voluntary ventilation (MVV) were taken before and after the interventions.

2.3.4. Chest Expansion Measurement (Secondary Outcome)

To measure chest expansion, the patient was instructed to breathe in maximally as much as possible and then to breathe out maximally. Then, the difference between chest girth at maximal inhalation and maximal exhalation was assessed by a tape at the level of nipples [18]. These measurements were taken before and after the interventions.

2.3.5. Verbal Descriptor Scale (VDS) for Pain (Secondary Outcome)

Self-report of pectoralis minor muscle tightness pain was done by using Verbal Descriptor Scale (VDS). It was used as a quick, valid, and reliable scale for the description of pain intensity upon palpation of pectoralis minor muscle region. All patients were told to verbally describe and score their muscle tightness pain intensity before and after the intervention, where 0 score indicated no pain and 10 score indicated extreme pain [19].

2.4. Treatment Interventions

2.4.1. Physiotherapy Intervention (Manual Therapy & Therapeutic Exercise)

A single physiotherapy treatment session was implemented for patients in group A, including myofascial release based-manual therapy applied only to pectoralis minor muscle followed by therapeutic strengthening exercises for shoulder depressors and scapular adductors [20, 21]. For myofascial release therapy, the maneuver was modified from McEvoy, and Dommerholt [20] as follows; (1) at first, the patient was positioned in a relaxed supine position on treatment table. His shoulder was abducted 90 degree, then one hand of the physiotherapist applied a down pressure on the coracoid process to stabilize the scapula, while the other hand grasped the patient's arm. Afterwards, while keeping the downward pressure applied to the coracoids process, the patient was instructed to take in deep inhalation. At the time, the patient breathed in maximally. A superior-lateral pressure was applied on the coracoid process to push it away from the rib cage, thus inducing widening of the chest. Then, a 3-5 seconds end inspiratory hold was emphasized before slow exhalation took place. This procedure was done three times/ session with increasing the duration of the end-inspiratory hold up to 15-20 seconds. (2) In addition, Trigger Point Compression Release was added if there was persistent tension or tenderness in the pectoralis minor muscle. The finger pads were used to apply for compression & release at muscle trigger points just beneath the pectoralis major muscle over the third, fourth, and fifth ribs. For therapeutic exercises, strengthening exercises of shoulder depressors (*i.e*. Lower Trapizius, latissimus dorsi, and pectoralis minor) and scapular adductors (*i.e.* Rhomboids major and minor, and middle trapizius) were conducted as follows; (1) to strengthen shoulder depressors, **t**he patient was positioned in sitting position at the edge of the treatment table; then he was instructed to press with his hands downward against the treatment table to elevate the waist from the treatment table while maintaining both elbows straight; (2) to strengthen scapular adductors, the patient was instructed to retract his scapulae and to approximate his shoulder blades as much as possible; (3) strengthening exercises were accompanied by a hold for 30 seconds, and were repeated 10 times [21].

2.4.2. Drug Intervention (Short-Acting Bronchodilator)

A single-dose of inhaled $beta_2$ agonist short acting bronchodilator (Salbutamol) was administered for patients in group B. The patients had to fully exhale, spray the short-acting bronchodilator (1 puff), take in slow deep inhalation until reaching total lung capacity, hold the breath for 5-10 seconds, and exhale.

2.5. Statistical Analysis

The raw data were assessed for normality at first by using Shapiro-Wilk normality test (web version**)** [22]. All data had shown normal distribution, thus parametric statistics were used to analyze the data. Changes within each group before and after the study were analyzed by Paired samples t-test, and Un-paired two-sample t-test was used to compare the variables between the two groups either at baseline or after the study. Values of $P < 0.05$ were considered as statistically significant. Statistical analysis was executed by using Graph Pad Prism software.

3. RESULTS

Baselines for both groups were similar with no significant difference found between them, as shown in Table **1**. After completion of the study, as shown in Table **2**, the results were; (1) in group A (physiotherapy intervention group), there were statistically significant differences in the measured primary and secondary variables after intervention compared to baseline values; (2) in group B (Bronchodilator intervention group), there was no statistically significant change in any of the measured outcomes after intervention compared to baseline value; (3) upon comparison between the two groups after interventions, there were no significant differences between both groups except for VDS pain score.

4. DISCUSSION

To our knowledge, this study is the first one to include a myofascial release based-manual therapy applied only to pectoralis minor muscle and not to any other accessory muscles of respiration. The major findings of this study can be summarized as follows; (a) a single physiotherapy session including pectoralis minor myofacsial release therapy and strengthening exercises of shoulder depressors & scapular adductors was very successful in inducing statistically significant ($p<0.05$) improvements in forced expiratory volume in the first second (FEV_1), forced vital capacity (FVC), maximum voluntary ventilation (MVV), chest expansion, and VDS of pectoralis minor muscle tightness pain; in patients with COPD. (b) Besides being statistically significant ($p<0.05$), the improvement in forced expiratory volume in the first second (FEV_1) was clinically significant as well (*i.e.* $\Delta > 10\%$). As there was an improvement in FEV_1 from 1.45±0.4 to 1.65 ±0.4 Liter, which was above the minimum clinically important difference (MCID) of 100-140 mL defined in COPD [23]. (c) A single administration of short-acting bronchodilator had induced improvement in ventilatory function but such improvement was not statistically significant. There were also non-significant changes in the other outcomes. (d) Between the two

Table 2. Results of the two Groups after the Interventions.

Variables	Group A (Physiotherapy Intervention Group) (n=27)			Group B (Bronchodilator Intervention Group) (n=27)		
	Pre	Post	Δ	Pre	Post	Δ
FEV_1 (litres)	1.45 ± 0.4	1.65 ± 0.4*	↑13.8%	1.2 ± 0.27	1.32 ± 0.4	↑10%
FVC (litres)	2.3 ± 0.5	2.64 ± 0.4*	↑14.8%	1.99 ± 0.40	2.17 ± 0.6	↑9%
MVV (litres/min)	49.6 ± 14.6	55.28 ± 14.9*	↑11.5%	45.95 ± 10.89	50.13 ± 12.3	↑9%
Chest Expansion (Cm)	1.52 ± 0.75	3.74 ± 0.98	↑146%	1.40 ± 0.50	1.5 ± 0.55	↑7%
VDS Pain	4.96 ± 1.65	0.37 ± 0.79*§	↓92.5 %	4.9 ± 1.7	4.8 ± 1.6	↓2%

All data are presented as means ±standard deviation.
Δ, relative mean change; FEV1, Forced expiratory volume in the first second; FVC, Forced vital capacity; MVV, Maximum voluntary ventilation, VDS, Verbal Descriptor Scale.
* : Statistically significant difference within group (Paired samples t-test, $p < 0.05$)
§: Statistically significant difference between the two groups (Unpaired two-sample t-test, $p < 0.05$)

interventions, there was no significant difference in the measured outcomes except for VAS score.

Engel *et al*. [13], investigated the effects of a 4-weeks period of manual therapy combined with exercise therapy in patients with COPD. They showed that adjoining manual therapy to exercise therapy in the treatment of COPD patients had induced a favorable improvement in Forced Vital Capacity (FVC). Despite that our treatment protocol is totally different from their one, the notion of combining two interventions to maximally attain the most desirable final outcomes is supported by our findings. Our findings considering improved forced expiratory volume in the first second (FEV_1) and forced vital capacity (FVC) may come in accordance with Yelvar *et al*. [11]. They had shown that myofascial release therapy applied to the main and the accessory muscles of respiration might have helped with other manual therapy forms in inducing improvement in the FEV_1 and forced vital capacity in patients with COPD. There is evidence which reinforces the possibility that improvement in ventilatory function could be due to correcting shortening of pectoralis minor muscle. As it has been reported that the length of pectoralis minor muscle was positively correlated with FEV_1 in COPD patients, it has been also suggested that any intervention implemented to increase pectoralis minor muscle length can possibly induce improvements in ventilatory function [24]. Based on that, the most likely explanation for the improved ventilatory function in physiotherapy group patients who had received combined manual and therapeutic exercise could be a synergistic effect resulting from both interventions. That is, myofascial release based-manual therapy had eased up restrictions and adhesions in pectoralis minor muscle & fascia with resultantly increased muscle length; this is together with therapeutic strengthening exercises which had stabilized shoulder and scapular muscles with the resultant maintenance of the gained muscle length. Thus, the net result would be elongating pectoralis minor muscle to a satisfactory length sufficient to induce significant improvement in ventilatory function.

It is not surprising that combined manual and therapeutic exercise intervention led to acute improvement in chest expansion. It has been well-known that myofascial release eases connective tissue tension, increases flexibility and elasticity of soft tissues, and lengthens the muscles, all of which could be attributed to reduced tonicity in muscle and connective tissue or increased temperature and circulation of restricted regions of soft tissues and/or fascia [21]. Thus, we do think that myofascial release therapy for pectoralis minor had loosened up restrictions in the muscle and surrounding tissue, and thus reduced chest tightness and allowed for more freedom of thoracic cage movement with resultantly increased chest expansion. In addition, strengthening scapular adductors and shoulder depressor played an important role in the postural correction of abnormal thoracic mechanics such as protracted shoulder or thoracic kyphosis, which in turn additionally promoted greater widening of the thoracic cage and allowed for more chest expansion.

Our last finding is that VDS scores, of pectoralis minor muscle tightness pain, were reduced significantly in physiotherapy group. This was in accordance with earlier literature indicating that myofascial release therapy can effectively reduce muscle pain [25-28]. The mechanism for this may be because myofascial release therapy can remove pressure from pain sensitive tissues after releasing fascial restrictions and softening extracellular matrix [29]. Also, myofascial release therapy could have increased blood flow and speeded up circulation to the restricted parts, this might have removed waste products and pain chemical substances from painful areas, and delivered more oxygen and nutrients [21].

Limitations of this study may include the inability to separately determine the contribution of either myofascial release based-manual therapy or therapeutic exercise to the ultimate results of the study. This is because application of both interventions in the same treatment session has made it difficult to recognize the individual effect of either intervention. Also, using only male participants and inclusion of patients with stage I and II COPD only, limit the generalizability of our findings to other COPD patients with different characteristics. Furthermore, chest expansion could not be measured digitally because the device was unavailable and instead it was measured by a simple tape, thus the precision of chest expansion assessment might have been affected.

CONCLUSION

In conclusion, physiotherapy intervention combining manual therapy and therapeutic exercise has proved to produce significant clinical benefits for patients with COPD, in terms of improvements in ventilatory function, chest expansion and muscle tightness pain relief. These observations need to be considered when designing alternative physiotherapy protocols adopted in pulmonary rehabilitation programs for patients with COPD. Despite the clinical benefits from our physiotherapy intervention, additional short-term studies are needed to confirm such benefits, and long-term studies are recommended as well to confirm the sustainability of our findings.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The protocol of this study was approved by the Ethics Committee of Human Scientific Research of the Faculty of Physical Therapy, Cairo University.

HUMAN AND ANIMAL RIGHTS

No Animals were used for studies that are base of this research. All human procedures were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Human subjects used in the study provided informed consent to participate.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

REFERENCES

[1] Said AF, Ewis AA, Omran AA, Magdy ME, Saleeb MF. Prevalence and predictors of chronic obstructive pulmonary disease among high-risk Egyptians. Egypt J Bronchol 2015; 9: 27:33.

[2] Orozco-Levi M. Structure and function of the respiratory muscles in patients with COPD: Impairment or adaptation? Eur Respir J Suppl 2003; 46:41-51.

[3] Dias C, Kirkwood R, Parreira V, Sampaio R. Orientation and position of the scapula, head and kyphosis thoracic in male patients with COPD. Can J RespTher 2009; 45: 30-4.

[4] Weinstock D, editor. NeuroKinetic therapy: An innovative approach to manual muscle testing. Berkeley California: North Atlantic Books; 2010.

[5] Noll DR, Degenhardt BF, Johnson JC, Burt SA. Immediate effects of osteopathic manipulative treatment in elderly patients with chronic obstructive pulmonary disease. J Am Osteopath Assoc 2008; 108: 251-59.

[6] Noll DR, Johnson JC, Baer RW, Snider EJ. The immediate effect of individual manipulation techniques on pulmonary function measures in persons with chronic obstructive pulmonary disease. Osteopath Med Prim Care 2009; 3: 9.

[7] Dougherty PE, Engel RM, Vemulpad, S, Burke J. Spinal manipulative therapy for elderly patients with chronic obstructive pulmonary disease: A case series. J Manipulative Physiol Ther 2011; 34: 413-41.

[8] Zanotti E, Berardinelli P, Bizzarri C, *et al.* Osteopathic manipulative treatment effectiveness in severe chronic obstructive pulmonary disease: A pilot study. Complement Ther Med 2012; 20: 16-22.

[9] Rocha T, Souza H, Brandão DC, *et al.* The manual diaphragm release technique improves diaphragmatic mobility, inspiratory capacity and exercise capacity in people with chronic obstructive pulmonary disease: A randomised trial. J Physiother 2015; 61: 182-89.

[10] Engel RM, Gonski P, Beath K,Vemulpad S. Medium term effects of including manual therapy in a pulmonary rehabilitation program for chronic obstructive pulmonary disease (COPD): A randomized controlled pilot trial. J Man ManipTher 2016; 24: 80-9.

[11] Yelvar GDY, Çirak Y, Demir YP, Dalkilinç M, Bozkurt B. Immediate effect of manual therapy on respiratory functions and inspiratory muscle strength in patients with COPD. Int J Chron Obstruct Pulmon Dis 2016; 11: 1353-57.

[12] Cruz-Montecinos C, Godoy-Olave D, Contreras-Briceño FA, *et al*. The immediate effect of soft tissue manual therapy intervention on lung function in severe chronic obstructive pulmonary disease. Int J Chron Obstruct Pulmon Dis 2017; 12: 691-96.

[13] Engel RM, Vemulpad SR, Beath K. Short-term effects of a course of manual therapy and exercise in people with moderate chronic obstructive pulmonary disease: A preliminary clinical trial. J Manipulative Physiol Ther 2013; 36: 490-96.

[14] Kesten S, Casaburi R, Kukafka D, Cooper CB. Improvement in self-reported exercise participation with the combination of tiotropium and rehabilitative exercise training in COPD patients. Int J Chron Obstruct Pulmon Dis 2008; 3: 127-36.

[15] From the Global Strategy for the Diagnosis, Management and Prevention of COPD, Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2017. Available from: http://goldcopd.org.

[16] World Health Organization (WHO): Technical Report Series. Obesity: Preventing and managing the global epidemic. Report of WHO consultation. WHO Tech Rep Ser 2000; 894: 1-253.

[17] Moore VC. Spirometry: Step by step. Breathe 2012; 8: 232-40.

[18] Cunha BA, Ed. Infectious diseases in critical care medicine. New York: Marcel Dekker; 1998.

[19] Edelen MO, Saliba D. Correspondence of verbal descriptor and numeric rating scales for pain intensity: An item response theory calibration. J Gerontol: Series A 2010; 65A: 778-85.

[20] McEvoy J, Dommerholt J. Myofascial trigger points of the shoulder. In: Donatelli R, Ed. Physical Therapy of the Shoulder. St Loius: Elsevier Churchill Livingstone; 2012, pp. 362- 66.

[21] Karageanes SJ, Ed. Principles of Manual Sports Medicine.1st ed. Philadelphia: Lippincott Williams & wilkins; 2005.

[22] Shapiro SS, Wilk MB. Analysis of variance test for normality (complete samples). Biometrika 1965; 52: 591-611.

[23] Cazzola M, MacNee W, Martinez FJ, *et al*. American Thoracic Society; European Respiratory Society Task Force on outcomes of COPD. Outcomes for COPD pharmacological trials: from lung function to biomarkers. Eur Respir J 2008; 31: 416-69

[24] Morais N, Cruz J, Marques A. Posture and mobility of the upper body quadrant and pulmonary function in COPD: An exploratory study. Braz J Phys Ther 2016; 20: 345-54.

[25] Castro-Sánchez, AM, Matarán-Peñarrocha GA, Arroyo-Morales M, Saavedra-Hernandez M, Fernandez-Sola C, Moreno-Lorenzo CC. Effects of myofascial release techniques on pain, physical function, and postural stability in patients with fibromyalgia: A randomized controlled trial. Clinical Rehabilitation 2011; 25: 800-13.

[26] Arun B. Effects of myofascial release therapy on pain related disability, quality of sleep and depression in older adults with chronic low back pain. Int J Physiother Res 2014; 2: 318-23.

[27] Hosseinifar M, Namvar H, Olyaei G, Moghadam BA. Effect of myofascial release technique on pain, disability, maximum isometric contraction of the extensor muscles, and pressure pain threshold in patients with chronic nonspecific neck pain: Double blinded randomized clinical trial. IJMRHS 2016; 5: 500-6.

[28] Arguisuelas MD, Lisón JF, Sánchez-Zuriaga D, Martínez-Hurtado I, Doménech-Fernández J. Effects of myofascial release in nonspecific chronic low back pain: A randomized clinical trial. Spine (Phila Pa 1976) 2017; 42: 627-34.

[29] Davis CM, Doerger C, Rowland J, Sauber C, Eaton T. Myofascial release as complementary in physical therapy for two elderly patients with osteoporosis and kyphoscoliosis: Two case studies. J Geriatr Phys Ther 2002; 25: 33.